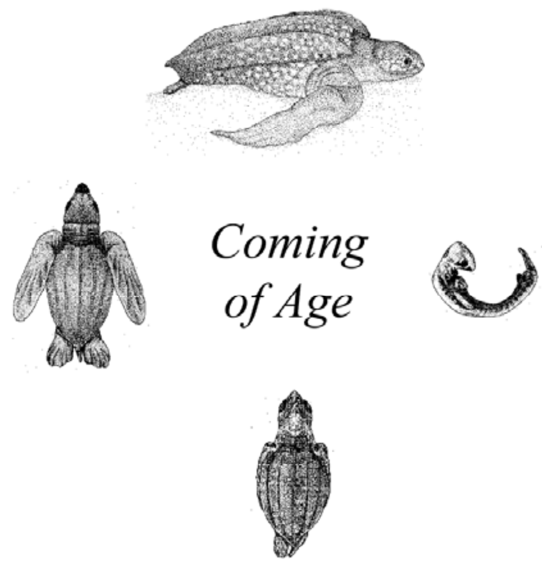
NOAA Technical Memorandum NMFS-SEFSC-528

PROCEEDINGS OF THE TWENTY-FIRST ANNUAL SYMPOSIUM ON SEA TURTLE BIOLOGY AND CONSERVATION



24 to 28 February 2001
Philadelphia, Pennsylvania, USA

Compiled by:
Michael S. Coyne & Randall D. Clark

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, FL 33149 USA

April 2005

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U.S. DEPARTMENT OF COMMERCE
Carlos M. Gutierrez, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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NATIONAL MARINE FISHERIES SERVICE
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NOTICE

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PRESIDENT'S REPORT

Overview

I am pleased to report that the 21st Annual Symposium on Sea Turtle Biology and Conservation was a great success. Beginning with the Latin American Reunion at the Pocono Environmental Education Center on 20-22 February, continuing with regional meetings and a wonderful Telemetry workshop on 22-23 February, continuing through the stimulating symposium itself and ending with workshops and six wonderful field trips on Wednesday 28 February all participants were fully engaged and energized. The snowfall in the Poconos and in Philadelphia on Thursday the 22nd gave an added touch for our tropical visitors. Fortunately it cleared off so that the meeting went on as scheduled. The large meeting space gave everyone room to gather and talk both formally and informally. A good time seemed to be had by all.

A total of 802 biologists, conservationists, scientists, managers, community members and local residents attended the Symposium. Of these, 124 were members of the indigenous Philadelphia community. We are a unique gathering because we are not only scientists and managers, but are also the people who live with sea turtles. Our approach has always been to include the indigenous people in an area in our projects. That is why I am particularly pleased that so many school children (50 from West Philadelphia and 21 from the suburbs) along with their teachers, parents and friends participated in the Symposium. That will have a long-term effect in their lives and in conservation both locally and nationally. In addition, local singers and artists joined us as well. This was a very diverse gathering. In all there were participants from 57 nations from around the world representing all continents except Antarctica.

Some new things were successful. To compensate for our large size we changed format. We had 86 oral presentations, of which one was a keynote talk, 5 were invited talks, and 16 were for the special leatherback session. Therefore, most papers were delivered as posters (293) in a large venue on high quality poster-boards, with the coffee breaks and vendors in the same room and meeting tables as well. That worked very well. The workshops were very successful with the Telemetry workshop attracting 200 people and the major telemetry companies. The full size leatherback turtle model and diorama made by the students of Carl Sandburg Middle School were very popular, well attended and the source of many fine photographs. It provided a chance for a full-scale PIT tagging demonstration and comparison of techniques as well as the source of ABC television coverage of the symposium. We were pleased to see how successful the Panel Discussions became. Excellent summary statements were delivered and the entire process is summarized in this Proceedings volume.

Volunteers

Thank you to all those people who made this a successful symposium. This is a wonderful organization; a unique organization and all who help are special souls. Because I have already thanked many people by name in the President's Report that was in the Marine Turtle Newsletter and due to the need to conserve space in the proceedings I am not listing your names here. However, that does not take away from my great gratitude to you all for your help.

Business

There was important business conducted at the Symposium. First, there were 8 resolutions passed by the assembly. These have been forwarded to the appropriate officials to whom they were addressed. The Resolutions themselves are posted on the Symposium web site.

Second and of great importance, the business meeting passed a resolution changing the "Annual Sea Turtle Symposium" into a "Sea Turtle Society." This was done to facilitate year around activities of our large organization. It was necessary due to the expanded nature of our commitments and the need for greater activity in the area of sea turtle conservation.

Financial Considerations

The new Society is on sound financial ground. Income and expenses balanced. It is important to keep in mind the tenuous nature of the finances for the Symposia this year and in the past. Most scientific and business meetings charge a registration fee of from $250 to $1500 for each attendee. Even the Ecological Society of America and herpetological societies are at a cost of $250 per person. This covers rental of meeting space, refreshments, invited speakers, printing, management, etc. This year we raised the fee for the Symposium to about $40. We also received generous support from the David and Lucile Packard Foundation ($132,000), the US National Marine Fisheries Service, Office of Protected Species ($10,000), the US Navy ($5,000), Drexel University ($3,000 plus staff, etc), the Center for Marine Conservation ($2,500), Sunoco ($2000), and Verizon Communications ($500 in kind). This is a total of $154,000 or $192 per attendee. Our Symposium is heavily subsidized. It is not likely to continue to be supported in this manner in the future. Therefore, we must be aware that we will have to raise the registration fee to cover the actual cost of the meeting. The registration fee needs to be a minimum of $80 per person That would give the organizers the opportunity to prepare an excellent meeting without having to spend all waking moments finding a few dollars to make ends meet.

Final Comments

As I pass on this office to our new president, Earl Possardt, I would like to thank all of you for the great honor that you have given to me in electing me to be your president for the 21st Symposium. It was a pleasure to serve and I look forward to a smooth transition. I pledge my full cooperation to Earl as he undertakes this adventure. Good luck and best wishes.

James R. Spotila, Ph.D.

COMMITTEES, CHAIRS, AND KEY ORGANIZERS

Registrar	Sam Sadove
Registration Coordinator	Donna Broadbent
Program	Amanda Curtin, Anika McKessey, Megan Griffin, Frank Falkenstein, Bryan Franks, Jocelyn Behm, Candice Patel
Program Committee	Pamela Plotkin, Richard Reina, Frank Paladino, Edward Standora, James Spotila
Local Committee	James Spotila (Chair), Jocelyn Behm, Barbara Bell, Walter Bien, Amanda Curtin, Francis Falkenstein, Bryan Franks, Megan Griffin, Lene Hendriksen, Janet Hochella, Barabara Interlandi, Heather Kalb, Anika McKessey, Richard Reina, Vince Saba, Pam Sotherland, Paul Sotherland, Susan Weiler, Christy Wojeculewski
Posters	Amanda Curtin and Vince Saba
Audio/Visual	Peter Bennett
Travel Committee	J. Nichols (Chair), Ana Barragan and Jeffrey Seminoff (Latin America), Karen Eckert (Caribbean), Brendan Godley (Europe and Africa), Nicholas Pilcher (Asia and Pacific), Alan Bolten (USA and Canada)
Transportation	Vince Saba, Bryan Franks, Frank Falkenstein
Historian	Barbara Schroeder
Parlimentarian	Frank Paladino
Logo	Barbara Bell
Auction	Rod Mast, Jennifer Homcy
Resolutions	Jack Frazier, Sali Bache
Entertainment	James Spotila
Thing Committee	James Spotila, Barbara Schroeder, Megan Griffin, Frank Paladino
Volunteer Coordinator	Heather Kalb
Field Trips	Walter Bien
Vendors	Tom McFarland
Nominations Committee	Randall Arauz (Chair), Robert George, Ed Standora, Jennifer Homcy, Jack Frazier
Student Awards	Anders Rhodin
Leatherback Session	Frank Paladino
Latin Reunion	Clara Padilla, Roxana Silman
Ask Vince	Vincent Saba

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STUDENT AWARDS

There were 104 student presentations (27.6% of all presentations) – 23 papers (27.4% of all papers) (16 biology, 7 conservation), 81 posters (27.6% of all posters) (47 biology, 34 conservation). $3250 awarded to 8 recipients (7.7% of all students). Awards Committee (14 members): Anders G.J. Rhodin (Chair), Ana R. Barragán, Lisa Campbell, Marydele Donnelly, Brendan J. Godley, William P. Irwin, Colin J. Limpus, Stephen J. Morreale, Wallace J. Nichols, Nicolas J. Pilcher, Richard D. Reina, Edward A. Standora, Blair Witherington, Jeanette Wyneken.

Oral Presentations

Best Biology Oral Presentation
Philippe Rivalan, M. Girondot, and A.-C. Privot-Hulliard. Estimation of tag loss and annual survival rates of leatherback turtle, *Dermochelys coriacea*, in French Guina. (Université de Paris, France). $500.

Runner Up Biology Oral Presentation
Susanna Clusella Trullas and F.V. Paladino. Energetics during the dispersal of olive ridley sea turtle hatchlings (*Lepidochelys olivacea*) using the doubly labeled water method. (Indiana Purdue University, Fort Wayne, Indiana, USA). $250.

Best Conservation Oral Presentation
Sonja Macys. Conservation policy and stakeholder involvement: tilting the balance for marine turtles in Yucatan. (Colorado State University, Fort Collins, Cororado, USA). $500.

Posters Presentations

Best Biology Poster Presentation
Maricela A. Constantino and M. Salmon. Prey detection by leatherback hatchlings. (Florida Atlantic University, Boca Raton, Florida, USA). $500.

Runners Up Biology Poster Presentations
Dale Youngkin and J. Wyneken. A long-term dietary analysis of loggerhead sea turtles (*Caretta caretta*) from Cumberland Island, Georgia. (Florida Atlantic University, Boca Raton, Florida, USA). $250.
Sadie S. Coberley, L.H. Herbst, L.M. Ehrhart, D.A. Bagley, S. Hirama, S.A. Schaf, R.H. Moretti, E.R. Jacobson, and P.A. Klein. Derological detection of herpes virus infections in marine turtles. (College of Medicine, University of Florida, Gainesville, Florida, USA). $250.

Best Field-Based Conservation Poster Presentation
Brian Riewald, A.B. Bolten, K.A. Bjorndal, and H.R. Martins. Effects of longline hooking on dive behavior and mortality of oceanic stage juvenile loggerhead sea turtles (*Caretta caretta*). (University of Florida, Gainesville, Florida, USA). $500.

Best Socio-Economic Conservation Poster Presentation
Florence C. Evacitas, C.J.L. Ty, J.G. Diola, and J.G.L. Sisican. Understanding behaviors toward sea turtle conservation of local communities in Hilabaan and Tikling, eastern Samar, Philippines. (University of the Philippines, Cebu, Philippines). $500.

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LEADERSHIP FOR THE FUTURE

Facilitator and Session Chair:

Amy Squires
John F. Kennedy School of Public Policy, Harvard University, Cambridge, MA

Two leadership panels took place at the Symposium. One was composed of senior researchers and conservationists who had contributed a lifetime of work to sea turtles. The other was composed of junior researchers and conservationists who are beginning a lifetime of work in sea turtle biology and conservation. Both panels provided insights into sea turtle biology and conservation and lessons that they had learned. Breakout sessions allowed the entire symposium to participate in discussions of the ideas generated by the panels. Presented below aree summaries of the panel presentations and lessons learned by both the panels and the symposium participants. We hope that this exchange will generate new ideas and discussion of sea turtle biology and conservation at future symposia.

Mature Adults: How We Did It

Panelists:

David Ehrenfeld, Professor of Biology, Ecology, Evolution and
Natural Resources, Rutgers University, New Brunswick, NJ, USA

John R. Hendrickson, Professor Emeritus, Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, AZ, USA

Henri A. Reichart, Interim Program Director for WWF-US in Suriname (retired)
WWF Senior Technical Advisor to Suriname Forest Service (1989-1998)
San Rafael, CA, USA

Jack Woody, International Sea Turtle Coordinator (retired), US Fish and Wildlife Service, Albuquerque, NM, USA

John Hendrickson spoke about his experiences in turtle conservation on the Malay Peninsula. The local community was eating the turtles and harvesting eggs from the nesting beach. John believed that he needed to pursue turtle conservation within the context of the communities' cultural attitude toward turtles—that is, that they are food. He worked with members of the Sultan's government to establish a management arrangement for the turtles. The local community was guaranteed a certain number of eggs each season, a number John considered reasonable to sustain a viable population.

Henry Reichart spoke about his work in Suriname to ranch green sea turtles. In that case, the local community had been harvesting the eggs, threatening the population. The challenge was finding a middle-ground conservation approach, between unrestrained use on the one hand and complete protection on the other. Henry worked with the local community to establish ranching facilities for the turtles, using members of the community in different roles. What Henry did not realize, until later, was that the community had a sophisticated caste system, and the assignments he had given different individuals did not reflect the caste order. This created contention within the community and undermined the success of the ranching effort.

Jack Woody spoke about his work with US Fish & Wildlife Service. Jack has worked to be the field scientists' ally within the bureaucracy, trying to bridge the gap between agency management and line scientists. His comments underscored the importance of dealing with someone within an agency who really understands conservation and the nature of field work but also speaks the language of bureaucracy, understands the process, and can work the system so that good field work can get done. Conservation scientists would be wise to cultivate such an ally, through good communication and cooperation, if there is not an obvious one already in the agency or institution.

David Ehrenfeld spoke about the role of science and humans in conservation. He encouraged creative thinking in conservation research but also cautioned that conservationists continue to apply rigorous scientific principles and standards to their work. He spoke about the human element in conservation, encouraging conservationists to embrace it as essential, rather than an obstacle, to conservation.

Lessons learned:

- The human element in conservation can confound the very best science and research, so don't neglect it
- Because humans are an essential part of the conservation equation, it helps to like them
- Know the community in which you are working
    - Political: Who has power and makes decisions?
    - Cultural: How does the community structure itself (e.g., authority, castes, etc.); what are the cultural attitudes towards turtles, conservation, science, Westerners?
    - Commercial: Who gains from turtle use? Who will lose from conservation?
- Craft a conservation approach based on that context
- Choose your battles—where can you be effective without dissipating all good will and tolerance for your efforts
    - Be patient
    - It is OK to lose some battles, as long as you live on to win the war

New Recruits: Expectations For the Future

Panel Members:

Randall Arauz, Central American Director, Sea Turtle Restoration Project, Turtle Island Conservation Network, San José, Costa Rica

Ana R. Barragán Rocha, Principal Investigator, Proyecto Laúd- I. N. P., Mexico, D. F., Mexico

Alison Leslie, Department of Nature Conservation, University of Stellenbosch, Private Bag X1, Maiteland, 7600, South Africa

Kathleen L. Moran, Department of Zoology, University of Florida, Gainesville, FL USA

Jeffrey A. Seminoff, Archie Carr Center for Sea Turtle Research, Department of Zoology, University of Florida, Gainesville, FL, USA

Charles Tambiah, Projecto TAMAR-IBAMA, Salvador, Bahia, Brazil

Randall Arauz has been working in turtle conservation throughout Costa Rica. He spoke about his experience working with local fisheries to adopt TEDs as an alternative to traditional long line fishing. He explained how he worked very closely with the fishermen to explore and modify the technology to meet their needs, so that they would be adopting something that they helped create, rather than having something imposed on them. The Costa Rican fisheries are now using this approach. But Randall expressed frustration about the difficulty of getting such innovative technology adopted elsewhere. His comments point to one of the major challenges of conservation—that the most successful conservation solutions typically have to be home-grown. That, in turn, suggests that, while good ideas and lessons can be shared with conservationists elsewhere, they have to be used in a grassroots fashion--they need to be pollinated and developed locally for people to buy in to the ideas.

Alison Leslie spoke about her experiences in South Africa working in crocodile and turtle conservation. Much of Alison's work has been carried out in reserve areas in the Province of KwaZulu-Natal. When asked about the biggest, future challenge facing sea turtle conservation in Africa, Alison suggested that we need to start at least thinking about sustainable use of some sea turtle species. Her argument is that, unless a value is placed on an animal in Africa, no one is going to bother with its protection. Alison has observed some of the unanticipated problems of the government's conservation efforts. For example, the government created a number of parks to protect wildlife in the country, but in so doing dislocated villages in the process. Communities were pushed outside the boundaries of the park. They were forbidden to utilize the land in any way, including hunting, and their only source of protein was therefore removed. Now that sea turtle populations on the southeast coast of South Africa seem to have stabilized, Alison suggests that conservationists should consider sustainable use approaches that build the human element into the equation. Pure conservation, in terms of full protection, has limited viability in the face of human poverty and need.

Jeff Seminoff talked about human consumption and species viability. Jeff's work in Mexico suggests to him that human use is largely incompatible with conservation except in very few, well-monitored and controlled situations. Jeff's conservation efforts have emerged from his research—involving the community in the research has given him the opportunity to discuss conservation with community members. In doing so, Jeff has recognized that, if the community has a stake in the conservation—really has ownership of it—then success is much more likely. In particular, community ownership of conservation has the added benefit of internalizing the enforcement burden—instead of conservation being enforced on the community, the community will be more inclined to self-regulate/self-police, which completely shifts the nature of the conservation solution, making it truly local and home-grown and part of the local culture and values system.

Ana Barragan has been working with leatherbacks throughout Mexico and the Caribbean. Ana's particular interest is information sharing and communications. She recognizes that there are different audiences for conservation information and has focused on tailoring the "message" to meet the needs of the different audiences. For example, a federal official, a fisherman, a local village leader, and a school class all have very different perspectives and different information needs, but they are all part of the conservation equation and need to understand the conservation activities.

Kate Moran has been working in Florida and the Caribbean, with extensive work on green turtle grazing and the effects on seagrass beds. In conducting her research, Kate became more sensitized to the ecological context of turtle conservation. She has begun working with scientists in other disciplines to understand and address the big picture within which turtle conservation takes place.

Charles Tambiah spoke from his work in several countries in the Americas and Asia, primarily regarding community-based conservation and human-wildlife dimensions. He emphasized the importance of understanding the connection between biodiversity and cultural diversity, where successful conservation can only be accomplished when people are accepted as part of the solution and not just as part of the problem. He called for biologists to be more accepting of the importance of the social sciences in conservation, to learn from non-biologists and local people, to give value to local knowledge/science, to engage in simpler communications with others, and to respect local organizational approaches. He alluded to examples of places in which there would be no sea turtle recovery if not for the involvement of local communities, given that government agencies involved are short-staffed and under-funded. He also emphasized the acute need for addressing consumptive use of sea turtles from a multidisciplinary perspective, and considering each location on a case-by-case basis. He concluded with the understanding that there was no model for sea turtle conservation, as cultural and location specific solutions were required for long-term success.

Lessons learned:

- Good ideas should be shared universally, but successful conservation projects still have to be home-grown

- Tailor your approach to the needs and values of the individual community
- Nurture grassroots conservation so that it becomes more comprehensive—community ownership at the local level can lead to self-policing and the development of more formal laws and policies, to broaden the conservation ethic
- Share information with one another so that everyone can start to assemble the pieces into a big picture.
- Leverage resources through partnerships and communications
    - Work with leaders in different aspects of the community and culture
    - Work across disciplines, not just with turtlers

Facilitated Group Discussions
Discussion Leaders:

F. Alberto Abreu Grobois, Laboratorio de Conservacion y Manejo de Recursos Bioticos, Estacion Mazatlan, Instituto de Ciencias del Mar y Limnologia UNAM, Apdo. Postal 811 Mazatlan, Sinaloa Mexico C.P. 82000.

George Balazs, NOAA, National Marine Fisheries Service, Honolulu, HI, USA

Lisa Campbell, Department of Geography, University of Western Ontario, Ontario, Canada

Karen Eckert, WIDECAST, 17218 Libertad Drive, San Diego, CA, USA

Colin Limpus, Queensland Parks and Wildlife Service, Brisbane, Australia

Peter C. H. Pritchard, Chelonian Research Institute, 402 South Central Ave., Oviedo, FL, USA

Donna J. Shaver, U.S. Geological Survey, BRD, Padre island Field Station, padre Island National Seashore, Corpus Christi, TX, USA

Jeanette Wyneken, Department of Biological Sciences, Florida Atlantic University, 777 Glades Road, Boca Raton, FL 33431 USA

Lessons Learned:
- Coordinate, collaborate, communicate, and educate
- De-mystify the science—reach out to the community, in their language
- Be a good guest, not an “ugly scientist”
- Work cooperatively to change the culture around conservation
- Improve communications—consider the many different paths possible to different audiences and partners for your conservation work. Consider how to get the information out through different venues—peer reviews, the media, even popular literature.
- Push the science to inform management—integrate the scientists with the managers
- Turtle symposium should target managers as well—not just the practitioners
- Persist over time—you might lose some battles but still win the war
- Address overall habitat protection as a context for turtle conservation (beach, in-water)
- Science has fads that come and go—work with them, and keep them in the context of broader information-gathering and science
- Orient research towards what is needed, not just what is currently being funded. If you build it (a good idea and good case), they will come (the funding).
- Your research will offer lots of case-specific findings, but always look for lessons or generalities that might be shared more broadly
- Be willing to try a range of approaches—experiment with them, and measure their various success and failures, being sure to communicate both your successes and failures more broadly so that others can learn
- Try to engage a variety of methods, disciplines, approaches, philosophies, and ideas, with attention to the scale of the problem.
- There may be a tendency to swing to either people-oriented work or very isolated research communities—but the future is in solid research with community-level agendas and participation
- Prioritize and evaluate program resources, emphasizing and exploiting modern technologies without leaving less funded organizations or nations behind
- Conservation must be democratic, not imperialistic
- The future is in managing and sharing information, networking with others, doing our best to avoid constantly re-inventing the wheel
- Help people make the link between conservation goals (which you’ve worked with them to articulate), laws, and enforcement of the laws
- Be part of the solution
- There is a need for community-based control and decisions about resources, like the turtles
- Stop or reduce the “missionary zeal” of telling certain peoples that it is wrong to kill and eat turtles
- There is the challenge of dealing with highly urbanized people removed from the environment, on the one hand, versus those people who still must or view themselves to be predators
- Before:
    - Typically all male scientists forming a somewhat exclusive club
    - Doing pioneering work with lots of trial and error
    - Involved with government to establish appropriate legislation
    - Good communicators—“gift of the gab”
    - Taking a species-specific approach
- Now:

  - People/communities can be part of the solution
  - Much more horizontal work (as opposed to vertical with national governments) and building networks with different organizations and individuals
  - More concern about and engagement with communities to understand their knowledge and perspective
  - More holistic approach
  - De-mystifying the science, bringing it down to an understandable level and making sure it can meaningfully impact/support conservation (noted how Archie Carr was very good at this)
- Unchanged:
  - "Movers and shakers" are the ones that make a difference
- International waters should not be!
- "All conservation is local" (with apologies to that great American politician, Tip O'Neill)

PART I. ORAL PRESENTATIONS

KEYNOTE ADDRESS

35 YEARS OF TURTLE RESEARCH AND CONSERVATION, LESSONS FOR THE FUTURE

J. Whitfield Gibbons

University of Georgia, Savannah River Ecology Laboratory, Aiken, SC USA

For more than two decades, the SEA TURTLE CONFERENCE has been successful in all of the ways that any group of conservation ecologists should be successful. In fact, the record is so impressive that I have changed the title of my talk to WHY ARE SEA TURTLE PEOPLE SO SUCCESSFUL? First, you have achieved a rigorous research record that has contributed to understanding turtle biology, vertebrate biology, and a variety of biological principles. But from a conservation perspective, and equally as important, you have taken the research foundation and communicated not only to other scientists but to groups and individuals that can make an even greater impact on conservation - politicians, the general public, school children.

Sea turtle conservation is perhaps the most successful effort on a single taxonomic group ever, as measured by growth, influence, and effectiveness. In fact, you are so successful as an organization and a group of dedicated individuals that you are at that pinnacle where someone addressing you can only do one of two things that are productive. The first might be to tell you what you've done right and encourage you to keep doing it but I'm pretty sure you know what that is so I don't think I'll spend too much time on that aspect. The second thing you do with a successful organization is you ask them to help out in another area of conservation.

Partners in Amphibian and Reptile Conservation (PARC) is a recently developed initiative designed to address conservation of amphibians and reptiles, which of course includes sea turtles. PARC is poised to find the solutions to the problems faced by herpetofauna. People who have an agenda that in some way involves snakes, frogs, turtles, salamanders, lizards, or crocodilians should find out about PARC.

The PARC Mission Statement puts it succinctly:

To conserve amphibians, reptiles and their habitats as integral parts of our ecosystem and culture through proactive and coordinated public/private partnerships.

These beleaguered animals (which include all of the sea turtles) and their habitats at last have people on their side, in North America and the whole world. Reptiles and amphibians have been steadily disappearing from much of the United States and other countries during the past few decades. PARC is the answer to helping maintain the herpetofaunal component of our natural heritage and recovering some of what we have almost lost. Herpetofauna represent a major part of our natural heritage. If these animals are in trouble, we are in trouble. Reptiles and amphibians are sentinels of our environmental health. If they are declining and ultimately disappearing, we need to make amends. What happens to herpetofauna is a sign of what could happen to other wildlife, including sea turtles, and maybe even to us.

PARC has a vision of providing the remedies necessary to correct the environmental problems that confront this group of animals and their habitats. It may be the last chance we will have for us to assure that humans and herpetofauna can live harmoniously in today's world.

Check the PARC Web site (http://www.parcplace.org) and let us know if you want to participate (parc@srel.edu)

LEATHERBACK MINI-SYMPOSIUM

NESTING OF LEATHERBACK TURTLES IN GABON: IMPORTANCE OF NESTING POPULATION IS CONFIRMED

Alexis Billes[1] and Jacques Fretey[2]

[1] PROTOMAC, Cellule de coordination ECOFAC, BP 15115, Libreville, GABON, mailto:alexisbilles@multimania.com
[2] UICN-FFSSN Muséum national d'Histoire naturelle de Paris, 57 rue Cuvier 75231 Paris cedex 05 France, mailto:jfretey@imatech.fr

Following a first assessment of the status of sea turtles in Gabon in 1997, the European program ECOFAC (Ecosystèmes forestiers d'Afrique Centrale) financed in 1999-2000 a field survey to ensure regular methodical monitoring of sea turtle nesting activity on the Gabonese South West beaches. From November 1999 to April 2000, PROTOMAC (Protection des tortues marines en Afrique Centrale), a network coordinating projects for the conservation of sea turtles in Central Africa, conducted a first field survey named Nyamu Mission; Nyamu being the vernacular name of leatherback in local dialect Vili.

Gabon is a Western African country in the Gulf of Guinea and on the Equator : it is situated at latitude 2°30' north and 3°55' south, between the 9th and 14th meridians. It is bordered on the north by Equatorial Guinea and Cameroon, on the east and south by Congo and west by the Atlantic ocean. Gabon has an area of 267 667 km^2, 75% of it being covered by the Ogoue river basin and 85% by a dense equatorial forest. The Gabonese coast line stretches for nearly 950 km (with the exclusion of the lagoons), and has the specific characteristics of most tropical littorals with low sandy coasts prevailing over rocky ones. From 20 to 300 km wide, the sedimentary coastal basin stretches over 50,000 km^2 of dry land and stretches extensively over the continental shelf (Lebigre 1983).

The beaches in the north of the country where rocky parts alternate with muddy and sandy ones are not often frequented by leatherbacks. But, south of Libreville, nesting sites are to be found all along the coast. The long beaches of "La Pointe Pongara", a peninsula facing Libreville in the Gabon estuary, are regularly frequented but without any real concentration.

South of Port Gentil, the economic capital of Gabon, aerial surveys have confirmed that the littoral, which consists of narrow sandy beaches bordering lagoons of fresh or salt water, is a site of regular nesting for leatherbacks. Mass nesting is observed on the 100 km long beaches from the south of the town of Mayumba to the Congolese border (Billes 2000). Most of the length of the beaches is hemmed by the Atlantic ocean on one side and the Banio lagoon on the other side.

In 1998-1999, within the framework of the network PROTOMAC, a first field survey was carried out by a local NGO (Aventures Sans Frontières) with the financial support of ECOFAC: 148 leatherbacks were tagged (Sounguet & Moundemba 1999). In 1999-2000, a more extensive survey made by PROTOMAC and supported by ECOFAC allowed the monitoring of more than 96 km of beaches from the mouth of the Banio lagoon to Congo (Figure 1). The Nyamu Mission went from November 8, 1999 to April 25, 2000. The main objectives of this first Nyamu Mission were to obtain an estimate, as accurate as possible, of the extent of turtle activity along the whole site, to identify as many females as possible to carry out a survey over several years and to define the threats to the sea turtles frequenting this site in order to decide and undertake measures for their conservation.

A team stationed at a basic camp located approximately 50 km south of Mayumba on the dense creeping vegetation covering the back of the beach carried out on foot daily counts of nesting tracks along a 7 km stretch of beach, and weekly counts of an additional 20 km. In addition, nesting along the entire 96.5 km was surveyed every 15 days with an ATV (Figure 1). During these daytime ground surveys, slaughters of nesting females for meat and egg poaching were recorded. A total amount of 171 counts has been noted on the 7 km long stretch of beach, 30 on the 27 km zone and 10 on the total length of the beach. Data were also collected during nightly beach patrols made on the 7 km stretch of beach and nesting females were tagged using a double tagging with Monel tags. The daily count on the 7 km stretch of beach took place from November 8th, 1999 to April 25th, 2000 and allowed a registration of 4175 leatherback nesting crawls and 45 false crawls. The highest rate of nesting activity was noted over 4 weeks in January and during this time, we were able to count up to 107 crawls per night. On the 27 km stretch, on January 30th, we could record a peak of 270 nesting crawls of *Dermochelys coriacea*. The highest number of nesting crawls recorded on the entire area, from the mouth of the Banio lagoon to the Congolese border is of 454 counted on January 30th.

In south Gabon, the nesting season for *Dermochelys coriacea* seems to last from the month of October to the month of April. Moreover, according to counts noted, the highest level of nesting activity was observed in the second half of January.From the daily counts which took place on the 7 km zone we decided to construct 2 mathematical models to estimate the nesting activity throughout the mission on the 27 km zone and on the total zone of 96.5 km. We chose multilinear regression models which permit the exploration of the relations linking a response variable N (number of crawls on the 27 km stretch for the first model and number of crawls on the 96.5 km stretch for the second) to a series of predictor variables Xi. To select the variables we opted for a method choosing "automatically" a group of optimal variables: "stepwise regression". This method led us to select a model in the formula : $N= a + by + cz$, where N represents the average number of nesting crawls on day X on the 27 km zone for the first model or on the 96.5 km stretch for the second model, where Y represents the number of nesting crawls noted on the same day on the 7 km stretch patrolled daily and where z corresponds to the number of days separating day X from the date of the nesting peak; the former was fixed on the 30th of January from the results of the counts which were carried out on the 27 km zone. a, b and c are the coefficients calculated.

On the 27 km zone throughout the duration of the survey, the model permits us to estimate the nesting activity at 15 600 leatherback nesting crawls (from November to April).The histogram (Figure 2) presents this estimation by regrouping the number of crawls estimated per week; the week of the 24th to the 31st of January the number of leatherback crawls noted was 1438. For the 96.5 km stretch of beach, an histogram similar to the preceding one presents the estimations by regrouping the number of crawls estimated per week (Figure 3). The week of the 24th to the 31st of January, the number of nesting crawls of leatherback noted on the total zone was estimated at 2684. We can estimate throughout the survey a nesting activity of 29 700 nesting crawls of leatherbacks, compared with 9 500 throughout the last nesting season in French Guiana (Girondot pers. Comm.).

During nightly beach patrols on 7 km, 935 leatherbacks were tagged. 91 leatherbacks were seen again once, 17 twice and 2 three times. Even if the number of observations is still a little limited (n=132), we calculated an initial estimation of the internesting interval of about 10 days. The estimation of the clutch frequency per female is difficult to make for this season because the daily zone surveyed (7 km) is to limited in relation to the total site (96.5 km) and many females coming back to nest have certainly been missed. They may have come to nest in another zone or when there were no patrols. Nevertheless we are able to provide an approximate estimation of clutch frequency (ECF) calculated as follows:

+ only tagged turtles already noted, returning at least once, are taken into account,
+ in order to limit the effect of the tagging date, only the turtles tagged in November or December are considered,
+ the clutch frequency is calculated by dividing the number of days between the two extreme observation dates of the turtle by the internesting interval previously estimated at 10 days. The ECF thus obtained is of 4.183 (n=60, SD=1.909, range=2-11) which is inferior to the ECF calculated for the population of leatherback turtles in French Guiana (Fretey & Girondot 1989): 7.04. By using these two values of ECF (4.183 and 7.04) and the preceding estimation calculated of the number of nests throughout the season on the total site we have obtained an estimation of the breeding population of female leatherback turtles for the whole site between 4200 and 7100 individuals.

During the season 1999-2000, analysis of 49 natural nests carried out 2 to 3 days after the emergence of the hatchlings, permitted us to determine an average percentage of hatching success of 67.29% (n=49, SD=18.59, range=18.18-92.39). Eventhough a quantitative study of the predatory pressure of airborne predators on nests was not carried out, it seems that the predatory influences on leatherback eggs are essentially due to Ghost crabs which are sometimes quite numerous. Leatherback turtle eggs dug out by airborne predators are only rarely recorded.

As regards hatchlings, predatory influences represent the greatest natural threat in Mayumba. It is mainly due to Ghost crabs but predatory influences such as Mongooses, Genets and Civets seem to be regular predators victimizing essentially nocturnal hatchlings. Airborne predation is probably mainly due to storks.

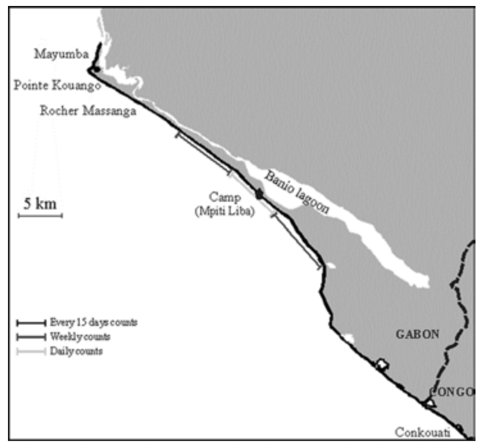
Poaching of leatherback eggs is a serious threat on the beaches close to Mayumba; in front of the city almost every nest seems to be harvested. Leatherback meat is mainly consumed by the inhabitants of Mayumba and of the two nearest villages. During the entire season, 93 carcasses of sea turtles were found, most of which having been killed by villagers on the sections of the beach near Mayumba. Local fishing practiced with nets especially takes place along the length of the coast near the fishing village of Mayumba. The impact of this activity as regards the accidental capture of marine turtles is not insignificant. More worrying, industrial trawlnet fishing is regularly practiced the length of the Mayumba coast to the border with Congo, very near the coast without respect for the legislation in force.

Offshore oil rigs are to be found of the coastal length of the site and we have noted regular wreckage on the beaches (every 10 to 15 days) of numerous tar balls and sometimes little spills. At this time we haven't yet observed turtle carcasses covered in oil.

The first estimation of the leatherback nesting population we made this season 1999-2000 confirms the international interest of the whole site for the species, especially in this period of growing concern about the survival of *Dermochelys coriacea* throughout the world.
For their monitoring, these Gabonese nesting beaches are actually inseparable from Congolese beaches that are an integral part of the coast of the Reserve de Faune de Conkouati (Congo) and that stretch from the border with Gabon to river Noumbi (whose mouth is located 27 km south of the border).

A partnership has to be made soon between Gabon and Congo in order to ensure the follow up of the study of the nesting sites in the entire area and in order to ensure a transborder monitoring of nesting activity from Mayumba to the river Noumbi.We recommend a transborder collaboration for a common and harmonious supervising scheme of this exceptional nesting zone and the creation of a Congo-Gabon transborder marine reserve.

Figure 1. The location of the site.



Acknowledgements:

We are grateful to the people who participated in the Nyamu Campaign in 1999-2000 and to the inhabitants of Mayumba who welcomed us. We thank the David and Lucile Packard Foundation and the Sea Turtle Symposium for accomodation support and IUCN France for travel support.

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Figure 2. Number of estimated leatherback nesting emergences per week on the 27 km zone from 8 November 1999-25 April 2000.

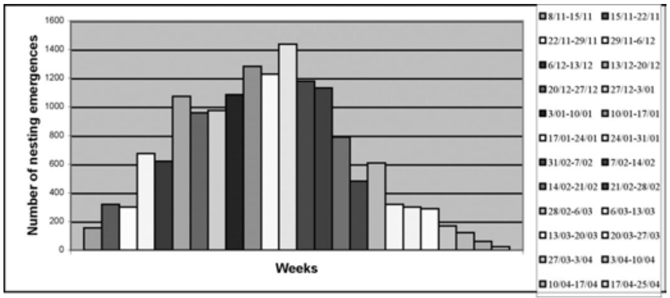
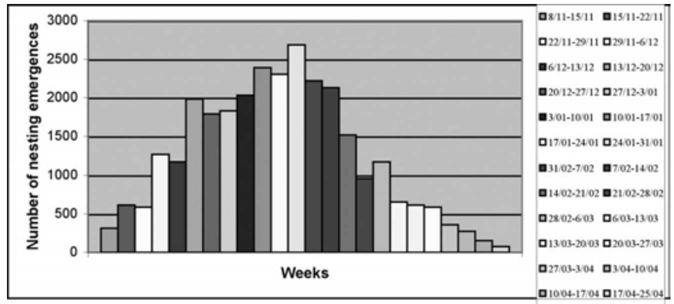


Figure 3. Number of estimated leatherback nesting emergences per week on the whole site (96.5 km) from 8 November 1999-25 April 2000.



INSIGHTS INTO EVOLUTION, STOCK STRUCTURE, MIGRATION AND MATING BEHAVIOR OF LEATHERBACKS GAINED FROM GENETIC STUDIES

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The rapid advances in molecular techniques have provided new tools to study aspects of population biology and behaviour that have been particularly challenging in leatherbacks. Some of the results have been surprising. Global analysis of genetic variation using mitochondrial DNA sequence data reveals that despite their ancient evolutionary history as a species, leatherbacks most likely underwent population extinctions during the last ice age that reduced the species to a single lineage that forms the basis of the extant populations worldwide. This paper will present the current state of our knowledge on geographic stock structure based on an integration of both mitochondrial and nuclear data and evaluate these findings as they relate to our understanding of migration and the theory of natal homing. The results of recent paternity studies and their implication to mating ecology will be presented. Development of new nuclear microsatellite markers have allowed genetic fingerprints to be compiled for almost all the females comprising intensively monitored populations, enabling sibling and possible mother-offspring relations to be identified. The implications for conservation of this species will be discussed, and potential applications for future studies will be outlined

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DISTRIBUTION AND STATUS OF THE LEATHERBACK SEA TURTLE, *DERMOCHELYS CORIACEA*, IN THE INSULAR CARIBBEAN REGION

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Identity

The leatherback or leathery turtle, *Dermochelys coriacea*, is the sole member of the monophyletic family Dermochelyidae (see Pritchard and Mortimer, 1999). The smooth black skin is mottled with pale spots and the strongly tapered, slightly flexible carapace is raised into seven prominent ridges. Adults have broad thermal tolerances and can exceed 1000 kg in weight. Temperate latitude foraging grounds provide Caribbean-nesting females with their preferred prey, including cnidarians (jellyfish, siphonophores) and tunicates (salps, pyrosomas). The specialized medusae diet placed the leatherback atop a distinctive marine food chain based on nannoplankton.

Nesting beaches are distributed circumglobally (approximately 40ºN-35ºS) and include the Caribbean Sea. Gravid females are

seasonal visitors to insular Caribbean nations, with observations largely confined to peak breeding months (February-July). Individuals generally nest on 2-5 year cycles, and mating is believed to occur prior to or during migration to the nesting ground. Females generally nest at 9-10 days intervals and deposit an average of 5-7 clutches/yr. After nesting, tag returns and satellite- tracking studies confirm that females depart the Caribbean basin for distant feeding grounds in the northern and eastern Atlantic Ocean.

Neither the dispersal patterns of hatchlings nor the behavior and movements of juveniles are known. Survivability, growth rate, age at maturity, and longevity in the wild have yet to be accurately determined.

Conservation Status

Classified as "Critically Endangered" by the World Conservation Union (IUCN), the species is fully protected by the region's only marine biodiversity treaty - the Protocol to the Cartagena Convention concerning Specially Protected Areas and Wildlife (SPAW, Annex II) and listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Other treaties relevant to the Wider Caribbean Region, including the Convention on the Conservation of Migratory Species (Bonn Convention) and the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere, also classify the species as needing special conservation measures.

Assessment Scope

The Tropical Northwestern Atlantic Province, bounded by Florida to the north and Amazonia (Brazil) to the south, includes the Gulf of Mexico, the Wider Caribbean basin, and the waters of the Guianas along the northern tier of South America. The Province is defined by five Marine Ecoregions (characterized by patterns of ocean circulation, coastal geomorphology, and the distribution of major faunal populations; see Sealey and Bustamante, 1999). These five Marine Ecoregions are: the Gulf of Mexico, the Bahamian Ecoregion, the Central Caribbean Ecoregion, the Lesser Antilles (Eastern Caribbean) Ecoregion, and the Guianas Ecoregion.

Three of these subregions embrace the 30 states and territories - English, Spanish, French and Dutch speaking - included in this status review of the "insular Caribbean region".

In geographic order, broadly from north to south, the Bahamian Ecoregion includes the Bahamas, and the Turks & Caicos Islands (U.K.). The Central Caribbean Ecoregion includes Cuba, the Cayman Islands (U.K.), Jamaica, Haiti, the Dominican Republic, Puerto Rico (U.S.), Trinidad & Tobago, and Aruba, Curaçao, and Bonaire (Netherlands). The Lesser Antilles (Eastern Caribbean) Ecoregion includes the Virgin Islands (U.S./U.K.), Anguilla (U.K.), Sint Maarten / St. Martin (Netherlands / France), St. Barthelemy (France), Saba (Netherlands), St. Eustatius (Netherlands), St. Kitts & Nevis, Antigua & Barbuda, Montserrat (U.K.), Guadeloupe (France), Dominica, Martinique (France), St. Lucia, Barbados, St. Vincent & the Grenadines, and Grenada.

To facilitate comparative analysis among this diverse array of range states, the following information was determined for each: (i) name and location of major nesting beaches; (ii) name and location of nesting beaches surveyed; (iii) survey effort or the frequency of monitoring (e.g., nightly, weekly, whenever the vehicle had gas) and longevity (how many years of data are available); (iv) type of data collected (e.g., crawls, confirmed nests, and/or tagged females); and (v) the estimated number of nests/yr. States were then characterized as having <25, 25-100, 100-500, or >500 nests/yr. Because females deposit 5-7 clutches per season in this region, the number of females can be estimated from the number of nests laid. For example, 100 crawls may represent 70 successful nests, and those 70 nests were most likely laid by 10-14 individual turtles.

Category I range states support <25 nests/yr (3-5 nesting females). Category II and III range states support 25-100 nests/yr (5-20 nesting females) and 100-500 nests/yr (20-100 nesting females), respectively, and are typical for the insular Caribbean. These states host cohesive local nesting assemblages that predictably utilize the island, and these assemblages are often, but not always described as depleted from historical levels. Category IV range states support >500 nests/ yr and are clearly important for the survival of the species. There are two geographic focal points for Category IV nesting: one in the north (Hispaniola-Puerto Rico-Virgin Islands) and one in the south (Trinidad & Tobago).

The review focused on a single life history stage: reproductively active adult females. There are no data on the distribution, abundance or behavior of males, juveniles or non-breeding females in the region, and no evidence (yet) that these life history stages predictably occur in the region.

RESULTS

The region boasts two uniquely long-term studies of saturation-tagged nesting assemblages (Sandy Point National Wildlife Refuge, USVI and Culebra Island, Puerto Rico), but for the most part the region's data are fragmentary, local survey efforts are inconsistent, and the terminology of reporting (e.g., "crawls" vs. "nests") is confusing.

Despite the challenges inherent in evaluating available data, it is clear that, with the exception of Trinidad (where an estimated 4,000 females deposit 20-30,000 clutches/yr), insular nesting is predictable but occurs nowhere in large numbers (by which we mean more than 1,000 nests or approximately 150 females/yr). There are no trend data for Trinidad, but as the consistency of Index Beach coverage increases, the coming years should provide insight into whether this important colony is rising or falling. Efforts by the Nature Seekers and other community-based groups have reduced the number of females killed each year to near zero (down from an estimated 30-50% per year on the east coast and near 100% on the north coast in the 1960's and 1970's), but high levels of incidental catch threaten to undo these gains.

The second focal point for Category IV nesting is the U. S. territories, and made all the more important because populations in both Puerto Rico and the U. S. Virgin Islands, where the species has been protected for more than three decades, are known to be increasing. At Sandy Point National Wildlife Refuge in St. Croix, an average of 26 females nested (with an average of 133 nests laid) each year between 1982-1986 and an average of 70 females nested (with an average of 423 nests laid) each year between 1995-1999, a near tripling over the course of two decades. Similar trends are seen at Culebra National Wildlife Refuge in Puerto Rico, where an average of 19 females nested (with an average of 142 nests laid) each year between 1984-1986 and an average of 76 females nested (with an average of 375 nests laid) each year between 1997-1999, a near quadrupling over the course of just 15 years.

The four Eastern Caribbean range states that support Category III nesting (100-500 nests/ yr) also play a critically important role in the survival of *Dermochelys* in the region. St. Lucia, St. Vincent & the Grenadines, Grenada, and St. Kitts & Nevis are characterized by good nesting habitat and healthy historical nesting levels that at least rival current nesting densities in St. Croix. These nesting assemblages have been severely depleted by an unregulated harvest of breeding adults, the widespread collection of eggs, and habitat destruction, such as by coastal sand mining and beachfront development. [Martinique and Guadeloupe (France) are also likely to support Category III nesting, but surveys have not been conducted.] If efforts to stabilize population declines in Category III states fail, the species will be reduced to only two primary breeding zones in the insular Caribbean (Category IV range states, see above), increasing its vulnerability to acts of man or nature.

Category I range states (<25 nests/yr) are unlikely to contribute meaningfully to the survival of the species in the region. Many of these states, including the Bahamian Ecoregion states of Bahamas and Turks & Caicos, and the Central and Eastern Caribbean Ecoregion states of Cuba, Cayman Islands, Jamaica, St. Eustatius, Saba, Bonaire, and Curaçao lack suitable habitat. Others, like Aruba, have seen local leatherback nesting reduced to zero over the course of the 1990's. In some cases (e.g., St. Martin, Antigua & Barbuda, Montserrat) we lack adequate data, but the best available information suggests that fewer than 25 nests/yr are laid. There is no current information on the extent of nesting in Haiti or the Dominican Republic.

DISCUSSION

The status of breeding colonies of *Dermochelys* in the insular Caribbean is mixed. On the one hand, closely monitored colonies under U. S. jurisdiction are increasing, clearly illustrating the benefits of protecting both turtles and critical habitat on a sustained basis. Numbers are also rising in the British Virgin Islands and Barbados, but these islands support known populations of fewer than 10 turtles each. Trend data are unavailable for Trinidad, the largest insular colony (roughly estimated at 4,000 females/yr), but hopes that the colony is stable are tempered by the fact that unsustainably high harvests were halted only a decade ago and the land-based harvest has now been replaced by a fisheries-based harvest. A minimum of 25% of nesters are accidentally ensnared in coastal gillnets each year and the associated mortality poses an immediate threat to the stability of the population.

For the rest of the region, it is clear that nesting populations have, on balance, experienced dramatic declines since World War II and that fully one-half of the 30 nations and territories in this review (i.e., all Category I states) have no virtually capacity to contribute to the survival of the species due to the near extirpation of local nesting colonies or a lack of adequate nesting habitat.

The survival of the species hinges on maintaining current trends in the U. S. territories, eliminating the fisheries threat in Trinidad, and minimizing ongoing threats in Category III range states. This will require an uncommon focus, especially in the smaller islands, which are often characterized by a complex mix of traditional use (oil, eggs), widespread habitat degradation, a culture of inadequate law enforcement, and relatively inaccessible habitats ill-suited for sustained protection and monitoring.

If we fail to change the status quo and fail to ensure the survival of gravid females on tropical Caribbean nesting beaches, there will be ecological ripple effects throughout the greater Atlantic ecosystem, as the apex predator of a unique marine food chain disappears. With fewer than five known "large" colonies (>1,000 nests/yr) left on Earth, it would seem prudent to act aggressively on the side of conservation and as soon as possible.

Acknowledgements:

We are deeply grateful to members of the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) and professional Fisheries personnel throughout the region for their participation in this extensive review. Dozens of published papers also provided valuable data. We sincerely regret that space constraints for this brief summary precluded a proper list of references. Detailed results, credits, and a complete bibliography will be published in the peer-reviewed journal, *Chelonia*n Conservation and Biology.

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STATUS AND NESTING OF *DERMOCHELYS CORIACEA* IN WEST AND CENTRAL AFRICA

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Dermochelys coriacea is the sea turtle with the largest geographic distribution throughout the Atlantic Coast of Africa. It is present in all countries from the Strait of Gibraltar to the Cape of Good Hope (although very rare in Macronesia and absent from Saint Helena). As with *Chelonia mydas*, its reproducing grounds extend from Mauritania to Angola.

In South America the focus zone for reproduction of the species includes Guyana and French Guiana (between 4° and 8° N) with a scattering of minor sites throughout the Caribbean and beyond Florida towards 30° N. An identical phenomenon is found in the eastern Atlantic, in western Africa, with a focus zone similarly covering approximately 4°of latitude from Gabon to the Congo (between the Equator and 4° S) and scattered among several minor sites extending almost to 13° S, and to the north to an extent currently unclear to scientists between 18°and 28° N.

Sightings of the species in Macronesia are rare, except perhaps in the Canaries where the bodies of turtles caught accidentally in industrial fishing nets wash up on the shore. If regular nesting in Lévrrier (Mauritania) is confirmed, this then would have to be the most northern location for the eastern Atlantic *D. coriacea* nests sporadically in various sites on the coast of Senegal, particularly on the Pointe de Sangomar and near Ndoss.

Although they are rarely sighted in Guinean waters, leatherback turtles may occasionally nest in the Bijagos Archipelago . A small nesting zone has been confirmed on the island of Sherbro (Sierra Leone). Monitoring of certain beaches in Liberia and west Cote d'Ivoire should show that regular nesting sites for Leatherbacks exist in the area. Nesting occurs all along the coast of Ghana. Nesting has been confirmed in Togo, Benin and Nigeria.

Nesting remains to be confirmed on beaches in northern Cameroon in the area between Kribi and the Nigerian border. The species nests regularly and in significant numbers in Equitoreal Guinea, both on the continent to the south and on Bioko island. Nesting is confirmed on the islands of Corisco Bay, but not on Annobón. Good sites for reproduction have likewise been identified in recent years on Sao Tomé and Principe. There is no known nesting on the island of Rolas.

D. coriacea frequents all of the beaches in Gabon, from the Pointe-Pongara across from Libreville all the way to the Congo. On the Congolese side of the border, nesting is concentrated in the region of Conkouati, but continues to the south all the way to Cabinda. During the 1999-2000 nesting season, monitoring of the site in Gabon stretching between Mayumba and the border made possible the counting of nearly 30,000 nests, representing the coming to shore of between 4222 and 7096 females. This new data places Gabon and the Conkouati region in a position of primary importance, along with French Guiana, for the worldwide conservation of *D. coriacea*.

Airborne counting carried out along the entirety of the Angolan coast allows the presumption of a remarkable level of frequentation which needs to be confirmed. Subadult individuals are observed in clear water. In Namibia, sightings of the species occur essentially between 22° and 23° S, but no nesting has been identified. In South Africa, turtles of this species are sometimes seen along the Atlantic coast and at the Cape of Good Hope. There are no reports of *D. coriacea* on Saint Helena.

Noteworthy is the accidental capture on the island of Príncipe ("Boné de Jóquei")in March 1999 of 3 juvenile leatherbacks between 17 and 21 cm in length. This exceptional discovery leads to the hypothesis of a development area in this zone for the species. It is necessary to explore the area in order to confirm the existence of a development area for turtles in their first year of life.

Except among a few African groups that do not eat meat, the leatherback is massacred everywhere. It is particularly sought out for its fat, used in cooking and in indigenous pharmacopeia.

It is necessary to rapidly establish the significance of nesting in Sierra Leone, Liberia, Ivory Coast, and in Angola, in order to encourage the protection of beaches which are judged to be well frequented. From a strictly biogeographic perspective, the most northern nesting sites of the species should be searched for.

SOUTH AMERICAN LEATHERBACK POPULATION STUDIES

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Leatherbacks nest in various locations along the South-American continent, but mainly on the Atlantic side. Nesting beaches are known in Colombia, Venezuela, Guyana, Suriname, Département français de la Guyane, and Brazil, spanning more than 10,000 km of coastline, both above and below the equator. There is a range in the quality of data that have been collected at these various sites, ranging from intermittent or anecdotal observations to long term monitoring programs. Suriname and the Département français de la Guyane host the greatest number of nesting leatherbacks in South America and have been studied intensively for more than 30 years. However, there is no clear trend in population size in this region because in general the dynamic is characterized by a very rapid change in the number of nesting females: a large increase during the 80s and rapid decline during the 90s. The reasons of these large fluctuations are under investigation. One possible explanation is that frequent and massive changes of nesting beaches by females (which have been described in this region) could mask changes in the number of nesting females on any one particular beach. However, a search of the literature from the Département français de la Guyane between 1700 to 1850 suggests that leatherbacks were very rare, at least in the 18th and 19th centuries. Life-history parameters of Guianan leatherbacks (age at sexual maturity, annual survival rates, etc.) recently have been estimated and are used to suggest a possible explanation about the rapid change observed.

LEATHERBACK TURTLES IN THE MEDITERRANEAN AND NE ATLANTIC

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There are numerous reports of sightings and strandings of leatherback turtles (*Dermochelys coriacea*) in the Mediterranean and Northeast Atlantic. These were first reviewed in a semenal work by Brongersma (1972). We build upon this work by reviewing over 500 records between 1972-2000 and discussing the spatial and temporal patterns of both sightings and strandings and investigating the available information on incidental catch in marine fisheries. A full report will be made available for a special edition of Chelonian Conservation and Biology.

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LOCAL AND LONG-DISTANCE MOVEMENTS OF LEATHERBACK TURTLES (*DERMOCHELYS CORIACEA*) SATELLITE TAGGED OFF EASTERN CANADA

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Leatherback turtles (*Dermochelys coriacea*) occupy nearshore and pelagic waters off Canadas Atlantic coast. There is little information available on the origins and destinations of leatherbacks encountered in Canadian waters, and their seasonal movements in this part of the Northwest Atlantic are poorly understood. Collaborative work with commercial fishers in Nova Scotia has yielded valuable opportunities for tagging free-ranging leatherbacks. In August 2000, satellite tags were deployed on four adult turtles (two males and two females). Tagged turtles remained resident in Canadian waters for up to ten weeks. One turtle proceeded directly offshore shortly after being tagged, while the other three animals occupied coastal areas of Nova Scotia, Newfoundland, and Prince Edward Island. The largest turtle tagged, a male, ventured into the Gulf of St. Lawrence and remained there until late October. This is of special interest, as leatherbacks are rarely reported from the Gulf. After departing Continental Shelf waters, all four turtles assumed migratory trajectories to the south. Turtle movements are interpreted in the context of available environmental data.

NEW DEVELOPMENTS IN THE POPULATION DYNAMICS OF PACIFIC LEATHERBACKS: WHAT CAN POPULATION MODELS TELL US?

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The Pacific population of leatherback turtles appear to be in great danger of extinction, almost certainly due to anthropogenic causes such as loss of nesting habitat, poaching and unsustainable mortality rate at sea. We recently proposed an empirical model that predicted near extirpation by 2004 of the population of leatherbacks nesting at Parque Nacional Las Baulas, Costa Rica (Spotila et al. 2000, Nature

405: 529-530). We have revised this model to include data from the last two nesting seasons. We observed a greater number of turtles than that predicted by the model, this was due to an unexpectedly high number of turtles returning with very long (6 or 7 year) remigration intervals, and also by an unexpectedly high number returning with very short (2 year) return intervals. The effect of the past two seasons on the model was to delay but not prevent the decline of the nesting population to less than 50 individual females in 10 year's time. We speculate that the increased proportion of returned turtles in the past 2 seasons is a result of more favourable climatic conditions following the end of a prolonged ENSO event.

We calculated the mortality rate of adult females to be 15% to 20% annually, compared with a predicted sustainable rate of 3% to 3.5%. This matches that rate previously calculated by a theoretical model (Spotila et al. 1996, Chel. Cons. Biol. 2: 209-222). In order for the population to stabilise, the model predicts that return rates must double and that hatchlings recruitment into the population must not fall. Thus we must work to reduce adult mortality and protect nesting areas to increase survival of all life history stages.

LEATHERBACK TURTLE *DERMOCHELYS CORIACEA* NESTING ALONG THE CARIBBEAN COAST OF COSTA RICA

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Leatherback turtles have been studied intermittently along the Caribbean coast of Costa Rica since 1957 but continuous monitoring was not initiated until the 1990´s. Leatherback nesting occurs along the entire coast and also on the Caribbean coasts of Colombia, Panama, Nicaragua and Honduras. Tagging studies have shown that movements of females between nesting beaches occur between nesting seasons (throughout the Honduras-Colombia range) and within the same nesting season (Costa Rica-Panama). Most monitoring and tagging studies in Caribbean Costa Rica have been conducted within three protected areas: Gandoca-Manzanillo Wildlife Refuge, Pacuare Nature Reserve and Tortuguero National Park. We estimate that 70 % of leatherback nests deposited along the Caribbean coast of Costa Rica are laid within these areas. Using number of nests deposited on monitored beaches (for years 1995-2000) as an index of total nests along the entire coast we estimate that between 2658-5191 leatherback nests are deposited yearly in Caribbean Costa Rica corresponding to 505-987 females/year. Comparison with other populations shows that the nesting aggregation of Caribbean Costa Rica is the fourth largest leatherback nesting population worldwide. The number of nests/year shows an average decline of 2.0 % per year over the study period. Killing of nesting females in northern Panama, egg poaching (probably approaching 100% outside protected areas), loss of habitat due to erosion and debris accumulation, and offshore oil exploration are the main challenges facing the nesting population. Priorities for leatherback conservation along the Caribbean coast of Costa Rica include: further monitoring to determine long-term trend in leatherback nesting, development of regional conservation initiatives, improved inter-organizational coordination and increased community participation

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THE LEATHERBACK IN U.S. EAST COAST WATERS: ABUNDANCE, SEASONALITY, ANTHROPOGENIC MORTALIY AND MANAGEMENT

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Leatherback nesting has been documented in most US mid-Atlantic states, Florida and Texas. There are verified nesting records dating from the 1940's through today. No nests have been found in Maryland, Delaware, Virginia, Alabama, Mississippi and Louisiana.

The most reliable estimates of leatherback abundance in the eastern U.S. come from nest-count surveys on nesting beaches. The presence of leatherback nesting in the eastern U.S. was once thought to be rare (Caldwell, 1959) but is now known to occur regularly on Florida's Atlantic beaches. During the period 1979-2000, 4112 leatherback nests were recorded from the eastern U.S. from New Jersey (one nest) to Florida's western Panhandle (16 nests). Approximately 99% of this nesting was recorded from Florida's Atlantic coast. Most of Florida's nesting is concentrated in the southeastern peninsula where beaches are closest to the Gulf Stream. In Florida during the period 1989-2000, the annual number of leatherback nests has increased significantly ($r^2 = 0.712$, $p = 0.0006$, Florida Index Nesting Beach Survey program, Florida Marine Research Institute). Nests counted in Florida during the1998, 1999 and 2000 seasons number 351, 558, and 453, respectively (Florida Statewide Nesting Beach Survey program, Florida Marine Research Institute). Using the mean number of nests (454 nests) and assuming a seasonal clutch frequency of 6 nests/turtle and an average remigration interval of 2.5 years (NMFS and USFWS, 1992), the number of breeding adult female leatherbacks currently using Florida beaches is estimated to be 190 and is certainly less than 200.

Leatherback use of US East coast waters

Aerial surveys show that leatherbacks use most if not all US East coast and Gulf of Mexico waters through the year. Leatherbacks sighting are of large juvenile to adult sized animals. They are most abundant in nearshore waters along the U.S. East coast during a spring northward migration, but they are found in U.S. coastal waters throughout the year. In the Northeastern region, leatherbacks are sighted in waters from May through October. There are no data for the winter months because there were no surveys for that period. Few turtles are sighted in the fall and spring. Most sightings are in summer.

In the mid-Atlantic states and Gulf of Mexico the sights differed from the Northeast. During the winter months leatherbacks were scattered along the SE coast. These sightings were lower in the winter than in the summer. In the Gulf of Mexico the leatherbacks sighted in the winter were found in waters from 100 m deep and outward. These are probably the warmer Gulf of Mexico waters. This distribution in the Gulf is also different from the other months suggesting a seasonal shift in habitat use. In the spring sightings along the East coast begin to peak and animals are seen in the Eastern Gulf of Mexico waters and in the west central region of the Gulf of Mexico

By summer there is a small concentration of leatherbacks off the East coast of Florida associated with 20-40 m deep water where thermoclines are common. It is assumed that these turtles are using these waters to find resources or we suggest they may also be using these waters to stay cool. In the Gulf of Mexico leatherbacks move into shallower waters from 100 m to the coastline, another seasonal shift in habitat use.

In the Fall, turtles occur in all SE waters but are less concentrated off the SE Florida coast than in other months. There are relatively few sightings in spite of significant effort. This further suggests that the turtles are shifting habitat with season and are migrating through these areas seasonally.

Strandings

Most leatherbacks strand on US east coast beaches; locations are almost equally divided between the NE (45%) and SE (42%) with just 13% along the Gulf of Mexico. There are different associations between strandings and anthropogenic impacts with region. Strandings in the Northeast appear to be associated with lobster pot entanglement. Strandings in the SE and Gulf of Mexico are correlated temporally with shrimp trawling, peaking in the spring.

Most of the US strandings are of adults and subadults; relatively few animals smaller than 130 cm CCL strand. Large animals strand in all regions (with the largest numbers occurring in the and in the Gulf of Mexico associated with trawling). Very few animals smaller than 100 cm CCL are found stranding along the US eastern coastline or Gulf of Mexico. None are located in the NE. This distribution of animal sizes is probably related to their biology. Eckert (1999) noted that smaller leatherbacks are restricted to waters of at least 26º C. The NE waters are colder than this at their warmest days.

The implications of body size

The leatherback is the largest of all sea turtles, it dives the deepest, and travels the farthest. Large body size may well be related to other aspects of leatherback biology. The biological implications of their large size include the possibilities that (i) either they have rapid growth or a very long growing period. (ii) Large body size provides for thermal inertia (animals don’t cool as quickly or heat as rapidly as a smaller animal of the same shape because, relative to their volume, they have less surface area from which to gain or lose heat); (iii) large body size can increase potential storage of energy; and (iv) large body size increases potential for high reproductive output (room for more eggs or bigger eggs). Clearly these are not exclusive features.

Once leatherbacks reach large size, thermal inertia becomes a major component of their suite of physiological features, and is related to their ecology and behavior. Large turtles have a low surface-to-volume ratio so that a proportionately smaller area is exposed to water. Hence, the body core can stay relatively warm in cold water and cool in warm water. The ability to stay near ideal (preferred) body temperature permits diving to greater depth (deep waters tend to be very cold) and swimming in cold water at higher latitudes. Thermal inertia may also facilitate early nesting when waters are somewhat cooler.

Implications of leatherback biology and body size to management

The ability of leatherbacks to range far means protection must extend into tropical, temperate and even near arctic waters. Ability to dive deeply may result in deepwater fisheries interactions. That other species would not encounter. Large size makes leatherbacks susceptible to entrapment in trawl nets, even when some turtle excluder devices are in place because exit opening in conventional TEDs may be too small for most to escape. Losses of turtles in US coastal waters may impact other Atlantic nesting populations. Strandings of tagged leatherbacks tell us that nesting turtles from at least French Guyana, St. Croix and Costa Rica die in US fisheries.

The large size of this animal imperils it in waters besides those along the US coast. Leatherback turtles are captured and drowned in trawl nets through out the world. Drowning in trawl nets is likely one of the largest sources of anthropogenic mortality in the western North Atlantic. The U.S. shrimping fleet alone is estimated to capture 650 leatherbacks annually.

To address this problem the National Marine Fisheries Service developed a leatherback contingency plan in 1993. This plan required the closure of shrimp trawling in US waters when sighting of leatherbacks in coastal waters become high or stranding numbers become too great. The only shrimping that could occur was by boats equipped with modified Turtle Excluder Devices that had a big enough opening to allow leatherbacks to escape. This opening was not tested until 2000.

To ensure that the leatherback modified TED was large enough, it was tested by the NMFS Pascagoula laboratory. A metal frame was constructed based upon morphometric data (CCL, CCW and BH) from the largest leatherbacks nesting in St. Croix and Suriname. This frame was used to determine that the leatherback TED released all but the very largest of the turtles, and hence was a successful modification that could be used in other regions as well.

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EDUCATION AND COMMUNITY-BASED CONSERVATION

CHILDRENS KNOWLEDGE AND ATTITUDES TOWARDS SEA TURTLES IN COLOLA, MICHOACAN, MEXICO

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Identifying attitudes can help orientates educational efforts in order to reinforce positive behaviors towards the environment or to modify, and hopefully eliminate, negative behaviors. The conservation of species depends on public participation and support. Therefore, there is a need to evaluate environmental education and management programs. Developing successful education and communication programs toward this end is an essential aspect of biodiversity conservation. The general objective of this study was to evaluate children's knowledge and attitudes towards sea turtles in Colola, a rural community in western Mexico. Colola is located in the pacific coast of México in the state of Michoacan. It is the main continental nesting beach of *Chelonia agassizii* and also of *Dermochelys coriacea* and *Lepidochelys olivacea*. In this study analyses included whether culture and formal education have an effect on the formation of environmental concepts and attitudes in young children. We determined if there were differences between gender and we evaluated the environmental education program undertaken at Colola since the last 15 years. Study subjects were 70 school children, which represents 51% of population from 9 to 14 years of age in the community. Children were from 4th, 5th and 6th grade of primary education (10 to 12 years of age). At this age the child's mind undergoes a developmental change (intellectually and socially), we wanted to find out if within this developmental process children developed an environmental concern. According to the typology in environmental education research, this work is based in an interpretative study, in which emphasis is given to children's knowledge, attitudes and perceptions in their social context. A variety of qualitative and quantitative methods were used. Six assessment instruments were applied over a period of six months (nesting season). Additional information was gathered through interviews to teachers and parents.

Results from one assessment instrument are reported in this work:

Drawings. Children were told to draw "what does the turtle need to live well?" Drawings were made during a single session (lasted between 45 minutes and one hour). There was no discussion before the session, except to introduce the activity. To make sure that what children drew was clearly understood, additional information was gathered by interviewing them when finished their drawings. Using content analysis (Barraza, 1999), drawings were analyzed separately. Based on the different patterns that emerged, four categories were used: a) food resource, children drew, fish, seaweed's, marine grass, shrimps, sea shell and other small sea animals; b) biological and physical elements, air, sea, and beaches (habitat). Interrelations with other animals were also depicted in their drawings such as: turtles, fishes, octopuses, crabs, whales and sea shells; c) protection, drawings in this category showed an action: not beating the turtles, not throwing rubbish in the sea, nor in the beach, patrolling the beach at night (with biologists); and d) conservation, children manifested their concern for creating protected areas, collecting eggs to save them from predation and safety delivering of hatchlings into the sea. Contingency tables, using the log likelihood ratio test, were employed to test for statistical differences in frequencies of categorical data. Comparisons were made mainly between age groups and gender. Children from Colola expressed a high level of information on different aspects about the biology and conservation of sea turtles. Children were able to provide information on the reproductive behavior of sea turtles and measures on how to protect them (boys 30%; girls 10%). They identified environmental problems (killing turtles to obtain the skin and other products, illegal commerce of eggs, and predation), and recognized morphological differences between the three sea turtle species found in Colola: leatherback (*Dermochelys coriacea*), black turtle (*Chelonia agassizii*) and olive Ridley (*Lepidochelys olivacea*). Environmental education programs in Colola have proven to be effective in transmitting a conservation awareness in young children. Education programs can help foster more favorable attitudes toward conservation and increase interest in the population. Generally, practice in environmental education has emphasized the promotion of activities: ACTIVITIS.

Educational research is necessary to improve the planning and evaluation of environmental education and conservation programs for sea turtles.

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FUNDRAISING IN TURTLE ORIENTED NGOS: A TOOL FOR INVOLVING THE PUBLIC IN CONSERVATION WORK. THE CASE OF CRETE

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INTRODUCTION

ARCHELON, the Sea Turtle Protection Society of Greece, was established in 1983 to protect and study the sea turtles. Since its very beginning, the Society has relied on voluntary work, recruiting people from Greece and abroad. The Society's Public Awareness program was soon established as an important tool for conservation. Among other target groups, beachgoers are informed of the sea turtles and fragile coastal habitats as well as the simple protection steps that they could take in order to help.

The case study for the present paper is Crete, Greece's largest island and a world-known holiday destination. Every summer, around 500 nests are laid on the nesting beaches of Rethymno, Chania and the Bay of Messara. These are the same areas that attract - during the very same season - most of the 3,000,000 tourists that visit the island every year.

THE STUDY AREA

Crete's economy has become dependent on tourism in less than two decades. No blueprint or planning whatsoever was provided for its rapid growth, which explains why the island is now facing increasing implications from this kind of far-from-sustainable development. Along the coastline, for example, several activities have led to beach degradation; further inland, water resources are becoming scarce, while land erosion is an increasingly common phenomenon.

Tourist development has had a devastating impact on the loggerhead sea turtle's habitat on all fronts. Extensive beach use by tourists is a major factor of the ongoing coastal degradation. The tourism industry is itself directly responsible for beach destruction through coastal development. The local society has played a major role, too; illegal buildings are the norm in the case of family housing and/or small businesses, which are often located along the coastline. This situation is tolerated by both local and national authorities, which fail to impose existing legislation.

The actors are themselves interlinked; Authorities are always unwilling to displease their local voters; for the local society, the tourism industry has become the major job provider by far; for this industry, in turn, increasing numbers of tourists are needed to counter balance falling profit margins due to international competition; and, to this goal, national authorities become major advertisers attracting more tourists. Overall, the loggerhead sea turtle visiting the nesting beaches is threatened from all sides, effectively making its protection a multi-dimensional issue. [see fig.1]

DISCUSSION

ARCHELON'S conservation strategy is indeed multi-dimensional, addressing all actors on a one-to-one basis, while at the same time taking steps to reverse their negative interactions. Lobbying and media work puts pressure on the tourism industry to shift towards - environmentally and financially- sustainable options. All-year-round environmental education projects call on the local society to minimize the impact from its activities on the sea turtle's habitat. An extensive public awareness program promotes implementation of simple protection measures from the tourists themselves. Last, but not least, authorities are approached directly (lobbying) and /or indirectly (through media work) in order to enforce existing legislation and to extend legal protection measures. [see fig.2]

Furthermore, the project takes steps to involve all actors as potential allies in reversing destructive trends. Informed tourists promote implementation of protection measures from the hotels that lodge them, just by stating their care for the sea turtle survival. Tourism corporations, such as tour operators, that realize that sustainability in the long run is to their own best interest, provide new opportunities and resources for the local communities. And environmentally aware citizens are a powerful force for changing public policies, while authorities can use environmental values to promote higher quality tourism.

During outreach activities the same actors become also funding sources for the Society's projects. Tourists support the organization directly through donations, sponsorships and purchase of merchandise. Tourism companies that make the strategic shift towards sustainability are the first to enter corporate sponsorship schemes such as sponsoring a hatchery. Environmental education provides opportunities for local financial support. Authorities can provide direct funding of projects or -more often- make substantial resources available at no charge, such as communal buildings for use as information centers.

All actions share a single underlying principle: combining fundraising and communication activities with conservation in order to maximize the overall efficiency and impact. In effect, each and every fundraising activity contains a conservation component, whereas each and every conservation activity contains a fundraising component. ARCHELON consistently targets its public -be it tourists, the local society, the tourism industry or local and national authorities- promoting conservation objectives and citing the organization's own work; the public responds by changing its attitude and providing funds for the continuation of the conservation activities. [see fig.3]

A few examples will be useful in demonstrating the above principle in practice:

(1) Slide shows conducted in the native languages of the tourists promote the conservation message. These are a self-financed awareness-raising tool: donations and merchandise sales from the shows provide valuable funds for the organization. At the same time, slide shows are one of the most cost-effective ways to familiarize tourists with the impact of their activities -as well as those of their hotels- and to promote alternative attitudes. Slide shows in effect become indirect lobbying tools; educating the tourists is an extremely effective way to put pressure on hotels to implement turtle protection measures.

(2) Information kiosks, like slide shows, provide an important outlet of merchandise and sponsorship products. The added value in this case is that kiosks are mini-environments where the organization's field researchers can better explain their own work on a one-to-one basis. In practice, this also becomes a tool for recruitment of new volunteers to support the Society's conservation activities.

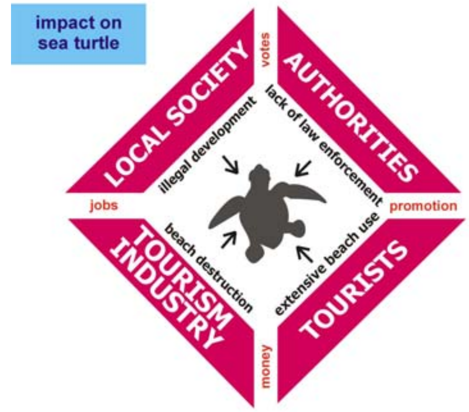
(3) Beach patrols when researchers survey the beach to examine turtle tracks, build cages to protect nests and move threatened nests to hatcheries, are primarily a conservation activity. They, however, have an important fundraising and communication component. Field researchers are in fact the most widely seen display of the organization's actual work; to this effect, the organization has taken steps to make its team members instantly identifiable and provide a clear image of straightforward scientific attitude. In addition, inquiring tourists are informed of the ways to support -or even join- the work and are invited to upcoming slide shows.
In order to effectively combine fundraising and conservation activities, a few principles should be noted. First, that everyone involved needs to be provided with a view of the full picture. Complex as they may be, comprehension of the interactions between the various activities is essential for team members to be aware of the actual impact that their own work has in ensuring a future for the sea turtle. People need to know that they can and do make a difference. Second, every effort should be made to maximize the impact of each and every activity. Continual monitoring, feedback and improvement is necessary, particularly in an ever-changing setting such as the developed areas of Crete. In fact, this approach also ensures maximum involvement of everyone taking part in the projects. Last, but not least, "a dollar saved is a dollar earned". Efficient management of resources at all levels is a self-sustaining policy.

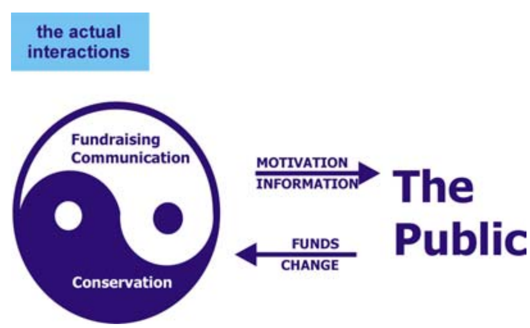
ARCHELON is not a big organization by any standards; even less so when compared to the rest of the actors whose attitudes need to be changed. However, the Society is probably the only actor in this scene that does have a long-term strategy. Through diversification of the organization's funding base, an NGO can ensure its financial sustainabily, political independence and ability to focus on its campaign objectives. At the same time, awareness activities gradually change the public's attitude and promote those same campaign objectives.

CONCLUSION

The implementation of protection measures such as the daily removal of sunbeds, based on a Management Plan produced by ARCHELON, is increasingly taking place. At a higher level, enforcement of legislation, such as the demolition of illegal buildings on the beach area, is no longer a case of wishful thinking. Awareness of the sea turtle issue is now widespread and has lead to a significant improvement in influencing the decision-making process at all levels.

The most powerful argument in support of ARCHELON's strategy in Crete is indeed that it works.





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USING SATELLITE TRACKING OF GREEN *CHELONIA MYDAS* AND HAWKSBILL *ERETMOCHELYS IMBRICATA* TURTLES FROM TORTUGUERO, COSTA RICA IN COMMUNITY AND INTERNATIONAL EDUCATION

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Caribbean Conservation Corporation (CCC) has continued the green turtle monitoring program begun in Tortuguero, Costa Rica by Dr. Archie Carr in the mid 1950s and year 2000 saw a significant event in the history of CCC and the village of Tortuguero.

It is well known that Dr. Carr was interested in the migratory behavior of Tortuguero's nesting female green turtles. He approached the study of migration pathways by attaching a balloon to the back of female greens and followed the balloon in a small boat to see where the turtles went. Dr. Carr knew that there had to be a better way to study sea turtle migrations and even predicted in his book, Sea Turtle: So Excellent a Fishe, that the study of migration pathways would involve the use of satellites. CCC believes that Dr. Carr would be amazed by what researchers are able to do with satellite tracking technology in this day and age.

In 2000, CCC not only fulfilled Dr. Carr's prediction of satellite tracking Tortuguero green turtles after they had nested, but also added hawksbills and incorporated the research into an educational program. The objective of this project was twofold. Firstly, it would be used to educate the public about the plight of sea turtles. Secondly, it would collect detailed information about Tortuguero green and hawksbill turtle migration patterns.

A total of eight satellite transmitters were attached to post-nesting green and hawksbill turtles over two different periods during the summer and fall of 2000. In July, 2000, CCC staff tagged two post-nesting green turtles with satellite tags. In addition, two post-nesting hawksbills were tagged with satellite transmitters as part of an international research project funded and organized by the U.S. National Marine Fisheries Service to obtain information on the migration of Caribbean hawksbill turtles. Costa Rica is one of seven countries where the project was carried out. Researchers from Nicaragua and Belize traveled to Tortuguero as part of the NMFS project and participated in the July attachments to learn satellite transmitter attachment techniques. In September, CCC staff fitted four more post-nesting green turtles with satellite transmitters.

The release of sea turtles fitted with satellite transmitters was a major event for the community of Tortuguero. Tortuguero School and High School children entered a contest to select names for several of the turtles being released. In addition, the release was also a major event for visiting tourists, and attracted attention from TV and newspaper media. The project was covered in Costa Rican media and also received coverage in Belize, Canada, USA and even France.

The educational component to the project was built upon CCC's Sea Turtle Migration-Tracking Education Program. Through this program students and the general public could follow the migration movements of the Tortuguero turtles on CCC's web site (http://www.cccturtle.org). The result was that the post-nesting migrations of the six green and two hawksbill turtles had a worldwide audience.

When we released the satellite tagged green turtles we were hoping that at least one green turtle would do something other than the anticipated route straight to the Miskito Cays, off the Nicaragua coast. CCC and the viewers were not disappointed. While most of the turtles did end up off the coast of Nicaragua, two of the greens traveled straight to, and then straight through, the Miskito Cays. One stopped off the coast of Honduras, while the other green, named by a Tortuguero High School student, decided not to stop until she reached the coast of Belize. This pathway provided a great story that was covered by both TV and newspaper media in Belize. It also provided justification for the development of blueways along the coast of Central America, as well as showing the importance of such treaties as the Tripartite Agreement and the Inter-American Convention.

With the attention paid to the web site and the online maps, CCC saw the need to increase the availability of the education program, so several of the web pages, including most of the educational program related web pages, were translated into Spanish.

Since Internet access is limited in Tortuguero, CCC staff print out updated maps of all the turtles to share with the schools and the entire Tortuguero community, including tour guides, park rangers, tourism operators and businesses. The tracking maps were used as an educational tool and seemed to get the greatest response from the school children.

CCC considers the first green and hawksbill turtle satellite tracking project at Tortuguero to be a great success. The project added to our knowledge of the migration pathways of post-nesting green turtles and gave us new information about the hawksbill turtles that nest at Tortuguero. The new research results were shared with local school children, residents and tourists through the activities carried out by CCC staff, and shared with anybody anywhere in the world through CCC's education program on the World Wide Web.

The ability to "follow" along with researchers learning new information is a unique feature to the education program and helps spark an interest in sea turtles and their conservation. While Dr. Carr's prediction about satellite tracking came true several years ago, it is now being applied to Tortuguero's green and hawksbill turtles and is being used in ways beyond what Archie probably imagined.

ACKNOWLEDGEMENTS

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DISTANCE LEARNING: THE SEA TURTLE EDUCATION MIGRATION.

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Distance Learning is the use of technology to bridge physical distance between an educator and students to present education materials. This can be accomplished through a variety of different media including audio, video, teleconferencing, Internet websites, and satellite broadcasts. Mote Marine Laboratory (MML) combines many of these media sources to educate students all over the world using videoconferencing technology. A system using high-speed (ISDN) telephone lines, real time video and audio, computer hardware, and video conferencing software provides a live two-way interactive classroom. Currently MML has developed State and National Science Standards and National Technology Standards based programs in subject areas such as sea turtles, sharks, coastal ecology, and manatees. A U. S. Department of Education grant provides the funds to reach a focus group encompassing 10 different school districts, 25 schools, 90 teachers/technical facilitators, and over 1400 students throughout Florida, USA. Independent of this grant, classes have also been brought to other states including California, Michigan, New York, Ohio, and Texas. International videoconferences have been done with the United Kingdom, Switzerland, and India. This technology gives MML the opportunity to provide students with experiences that they might not get in their local community. It also allows MML to raise awareness on a national and international level about endangered species such as sea turtles with a far broader reach than traditional campus-based programs.

COMMUNITY BASED CONSERVATION OF OLIVE RIDLEY TURTLES IN INDIA

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Olive Ridley turtles have been known to nest along the Indian coast - both along the eastern and to a lesser extent along the western coast. The arribada that occurs every year along the Orissa coast is not only a major tourist attraction but also a confirmation that the oldest amphibians are still around to procreate masses of future generations. But, unfortunately, Orissa coast also witnesses turtle mortality in several thousands, thanks to human interference. Shrimp trawling has been the biggest contributing factor to this. Efforts by the state machinery to bring a stop to this rising turtle mortality, through laws and policing has not proved very effective. What then happens to the thousands of turtles that come to nest enmasse every year? Will this eventually lead to the extinction of the Olive Ridley turtle? Maybe there is still hope. And that is exactly what the local fisherfolk communities in the states of Kerala and Goa, which lie on the western coast of India, are showing by example.

Morjim beach situated in North Goa is an example of joint wildlife management and how the local community is accruing economic benefits from this experiment. Although Morjim does not witness mass nesting of olive ridleys as Orissa, these turtles religiously visit Morjim during the nesting season of September to February. A small one kilometre stretch on Morjim beach which falls in Tembwado is where the community conservation is happening and which is why the residents here are in the news. The turtle conservation movement began in 1995-96, thanks to Capt. Fernandes and his wife Merle Fernandes, and several other fisherfolk who have opted out of fishing. The story begins with the Fernandes couple making the locals aware of the endangered status of the sea turtles, the importance of conserving them and how through conservation they could turn the area in to a potential tourist spot.

The turtle eggs, which are softer and rounder than poultry eggs fetch a local market price of two or three rupees more than the poultry eggs. Hence it is more lucrative for the fishermen to poach turtle eggs and sell them in the market during the nesting season. Capt. Fernandes began to offer them an economic alternative since he realised that mere rhetoric about wildlife conservation would not succeed here. So he pooled in an amount of Rs. 5,000/- (approximately $137) from his personal savings for awards to individuals who reported turtle nesting sites. This weaned the villagers, especially the youth, away from poaching turtle eggs, directly and indirectly. Those who were reported to be indulging in poaching were discouraged from repeating the offence as it led to disgrace in the small community. A breakthrough was achieved when once-expert-poachers also started reporting nesting sites that needed protection. The youth have been astute enough to realise that the tourists who visit Morjim seek solitude and peace away from the rest of the crowded beaches. And they have responded by putting up temporary shacks that provide shelter and food. They do not blare loud music and do not use bright lights, especially during the nesting season. This ensures that the turtles are not disturbed while nesting. By keeping the beach clean, the natural predators of the turtle hatchlings such as stray dogs and sea gulls are kept away. At the same time rag pickers and beggars who create a nuisance for the foreign tourists have also been kept away. Some of the locals have added an extra floor or room to their house which are then let out to tourists. A new model of eco-tourism has thus taken birth in Morjim.

The Forest Department stepped into the effort in 1996-97 by deploying two guards during the nesting season to keep a watch over the beach. Apart from that they have started paying daily wages to six other local youths who report on any poaching that takes place. Critics say that in spite of all the hype created over the joint management effort, not a single case of poaching has been reported. What they fail to understand are the dynamics involved in social community conservation. To give an example, Galgibag, a beach located in south Goa where the community conservation of turtles has caught on, a young boy of about 13 years was keeping watch over the beach when I visited Galgibag. When I asked him whether he does not fear being attacked by poachers during the night, pat came the reply from his companions "But he is not alone. No one would dare touch him because the poachers (who are normally residents from within or neighbouring villages) know that behind him stands an entire village. The attacker would have to face the ire of the entire village if they attack him and it is the strength of this knowledge that makes this young man do his duty fearlessly.

The Forest Department has also continued with the award-giving scheme to locals who report nesting sites. Presently an award of Rs. 500/- is given to each volunteer. In recognition of his efforts, Capt. Fernandes was awarded a plaque by the Govt. of Goa in October 1998 for wildlife preservation. The Deputy Conservator of Forests, Mr. Reddy's enthusiasm to sustain this effort has taken shape in the form of Project Turtle of the Forest Department of Goa. A 'Turtle Study Centre' has been set up at Pernem within the campus of the Range Forest Officer, Mr. Phadte, who has also been deeply involved with this movement.

The construction lobby on the landward side, and the trawler lobby on the seaward side form real threats to this effort. The adjoining village, Vithaldaswado, shares the same beachfront with Tembwado and hence has turtle nesting sites right upto Ashvem and Harmal village, further north in Pernem taluka. However, the villagers from Vithaldaswado have not responded to the turtle conservation programme in the same manner as those in Tembawado. The landowners along the beachfront fear that the turtle conservation programme would attract stricter implementation of the Coastal Regulation Zone Notification, 1991 here. This means that they would not be able to sell their land, especially to the hotel lobby, as the real estate price would go down. Capt. Fernandes has been trying to convince the villagers not to sell their land. Instead, he proposes that they could add an extra floor to their houses, which could be let out to tourists and thus earn a good revenue. This way they could manage to retain their ancestral lands, secure an income through good quality tourism and preserve their environment. The villagers from Tembawado are convinced, but not those from Vithaldaswado.

Although the incidence of nesting appears to be increasing, the past year has witnessed high mortality of hatchlings due to flooding of seawater over the nests. Villagers believe that this could be a fall-out of the land reclamation elsewhere including the massive reclamations that are going on in Bombay city. This is leading to increased erosion of sand dunes in Morjim by high tides as the years progress.

The problem of sea erosion on the coast is much more severe in Kolavipaalam, a fishing hamlet in Payyoli village of North Kerala. So much so that this year the sea has eaten away part of the hatchery that the youth of this village had constructed.

Mr. Surendra Babu, now an autorickshaw (a three-wheeler taxi) driver has been the main motivation force behind the community initiative apart from Mr. Vijayan and a dozen other young men. These young men have formed an organisation called Theeram Prakriti Samrakshana Samiti, whose President is Surendra Babu and Vijayan acts as the Joint Secretary. This community conservation began in 1992 when some of the youth belonging to the fisherfolk community read an article about Olive Ridley turtles in the newspaper. This motivated them to act upon what nature had blessed them with.

Turtle eggs are considered to be a good curative for piles and were sold in the local market. Consumption of turtle meat was more in south than north Kerala. Initially, the youth tried to protect the nests by fencing them with dried palm thatch. But, the jackals which reside in plentiful numbers there bury through the sand and eat the eggs. They then replaced thatch with iron cages, but that still did not keep them away. The Theeram member then got together and constructed a hatchery. Material for this and the finances were provided by both the local community members and the Forest Department. The hatchery is a small portion of the beach beyond the highest high tide line. It is bounded by palm thatch and bamboo stakes up to seven feet high. Old fishing nets supported by bamboo stakes provide good protection from jackals and stray dogs. During the nesting season, the youth of the village keep watch over the beach to check on turtles that come to nest. As soon as a turtle lays its eggs and returns to the sea, the watchful youth transfers the eggs into the sheltered hatchery. A meticulous record is maintained of the number of eggs that are laid by each turtle, the dates when these were laid etc. On hatching the turtles are immediately released into the sea. The major threat to these eggs is from the jackals that inhabit the mangroves nearby. They smell the eggs as soon as they are laid and immediately prey on them. Those that escape the jackals are preyed upon when they hatch. It is for this reason that the village youth transfer the eggs into the protected hatchery as soon as they are laid.

As in the case of Goa, the group also met with active support from the Forest Department, though not to the same extent. The then DFO, Mr. Mallik took interest in the effort. Later, in 1997, Mrs. Prakriti Srivastava, DFO encouraged the local youth to keep watch over the beach and started paying daily wages for four people during the nesting season. Before the involvement of the Forest Department, funds for guarding the eggs were generated by donations in cash and kind from within the group and the community. Presently, there does not seem to be any interest from the Forest Department side. However, further studies will give a clearer picture.

The biggest threat that this initiative faces is from the sand mining lobby. The entire coastal stretch of Kerala is marred by patches of sea wall protection wherein the sandy beaches, eaten away by sea erosion, are being protected by basalt stone blocks. There are several contributing factors to this. Coastal erosion of the sandy beaches have reached this proportion in Payyoli village simply because of the massive sand mining that is being carried out in the Kottapuzha estuary. As a result, the sand that was transferred to the estuary from the beach and vice versa through changing tides and currents have been disrupted. By artificially taking away the sand from the estuary, the beach is no longer replenished with sand and at the same time its sand is increasingly being eroded away by the coastal currents. The end result is that at Kolavipalam beach, year after year the beach stretch is getting narrower, thus leaving very little area for the sea turtles to nest. Theeram Prakriti Samrakshana Samiti has filed a case in the Civil Court against the sand mining lobby that is operating here. An interim stay order was granted by the court, but the enforcing authorities seem to be helpless in putting a stop to this. One of the reasons could be that the present ruling political party supports the labour unions who are involved in sand mining. The fish drying occupation of the fisherwomen here have also been affected by the diminishing beach stretch. They no longer find the space to dry fish that used to be exported. This has affected 500 fisherwomen who were otherwise employed during the summer season. The latest information is that this year the sea tide has destroyed the hatchery and the youth do not know what can be done to save the turtles. This initiative runs a real risk of fizzling out since the natural habitat of the Olive Ridley turtles is itself disappearing.

In both Goa and in Kerala the youth of the village are involved in the conservation initiative and that can be taken as a positive sign for the continuance of the turtle conservation effort. In Goa economic benefits have been responsible for the continuation of the community effort at conservation. However, it also runs the risk of tourism interests over-riding conservation concerns. It is here that the role of the Forest Department becomes vital. In Kerala, the initiative was born and is surviving purely because of concern for the turtles. That this has led to their empowerment in terms of becoming aware of environmental issues outside their village is an added benefit. What is of real concern though is that since both Goa and Kerala faces serious threat of sea erosion. And the solution lies beyond their worlds - of stopping reclamations of the sea, of trawling, of increased sand mining to satisfy the construction lobby and of lifestyles that feeds these threats.

This paper is being presented at the 21st Annual Symposium on Sea Turtle Biology and Conservation, Philadelphia, 24th – 28th February, 2001. This paper is based on a study titled "A Study of Community Participation in the Conservation and Management of Sea Turtle Nesting Beaches in Goa, Kerala and Orissa". The study is being funded by the Government of India – United Nations Development Program Sea Turtle Project.

HAWKSBILL (*ERETMOCHELYS IMBRICATA*) NESTING AND COMMUNITY-BASED CONSERVATION PROJECT IN THE PEARL CAYS OF NICARAGUA

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Hawksbill turtles, *Eretmochelys imbricata*, can be found foraging among the shallow reefs and nesting on the beaches of the Pearl Cays, located approximately 6 km off the central Caribbean coast of Nicaragua. Until recently, nesting hawksbills and their eggs were harvested by local fishers for personal consumption or sale. With the support of nine local communities, and the regional and central governments of Nicaragua, a community-based project was initiated in 2000 to protect nesting hawksbills and their eggs. Local inhabitants were employed to conduct daily nesting beach surveys on 11 of the 18 Pearl Cays. During each survey the number of nesting emergences and number of clutches poached, destroyed, relocated or left in situ were recorded for each cay. In 2000, 70 % of the egg clutches laid were left to incubate compared to previous years when nearly 100 % of the clutches were harvested. Much of the success of this conservation initiative is due to the voluntary cooperation of many of the local fishers.

Acknowledgments:

We would like to thank the people and communities of Nicaragua whose cooperation and support made this first year's hawksbill conservation project a success, especially the people of the following communities: Awas, Corn Island, Pearl Lagoon, Haulover, Kakabila, Marshall Point, Orinoco, Raitipura, and Set Net. We thank Roy Hodgson, Wesley McCoy, Wilfred McCoy, Mykel Medrano, Carl Nickens, and Hilberto Wilson for their dedication in conducting the daily beach surveys and egg clutch protection activities. We also thank the Regional Council of the South Autonomous government for their support and the Nicaraguan Ministerio de Ambiente y Recursos Naturales who provided the permit to conduct this project. Financial support was provided by DIPAL (a Dutch government aid project), the Municipality of Pearl Lagoon, the National Fish and Wildlife Foundation, and the Wildlife Conservation Society. William McCoy would also like to thank the David and Lucile Packard Foundation, the Sea Turtle Symposium International Travel Grant Committee, the Dutch government, and the Wildlife Conservation Society for their financial assistance for him to attend this year's symposium.

TURTLE WORKCAMP AT PLATANITOS, NAYARIT, MEXICO, A SUCCESSFUL EFFORT

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Axuni is a non-profit, non-government organization devoted to help preserve and conserve endangered species of flora and fauna. Along six years of experience, we have developed a work model that pretends to integrate and coordinate in one same project the work of diverse actors. We seek for collaboration from the Mexican Government, communities, corporations, scientific and academic communities since they are essential for the success of the project. In the model, an intermediary among parts is needed in order to make agreements and solve problems in the development of the program. Axuni wants to be that intermediary.

The model was created because of the imminent need of preserving our natural resources. We invite Mexican and foreign volunteers to participate in this conservation works. They give their knowledge and effort for a good cause and can experience cultural exchange with people from other countries. This is why we call our activities ECOTOURISM, word that has been misused in Mexico to mean "adventure tourism".

We intend to create together with the communities, alternative sources of money for them and train their interested members in the adequate and rational use of the natural resources with which they will work, avoiding environmental damage.

OUR SUCCESFUL EFFORT

Platanitos Turtle Camp is located on the Pacific Coast of Mexico in the state of Nayarit, approximately 78 miles north from Puerto Vallarta, Jalisco on the north end of 11 miles of beach named on maps as “Playa Custodio”. The camp lies between the beach that is nesting habitat for three species of marine turtle, and over 1000 acres of salt-water tidal estuary, home to mangroves and a large variety of waterflow and other fauna. The closest community, Platanitos is crossing the estuary and has 40 habitants.

We first started working at Platanitos this year 2000 as a pilot plan of the Sea Turtle Protection and Conservation Program from the Federal Government. Our model consists of three phases for its development and sustainability:

PHASE 1, WORK WITH ECO-VOLUTEERS

A minimum of four and a maximum of ten volunteers are needed monthly at the camp. Functions are assigned to each one of them during their stay at the workcamp. Volunteers work for at least two weeks up to six months if they want to do so and give Axuni a donation for each two weeks of stay that covers their meals and lodging expenses. We have planned to have this phase complete in two years. Our goal for this June to December 2001 season is to have 44 to 55 volunteers.

PHASE 2, ECO-TOURISTS

After the volunteer base becomes consistent and is prepared to begin receiving visitors, the Camp will begin offering a service whereby ecotourists would be able to make reservations to visit the Camp for 1 to 5 days per visit. The communities would be in charge of offering them excursions and adventure trips to the nearby places; this activity will generate jobs and direct economic benefit for them.

PHASE 3, ECO-STUDENTS

Students or professionals that will visit the Camp for educational purposes. The educational programs may include: introductions of flora and fauna, university driven programs for scientific investigation and thesis work, and Spanish classes for foreigners. The type and number of educational visitors will be defined according to the needs and objectives of the Camp whose maximum capacity is of 25 people including Axuni’s staff and volunteers.

It is very important to mention that the Camp’s facilities are property of the Mexican Government. They were practically abandoned when we first got there. We have not received any money from the federal or state government nor support from Mexican institutions.

THE PROBLEMS WE HAVE FACED:

1. We found out that people from the communities who were in charge of the camp during the 99 season, sold turtle eggs at the camp!
2. There is a lot of corruption at the government and they are not interested in the Camp nor in Axuni’s support. They believe they are making us the favor of letting us stay there.
3. The police, government representatives and marines were looking for the opportunity of buying turtle eggs.
4. Until now, the corresponding government offices have not answered to any of our written and verbal requests or reports.

WHAT WE HAVE DONE:

1. An incipient program of environmental education and English lessons for the children of the nearby communities.
2. Efficient nightly beach patrols.
3. Presented denouncements on environmental felonies, nevertheless, without results. Because of that we have started to seek for legal advice from the Mexican Environmental Law Network and from the Environmental Law Alliance Worldwide (E-LAW).
4. We could carry out the season with good results. We gave maintenance to the facilities with the help of volunteers, got (for the first time in the Camp) the services of electricity, running water, gas, cellular telephone and internet access. We also have the minimum indispensable infrastructure for managing the Camp. But most important of all, our collection of nests this year, is 250% larger than last year’s and the percentage of living hatchlings was of 85%.

Nowadays, even if it seems ironic, the Mexican government has not decided if they will give us the Turtle Camp this year because of the many changes with our new President and the indefinition of competencies among government offices. We are waiting for a positive response because we already have people ready to register as volunteers and as social service students from several Mexican universities. We also have money invested on advertising, as in our internet website and our publication, also in infrastructure and equipment.

Ours is a great effort with very little funding; and still, we are helping thousands of turtles reach the sea.

ENVIRONMENTAL EDUCATION AND THE PRESERVATION OF THE LEATHERBACK SEA TURTLE AT PLAYA GRANDE, COSTA RICA

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Since 1994 the education program for the Las Baulas de Guanacaste Leatherback Sea Turtle project in Costa Rica has focused primarily on the school of Matapalo. This small village is in the dry tropical forest 6 kilometers from the Pacific Ocean, and the fourth most critical nesting beach for the leatherback sea turtle.

The villagers of Matapalo live in a rural area. Their school is a modest 3-class room structure that currently serves 188 children from kindergarten to 6th grade. Tourism and development began to grow in the 70s and the 80s and recently there has been an explosion of both. The rapid changes near the nesting beach and the neighboring communities are moving at a pace that is greater than advances in the children's education.

The futures of the children of Matapalo and nearby areas will interface in some capacity with the turtle. The leatherback sea turtle is their heritage and responsibility. These children will be the animals' guardian as well as tomorrows' voters and lawmakers. They will inherit all of the past decisions about the turtle, good and bad. The need to conserve this resource and prevent its exploitation in the wake of all the changes is of utmost importance. It has been the aim of the educational program to offer supplemental materials and projects to the school of Matapalo. These projects encourage a broader base of understanding the plight of the leatherback.

There is no curriculum in the school to teach the children about the turtle and environmental education. As a teacher, I have worked on providing one that will be age appropriate for the k-6 school, is easily integrated into their existing program and is fun and creative. I also made every effort to be sensitive to cultural differences and tried to encourage pride and ownership when teaching about the leatherback.

Successfully integrating the goals for a new program so it would be welcomed and used in the school was the first and most crucial step. This was achieved by visits to the school with the cooperation of the park and MINAE and establishing open communication with the school staff and the children. It has been important to honor and respect their past and current efforts at conservation and to remember that our program is there to assist, not to govern. Once trust for our program was established and enthusiasm was shown, we were able to assess the exposure to the leatherback that the children had had. We learned that almost none of the children had seen a leatherback and that some had never been to the beach. To remedy this we initiated a series of trips that have been conducted annually since 1994.

With the assistance of the Park Guards, there were numerous slide presentations of the nesting process shown to the school and follow-up trips to the beach to see a nesting turtle. Also in the evening were trips to see hatchling releases, again, a first for the children. Daytime beach trips have involved beach cleanups with lessons about the dangers that debris presents to the nesting adult and to the hatchlings. There have been trips to the hatchery where teachers and students saw the corrals and were instructed in the need to relocate nests that would have been at risk from beach erosion. They also watched a nest excavation that had many live hatchlings.

Since the Turtle Museum was built, regular trips were scheduled for the children as well as parents to visit the museum free of charge to learn more about the turtle. This year the children had their first tour of the brand new park office. Visits to the museum and the park office show the children various efforts to help the turtle and encourage them to get to know these local resources.

In conjunction with the trips to the beach, there have been various creative follow up activities. Because we were initiating these activities and did not want to exhaust the supplies available to the school, we brought donations of materials down every season including paper, crayons, pens, pencils, toys, books and manipulatives for the kindergarteners. Using the donated supplies the children created a diorama of the beach and ocean environments; made numerous works of art with the baula theme and wrote pen pal letters to be shared with children in the United States. A board game was made, BAULA based on the theme of BINGO, and banners were created. All of these activities helped teach the children about the threats to the leatherback and its life cycle while being fun and creative.

The school participated in a petition-writing campaign to encourage the fisheries to offer more protection to the leatherback from incidental capture in longline, purse seine and drift nets. This was a unique activity that allowed the children to voice concerns about the leatherbacks' safety, make their own statement, and learn to become active in effecting change for the better.

Two years ago the children made paper-bag puppets to tell the story of the leatherback, "El Mundo de la Baula". This proved to be such an excellent vehicle for creative expression and sharing the need to protect the turtle, that the program was expanded. With some ingenuity and resource and the donation of a trunk, a collapsible and portable puppet theater was created with stuffed animals and hand puppets to tell the story.

This year the education program was given a huge boost from a grant from the Fort Wayne Children's Zoo. We were able to take the graduating 6th grade class of 2000 on a 3-day trip to San Jose to visit the National History Museum and the Tirimbina Rain Forest.

Before the trip the children had to complete a questionnaire about the importance of the protection of the leatherback, why the leatherback is important to Costa Rica, what is the significance of conserving natural resources, what they would like to do for their village and what their plans are for the future. This was done to encourage the students to take some responsibility for the trip as well as to help them to think of important challenges ahead. At the Tirimbina Rain Forest, a special environmental education program was designed for these students to help point out the differences and the similarities of the rain forest and their own dry tropical forest. Experiencing these differences first hand gave them a new and enhanced appreciation of their own region. Hopefully this new appreciation will encourage the protection of their homeland, and with it, protection of the leatherback. As one student said, "I never knew anything like this existed before."

Also this year, the puppet theater of Matapalo hit the road. With excitement and enthusiasm, the school brought some of the leatherback theme worksheets to share and put on a wonderful edition of "El Mundo de la Baula" for the nearby school of Waucas. After performing the puppet show, the Matapalo teacher and some students explained the nesting cycle of the turtle and the various hazards, manmade and natural, to its survival. The successful efforts of the previous year's work seemed apparent when the school of Matapalo was teaching another school about the leatherback. The pride was evident as these young people shared their show and their knowledge with their peers.

The project biologists have visited the school to share their experiences with the turtles as well as what country they are from. Some of the biologists have had experience working with other species of sea turtles as well as the leatherback. The students were able to learn form these visits about other regions that support sea turtle conservation and other species that are in peril.

This year the students of Matapalo had a very special treat when the project staff put on a musical play for them about "Paula la Baula". The play combined music, costumes, juggling and comedy all while telling the story about the life of the leatherback.

Because the program has been fun, creative and rewarding, it has stayed active during the time of the year that the project is not in Costa Rica. The relationship with the children and the staff continues in the absence of the project and plans and ideas for the future are now part of a regular dialogue between the United States and Costa Rica. The school has expressed gratitude to our involvement with them and our assistance, often thanking us by dancing in ceremonial costume. Our reward is the knowledge that since we started the program, there is an enhanced interest in the leatherback and its need for protection.

Our goals for the future are to continue to enjoy a close relationship with the school of Matapalo and assist the puppet theater with visits to other schools in the region. We will be adding to our curriculum to keep the children up to date on the advances in research and science to protect the leatherback. We are creating a new web site. There are sister school connections and possible Internet communications that we are working on. We hope to help sponsor the children that have limited opportunities for higher education and to have student exchange programs set up. We are designing a special Leatherback Day Festival to celebrate the leatherback and teach more about the importance of keeping beach lighting to an absolute minimum.

We will continue to look for donations to assist the school as well as external funds to help support the educational program. We will continue to share our project with schools and groups in the United States and monitor the program to be sure our involvement with the school continues to be positive and productive.

When interviews were conducted with the school children of Matapalo about their hopes for the future, many mentioned career paths in education, conservation and marine biology. This enthusiasm for the preservation of the leatherback is what is needed for the future and an indication that our efforts are having an impact. Having informed the children of the plight of the leatherback, we would also like to offer solutions for a brighter future.

Recent 6th grade graduate Margarita hopes to become a biologist. After assisting with a nest excavation I asked her if she wants to be a biologist more or less than before she dug out the nest. She answered an enthusiastic " MUCH MORE!!" With scientific work and park protection on the beach and education about the leatherback in the schools, perhaps the future of the leatherback won't be so grim. We hope this joint effort will help to save the leatherback from extinction, and when Margarita becomes a biologist that there are many Baulas for her to study and continue to protect.

Acknowledgments:

We would like to thank all the individuals and organizations that have helped support the education over the years, and a special thank you to the Parque Nacional Marino Las Baulas, MINAE, Earthwatch, Drexel, IPFW, the Leatherback Trust and the Fort Wayne Children's Zoo for funding and support of this project.

CONSERVATION, MANAGEMENT AND POLICY

SEA TURTLE BYCATCH MITIGATION IN THE HANDS OF INTERNATIONAL INSTITUTIONS: D*EMYS*TIFYING THE WTO AND FAO

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There exist a number of international accords that focus heavily on sea turtle conservation and management, and these hold a commensurably high level of recognition by the sea turtle community worldwide. The Inter American Convention on Sea Turtle Preservation and Conservation (IAC) has received its eighth ratification and will enter into force on 2 May 2001. Under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS or the Bonn Convention) two non binding Memorandum for Understanding have been negotiated in the West African and the Indian Ocean and South East Asian Region, both of which will hopefully be concluded with plans of management in 2001. Finally under the Convention on International Trade in Endangered Species of Fauna and Flora (CITES) trade in hawksbill shell has recently been reconsidered. Less well know are two other international accords which have, and are likely to continue to have, significant impact on sea turtles. These are the World Trade Organisation (WTO) and the Food and Agriculture Organisation (FAO) of the United Nations, and are discussed in turn below.

The World Trade Organisation and the Turtle-Shrimp Dispute a range of measures that are used in the regulation and conservation of marine, and in some cases terrestrial, resources fall under the heading of environmental trade measures. These include conditioning of import approval on the meeting of certain environmental criteria, and placement of product embargoes upon foreign nations where requirements are not met. Perhaps the best known example of this is the US law known as section 609 relating to sea turtle shrimp-trawl bycatch. Another means whereby one nation may attempt to regulate the activities of another is to deny access to their ports based on environmental performance. This is becoming an increasingly popular way by which to influence the activities of nations fishing on the high seas. Finally, and markedly different to the first two examples, is the use of consumer preference and market forces through labelling and certification schemes to influence the environmental credentials and marketability of an industry. In the marine arena examples of this include dolphin-friendly tuna labels in place since the 1980s, and the Marine Stewardship Council certification scheme.

The primary agreement on which current international world trading system is based - the General Agreement on Tariffs and Trade (GATT) - was created in 1947. The premise then, as was carried over in the 1980s Uruguay Round of trade negotiations, was that in the absence of government regulation free trade would lead to increased productivity and specialisation, resulting in more available and affordable products. While it was recognised that safeguards needed to be put in place to ensure that cheap production was not at the expense of the environment, these two goals of environmental protection and trade liberalisation have not found an easy coexistence. There remain many uncertainties in the relationship between the two imperatives.

The Uruguay Round of trade negotiations, as with the anticipated Millennium Round, endeavoured to remedy some of the conflicts, and create a more functional and detailed system. Included in the outcomes were a range of agreements that elaborated the basic text of the GATT. These included an arrangement establishing the World Trade Organisation as a body to administer these accords, a dispute settlement understanding to adjudicate on any conflicts between States, and a series of issue specific arrangements that relate to, among other things, agriculture, subsidies, quarantine and health, and intellectual property. Parties to the WTO must agree to the entire suite of accords, no reservations are allowed.

Two of the core principles of the GATT are that of most favoured nation (MFN) and the national obligation treatments. Together these hold that a WTO party must extend immediately and unconditionally any privilege or advantage it provides to an imported product or product of national origin, to all other "like products" imported from any destination. The traditional test for a like product focused on the characteristics of the product itself, rather than on how it was produced. A 1970 test that was used by many subsequent panels considered "the product's end-uses in a given market, consumers' tastes and habits, which change from country to country, the product's properties, nature and quality." From the environmental perspective this has major implications for efforts to promote sustainable fisheries. If "likeness" relies upon the physical characteristics of a product alone, then a product can not be discriminated upon in regard to the method or process by which it has been produced, irrespective of the laws or prohibitions in the importing nation. Even if production or process methods (PPMs) are inconsistent with the MFN and like treatment requirements, they may nonetheless be permitted under the GATT's Article XX exceptions. Conflict arises between WTO restrictions, and a countries ability to use trade measures to refuse imports it considered undesirable for domestic policy reason. The fact that consumers' ethical values are not the same in all countries has led to some tensions, and opinion on the validity of environmental based import restrictions is polarised.

In the mid 1990s, four nations - India, Malaysia, Pakistan, and Thailand - requested the establishment of a dispute settlement board to consider the legality of section 609 shrimp embargoes applied by the US to nations that caught shrimp without the use of turtle excluder devices or TEDs. Heard under the jurisdiction of the WTO, a three person dispute resolution panel found that US measures were inconsistent with Article XI of the GATT, which maintains that WTO members shall not impose import restrictions. In July 1998 the US lodged an appeal on the WTO's turtle-shrimp decision. In issuing its surprise findings, the Appellate Body (AB) largely rejected the Panel's original decision, describing its earlier interpretation as a result abhorrent to the principles of interpretation we are bound to apply. The AB decision made a number of significant findings. Firstly, with reference to the scope of environmental exceptions regarding PPMs the AB in upholding the validity of the US law found that an exception may be upheld in relation to a PPM if Article XX can be shown to apply. The second significant finding related to conditions which must be met in applying Article XX.

Exceptions to the GATT are included in Article XX the purpose of which is to "allow contracting parties to impose trade restrictive measures inconsistent with the [GATT in order] to pursue overriding public policy goals to the extent that such inconsistencies were unavoidable". Herein is mentioned the protection of the environment as a potentially acceptable grounds for commercial discrimination. This provision, Article XX(g), reads "…nothing in this Agreement shall be construed to prevent the adoption or enforcement by any contracting party of measures: … (g) relating to the conservation of exhaustible resources if such measures are made effective in conjunction with restrictions on domestic production or consumption." A nation wanting to use Article XX has two hurdles to clear. Firstly it must establish the provisional justification for using Article XX by showing that the relevant sub-paragraph applies. It must then establish a final justification by showing that the measure in question does not contravene the chapeau (or introductory paragraph). In terms if subsection (g) a series of tests apply. Firstly, a State claiming an exception must be able to demonstrate that the resource it is aiming to protect is an exhaustible natural resource. Secondly, in order for a measure to be deemed "related to" the conservation of an exhaustible natural resource, the law must be "aimed primarily" at the conservation objectives and show "a close relationship between means and ends".

The clearest statement on determining whether a specific action meets the Article XX exception requirements comes from the shrimp-turtle decision, where the AB defined a number of criteria for not meeting these tests. Although upholding the use of Article XX(g) to except section 609, the AB was essentially critical of the US application of the law, *sayi*ng that it resulted in arbitrary and unjustified discrimination against the four complainant nations. In this regard it established a series of requirements including:

o A nation may not require another state to adopt a particular technology or measure - other technologies or measures that have the same effect must also be accepted;
o When applying measures, account must be taken of differences in the prevailing conditions in other countries;
o Before enacting trade measures nations should attempt to enter negotiations with the exporting state;
o Countries affected by trade measures should be allowed adequate and equal time to make adjustments; and
o Due process, transparency, appropriate appeals procedures and other appropriate procedural safeguards must be available to foreign states or producers to review the application of the measure.

The adequacy of US actions in implementing these measures has been questioned by Malaysia, and adjudication on this complaint is pending.

Sea Turtle bycatch under the FAO's International Plans of Action

The United Nations Food and Agriculture Organisation (FAO) holds primary responsibility within the UN structure for fisheries. The primary instrument thereof is the FAO Code of Conduct for Responsible Fisheries, created under the auspices of the Committee on Fisheries (COFI). Contained hereunder are a range of measures relating to the conduct of fisheries, both within national jurisdiction and on the high seas, including bycatch provisions. The Code uses the terminology of non-target and of associated and dependent species, and as such is concerned with fisheries interactions of a broader scope than bycatch. The Code requires countries to ensure the use of selective fishing gear; minimise ghost-fishing, bycatch and other negative impacts of fishing; and reduce waste and discards (fish and non-fish). It places the responsibility for the development and use of selective gear on fisheries management authorities.

Under the Code, issue specific International Plans of Action (IPOA) may be created. IPOAs are, as is the Code itself, non-binding instrument, with biennial reportage mechanisms. Three IPOAs were created in 1999: seabird longline bycatch; shark conservation and management; and overcapacity. A fourth plan for illegal, unreported and unregulated fishing (IUU) was recently completed. A resolution was passed at the 20th Annual Sea Turtle Symposium in 2000 that:

· urged the development of an IPOA for sea turtle longline bycatch;
· called on the FAO to consider the bycatch of all species in longline fisheries and ensure that action to protect one species does not negatively impact other species; and
· called on the FAO to conduct a technical consultation on sea turtle

longline bycatch.

The second of these was in direct reference to the seabird IPOA and the fear that one mitigation measure - that of night setting - may act to increase the take of endangered sea turtles. In terms of the call for the creation of a sea turtle IPOA, it is instructive to examine the progress thus far of extant plans, and in this regard the IPOA-seabirds has the most similarities to a sea turtle bycatch minimisation plan. The IPOA for the minimisation sea bird capture in longline fishing operations was aimed primarily at reducing albatross bycatch. It has a clear series of steps that nations are encouraged to take, firstly to assess if a seabird bycatch problem exists, and if so to then create national plans of action to mitigate the problem. Though it does not proscribe any particular actions, it does suggest a range of mitigation measures that countries may find useful.

Held simultaneous to the 21st annual symposium 2001, was the biennial COFI meeting in Rome at which national reports on implementation of both the Code and the IOPAs were requested. Information was gathered prior to the meeting through means of a questionnaire. Of the 100 responses received, 8 countries concluded that they had a problem with seabird longline bycatch, 22 said they had no problem, 19 no need for an NPOA, & 33 had insufficient data. A remaining 18 nations did not provide any information.

Though it is too early to determine the success of IPOAs as a fisheries management and conservation tool, some preliminary assessments may be made. Firstly, IPOAs are useful for raising the profile of certain issues. Notwithstanding this benefit, the overuse of these tools is a potential threat to their utility. If every issue that is of concern in fisheries were to be considered under an IPOA, then there would be an exhaustion of interest, momentum and funding for the implementation of these plans. To date, their greatest potential seems to be twofold. Firstly, as a data collection mechanisms where national information already exists but is yet to be collated at an international level: and secondly, as a tool for the extension of best practice fishing methods (eg bycatch reduction technology) where such have been devised. Only very limited financial assistance has been offered to assist nations in assessing and remedying problems subject to IPOAs, and as such the establishment of an IPOA should not be seen as a means to boost research funding or acquire financial assistance.

Notwithstanding the limitations of IPOAs, promoting awareness of sea turtle longline bycatch in the FAO, as well as the potential conflicts in bycatch mitigation methods aimed at different non-target species, is necessary. The conduct of a consultation offers a means to raise awareness of the problem, and to gather information where such exists, absent the long term investment required for an IPOA. The basis for holding such a consultation could rely upon existing Code of Conduct provisions. Because a technical consultation traditionally involved invitees from all 170 FAO member governments, the most appropriate form would, rather, be an expert consultation. One key to success in any FAO initiative lies in finding an FAO member government to champion a particular issue. To date, the United States government seems to have demonstrated the most willingness to take on this role.

In addition to the options contemplated under the FAO, it is important to recall that similar conservation requirements exist under the UN Law of the Sea Convention and the Highly Migratory and Straddling Fish Stocks Agreement. These are both legally binding accords (though the latter is not yet in force) which require member nations and regional fisheries management organisations to conserve and manage associated and dependent species. Their implementation and translation into management measures is likely to have a significant impact on sea turtle and other bycatches. In addition to these international fisheries accords, sea turtle conservation arrangements such as the IAC and CMS offer much promise and provide for the issue of sea turtle conservation to be addressed in a wider context than that of fisheries impacts. Indeed, raising awareness and encouraging governmental support for, and implementation of, commitments under these accords is perhaps an even more necessary and potentially effective pursuit than the creation on additional measures under the FAO.

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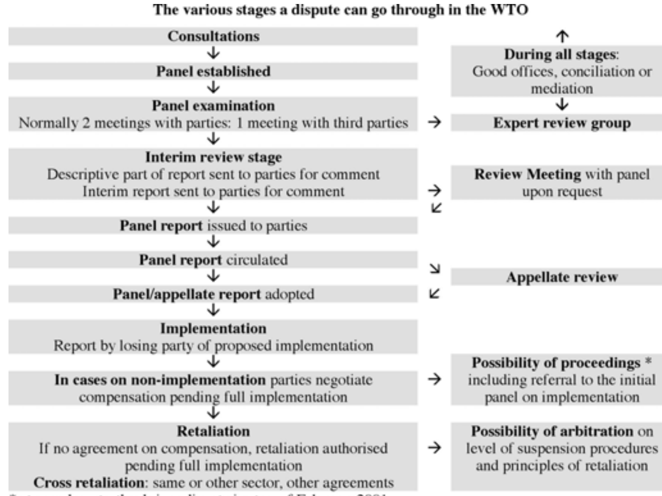
The various stages a dispute can go through in the WTO



* stage where turtle-shrimp dispute is at as of February 2001

TURTLES AND TOURISTS IN A GLOBAL ECONOMY: THE FUTURE OF ECOTOURISM AS A CONSERVATION TOOL

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Ecotourism is a popularly promoted means of reconciling conservation and development objectives, and can accommodate two conservation catch-phrases: sustainable use and community-based conservation. Ten years have passed since ecotourism gained wide-spread recognition with the publication of Elizabeth Booís (1990) Ecotourism: potentials and pitfalls, and it is timely to look at the strengths and weaknesses of the ecotourism approach based on experiences to date. This paper combines research on wildlife based ecotourism in general and around marine turtles specifically with data and examples from Costa Rica, to illustrate the successes and failures of the ecotourism approach. The meaning of ecotourism in general, its links to the global capitalist system, and its potential to both conserve and destroy what it purports to value are discussed. While the paper does not presume to offer solutions, it does attempt to raise some important questions and to broaden the discussion of ecotourism beyond its immediate application to marine turtle conservation.

SCIENCE, CONSERVATION, AND SEA TURTLES: WHAT'S THE CONNECTION?

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SCIENTIFIC PRODUCTION

Scientific activities are appraised in terms of the growth in human resources and production of information: i.e., the training of students, especially graduate students, and publication of articles. A simple way to gauge scientific production is with the Annual Symposium on Sea Turtle Biology and Conservation, where there has been steady growth in both human resources and presentations (Table 1). Academic journals also show an increase in the number and proportion of publications that deal with sea turtles. Moreover, during the past decade various courses have been developed specifically for teaching sea turtle biology and conservation. Research groups specializing on sea turtles have been established in scores of countries on all continents, and graduate students working on sea turtles have been trained at laboratories in dozens universities. Improved technologies, such as genetic sequencing, GIS, and satellite tracking, have made possible research in areas that is rapidly producing enormous amounts of new information. Clearly, the growth in human resources and production of scientific information on sea turtles has been staggering.

THE STATUS OF SEA TURTLES

This remarkable scientific production begs the question: what are the consequences of growth in human resources and information, particularly in relation to the status of sea turtles? The most endangered of all, *Lepidochelys kempii*, is at long last – after millions of dollars and decades of dedicated work by a bi-national program – in the early stages of recovery (TEWG, 1998); but it is nowhere near as abundant as it was 50 years ago. Recent reviews for 3 other species, *Caretta caretta*, *Dermochelys coriacea*, and *Eretmochelys imbricata*, show that far more than two-thirds of the respective nesting populations fall into 2 categories: depleted or declining, and too poorly known to be able to estimate trends (Fig. 1). The concepts of "population" and categories of status can, and will, be debated. Yet, does increased scientific production mean better knowledge and conservation of turtles? The overall picture bodes poorly. Rather than increased scientific production resulting in enhanced status of sea turtle populations, it seems as if we are learning more and more about what is becoming less and less!

THE CASE OF POLICY DECISIONS, WITH SPECIAL REFERENCE TO THE CARIBBEAN

The status of sea turtles is influenced by policy decisions. There are 47 geo-political units (G-PUs) in the western hemisphere, including sovereign states and dependent territories. Sea turtles, their eggs, and derivative products are totally protected in most of these countries, but there is legal exploitation of turtles in 12: Antigua and Barbuda (A & B), Bahamas, Belize, British Virgin Islands (BVI), Cayman Islands, Cuba, Grenada, Haiti, Nicaragua, St. Kitts & Nevis (St K & N), Trinidad and Tobago (T & T), and Turks and Caicos (T & C) (remarkably, 75% are, or were, part of the UK). Details vary between these territories, but eggs are protected in 11, and nesting females, in 8 (Table 2). Open seasons for turtling vary from 4 to 12 months; timing varies between territories and is often planned to avoid hunting during the nesting season.

Eretmochelys is totally protected in 3 G-PUs, and *Dermochelys*, in 4. In 75% of these territories there are legal size limits, and with the exception of Belize, it is a **minimum** size that is legal – the smaller turtles are protected and human exploitation is focused on the larger animals.

Which phase of the life cycle is most critical to a sea turtle population, and most in need of protection? For decades demographers have argued that the larger turtles are most valuable to a population. Crouse et al. (1987) explained the reproductive value of different life phases; these ranged from 1 for egg and hatchling to over 500 for reproductive animals. This is not to say that eggs are worthless, but rather that one breeding animal is 500 times more valuable than one egg.

Setting aside debates about exploitation of sea turtles, the laws that allow for legal exploitation need to be considered in the light of scientific studies. The "science" shows that larger turtles are most important for maintaining a population, yet the laws focus exploitation on just these life phases. These laws do not reflect the "best scientific information." In this respect it is important to appreciate that the Caribbean is not only a well-circumscribed area, but it has enjoyed decades of intensive research, environmental education, training programs, regional meetings and other conservation activities focused on sea turtles. Furthermore, there have been diverse activities of commerce and investments focused on sea turtles for decades, if not centuries, involving numerous sectors of local societies. Why are the laws so discordant with the science?

CLARIFICATION OF FUNDAMENTAL CONCEPTS

What is Science? Like so many other concepts fundamental to certain disciplines (e.g. "culture," "life," "species"), "science" is difficult to define. However it may be defined, "science" is characterized by "*the art of curiosity, the gift of observational tenacity, the capacity to organize and systematize, and an omnipresent sense of skepticism*." (Smith, 1996). "Western," or "occidental" Science is the compilation of information through empirical observation, experimentation (reductionism), formulation and testing of hypotheses, and organization of knowledge into theories. Of central relevance to this discussion are the "natural sciences:" practitioners refer to the "search for the truth" through objective, replicable, pragmatic methods. On the other hand there is conservation (or more precisely "conservation biology"). This term has been defined in many ways, but in the end it is "*The management of human activities so that populations, species, environments, landscapes, and ecological and evolutionary processes are maintained at levels acceptable to society*."

Is "science" conservation? Or is "conservation" science? According to the definitions above, "Science" is about managing **information**; "Conservation" is about managing **people**. This dichotomy may be hard to accept for many field biologists and conservationists who consider conservation biology to be a sub-discipline of biology. Yet, the divergence between science and conservation is conceptually profound, and it is worth considering the roots of the term "science." Although the word was in use as early as the 1300s, it was not until the mid 19th century when it came to mean a special type of knowledge and method in acquiring information. Hence, "science" as it is used in modern societies today, is a relatively recent cultural phenomenon (Nader, 1996). Aristotle is recognized as a founder of western science because of the methods of inquiry and hypothesis testing that he employed and promoted. The same Aristotle called the management of people "**politics**" (in fact, he called the structure, organization, and administration of the state "politics," but these activities clearly involve **managing people**). Hence, conservation is not only outside the field of natural science, it is akin to politics.

The natural sciences are not the only bodies of knowledge relevant to conservation: disciplines related to understanding and managing people are highly germane, including: communication sciences, educational sciences, legal sciences, political sciences, and social sciences. Even the "western sciences" are not the only bodies of knowledge. So-called "indigenous knowledge" has clearly been crucial to the survival of human beings for hundreds of thousands of years, as well as to the development of complex societies and cultures over the existence of our species. Many of these knowledge systems rival western science in the ability to explain and predict our world. It is essential to appreciate that "indigenous knowledge" is not limited to romantic visions of half-naked people with feathers in their hair, dancing feverishly around glowing fires, but potentially applies to any group of people who have acquired knowledge about the world in which they live, including urbanites in First World Metropoli (Nader, 1996).

In many modern societies, science is regarded as a sacrosanct, almost divine, activity. Scientific knowledge forms the foundations to develop technologies by providing information to solve specific problems. Through technology, "Man conquers nature" - thus the veneration of science. The distinction between Scientific and Non-scientific information is regularly expressed with the following contrasts: Objective/Subjective; Unemotional/Emotional; Rational/Irrational; Unbiased/ Biased; Detached, neutral/Value-laden, politically motivated; Autonomous/Dependent on cultural and social roots; Uncensored/Censored; Reliable/Unreliable; Replicable/ Unpredictable; Undeviating/Provisional; Lasting/Ephemeral; Realistic/Unrealistic, naive. However, even the smallest familiarity with "science in real life" or the history of science reveals that the differences are not so clear: scientific activities and information often typify just what is claimed to be anathema to the profession. This leads to basic questions: How is knowledge acquired? Who builds systems of knowledge? Who controls systems of knowledge? Who owns systems of knowledge? Who evaluates knowledge? Who validates knowledge? As long as certain "sciences" claim to be in control of these processes, intellectual development will be stunted (Nader, 1996).

CONCLUSIONS AND RECOMMENDATIONS

Several points are basic to understanding the connections between science and conservation. In terms of the "Natural Sciences" it is essential to understand the **strengths** and **limitations** of the science **and** the scientists. Practitioners must seek professional help and collaboration from professions that specialize in **understanding** and **managing people**: how and why *Homo sapiens* is organized and behaves. In terms of those "Other Sciences" it is also essential that the practitioners understand the **strengths** and **limitations** of their science, and also their scientists. They must learn how to converse with natural scientists – and not hide in their ivory towers either! These are the people who need to work hardest at building teams with natural scientists – after all, "other scientists" are the specialists in human behavior and interactions! Science, conservation and sea turtles: what's the connection? It's what we make it!

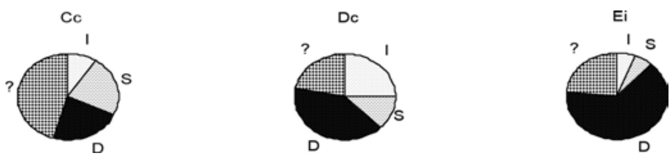
Table 1. Summary of vital statistics from the Annual Symposium on Sea Turtle Biology and Conservation (* includes presentations made at the associated "mini-symposium").

Symposium	8	10	11	12	13	14	15	16	17	18	19	20
Participants	245	446	500	544	565	547	602		720	653	714	960
Countries		18	17	28	29	21	28		38	43	34	67
Presentations *	44	126	113	140	136	141	161	87	199	265	208	282

Table 2. Summary of legal exploitation of sea turtles in eleven Caribbean geo-political units.

G-PU	Egg	Nesters	Season	*C. caretta*	*Ch. mydas*	*E. imbricata*	*D. coriacea*
A & B	No	?	Sep-Feb	>160lbs	>180lbs	>85lbs	>350lbs
Bahamas	No	No	Aug-Mar	>30"	>24"	None	?
Belize	No	?	Nov-Mar	<60cm	<60cm	None	?
BVI	No	?	Dec-Mar	>20lbs	>20lbs	>20lbs	?
Cayman	No	No	Nov-Apr	>80lbs	>120lb	>80lbs	None
Cuba	No	No	Aug-Apr	>65cm	>65cm	>65cm	None
Grenada	No	Yes	Sep-Apr	>25lbs	>25lbs	>25lbs	None
Haiti	No	No	Nov-Apr	all sizes	all sizes	all sizes	all sizes
Nicarag	Yes	No	Jul-Feb	None	all sizes	None	None
St K & N	No	No	Mar-Sep	>160lbs	>180lbs	>85lbs	>350lbs
T & T	No	No	Oct-Feb	?	all sizes	all sizes	all sizes
T & C	No	No	Jan-Dec	>20lbs	>20lbs	>20lbs	>20lbs

Figure 1. Summary of status of nesting populations of *Caretta caretta* (“Cc”) global (Margaritoulis, pers. com.; Witherington, pers. com.); *Dermochelys coriacea* (“Dc”) global (Sarti, pers. com.); and *Eretmochelys imbricata* (“Ei”) Caribbean (Meylan, 1999). “I” = increasing; “S” = stable; “D” = decreasing or depleted; “?” = information not available.



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US NAVY'S SEA TURTLE CONSERVATION EFFORTS

Matthew Hess

Navy has a good record of accomplishments in the area of sea turtle conservation. In addition to governing laws and regulations that are applicable to Federal agencies, as well as the general public, the Navy and DOD have policies for the protection of threatened and endangered species. Navy has a network of natural resource specialists encompassing many disciplines that work to ensure Navy activities comply, and where possible exceed, its legal and policy obligations. This presentation will provide some specific examples of past and present conservation efforts to illustrate the nature and extent of the Navy's commitment to protecting and conserving sea turtles. It will also provide an understanding of the cooperation and teamwork that is employed in accomplishing these tasks. Lastly, this presentation will provide information on efforts that Navy is currently undertaking with regulatory agencies in the area of spatial data analysis (Geographic Information Systems) to further our protection and conservation objectives for sensitive species, as well as to avoid impacts on military training and readiness. In achieving this objective, our hope is to solicit interest and assistance from the scientific community represented at the symposium.

MANAGEMENT RECOMMENDATIONS RESULTING FROM SATELLITE TRACKING RESIDENT, IMMATURE LOGGERHEADS (*CARETTA CARETTA*) IN AND AROUND THE FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARY, NORTHWEST GULF OF MEXICO

Emma L. Hickerson

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Six large immature loggerhead sea turtles (*Caretta caretta*) with carapace lengths (CCL) ranging from 70.5-101 cm were captured at depth by SCUBA divers. Five of the six were outfitted with radio and/or satellite transmitters. Five of the six animals were females. A pubescent male was recaptured three times over a period of 20 months. Over 40% of the satellite locations fell within the Sanctuary boundaries. Geographic Information System (GIS) analysis revealed an average core range of 133.6 square kilometers and an average home range of 1074 square kilometers. These ranges are not significantly different from satellite tagged *C. caretta* captured underneath oil and gas platforms in the Gulf of Mexico. The average core ranges fell within one kilometer of the sanctuary boundaries, and the home range within 30 kilometers of the sanctuary boundaries. Management recommendations are made to the National Oceanic and Atmospheric Administration’s (NOAA’s) Marine Sanctuary Division.

SEA TURTLE PROTECTION ACROSS FRONTIERS: EXCHANGE OF EXPERTISE BETWEEN THE NETHERLANDS, BENIN AND COSTA RICA

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INTRODUCTION

As an implementation of the Rio Declaration, The Netherlands, Benin, Costa Rica and Bhutan, signed international agreements in 1994, in order to promote sustainable development in each of these countries. The agreements are based on reciprocity, equality and participation. Normally, a bilateral co-operation between the Netherlands and one of the other signatory countries is established. Within the framework of these international agreements, several NGO's from The Netherlands, Benin, and Costa Rica, have started in 2000 to collaborate on the protection of marine turtles.

HISTORY

In 1999, the Beninese NGO Nature Tropicale started a sea turtle conservation program in order to protect the three species of marine turtles that nest in Benin. As Nature Tropicale was in need of expertise they were looking for possibilities to share information with other organisations that already had experience with turtle conservation. Through the Dutch IUCN, Nature Tropicale came in contact with Biotopic, a Dutch organisation that is involved in marine turtle conservation. As NGO's from the Netherlands, Benin and Costa Rica are all involved in sea turtle conservation, the idea was born to start a trilateral collaboration between these countries. We identified partners in Costa Rica in order to participate in the co-operation, and the result was the project titled: "Sea Turtle Protection Across Frontiers".

The goals of the project are to:
1) exchange expertise and information in order to learn from each others experience;
2) improve the sea turtle project in Benin using the experience that is present in Costa Rica and The Netherlands.

The means in order to reach these goals were:
1) a study trip to Costa Rica in order to visit several turtle projects;
2) an evaluation of the sea turtle conservation project in Benin;
3) the organisation of a workshop in Benin in order to train conservationists in Benin and neighbouring countries in the different aspects of sea turtle biology and conservation.

The partners that are co-operating in this project are;
1) Biotopic, a Dutch NGO with six years of experience on marine turtle conservation in Suriname ;
2) Nature Tropicale, a NGO from Benin that started to work on marine turtles two years ago;
3) STRP and ANAI, two NGO's from Costa Rica, both with many years of experience in sea turtle protection;
4) IUCN France, which is involved in sea turtle protection in Africa.

PART 1: STUDY TRIP TO COSTA RICA

The first part of the collaboration was a field trip to Costa Rica in order to visit a variety of sea turtle conservation projects. The main goal was to learn from the vast experience in turtle conservation that has been obtained in Costa Rica during the last decades. For a period of three weeks, two members of Nature Tropicale and two members of Biotopic visited five different sea turtle projects: Tortuguero, Ostional, Playa Grande, San Miguel, and Gandoca. San Miguel is an example of a small project in which STRP started two years ago to work together with the local community. In Gandoca, on the Caribbean side of Costa Rica, ANAI is running a project in which ecovolunteers are participating in the protection of sea turtles, thus providing the local community with an income.

All together, the diversity in sea turtle projects in Costa Rica provided us with many examples of sea turtle conservation by research, ecotourism, community involvement, legal egg harvesting, and ecovolunteers.

PART 2: EVALUATION IN BENIN

The second part of the project consisted of an evaluation of the sea turtle conservation program in Benin. The main goal was to see whether some aspects of the project that is executed by Nature Tropicale could be improved.

During the evaluation, Biotopic and Nature Tropicale were supported by Dr. Jacques Fretey (marine turtle expert and scientific co-ordinator for IUCN-France and the CMS in the West and Central African region). For 2 weeks visits were made to environmental organisations, the university of Benin, local communities and ecoguards, nesting beaches , and markets. The participation of STRP and ANAI in the evaluation was technically not possible, but future co-operation between Nature Tropicale, STRP and ANAI is currently being prepared.

MARINE TURTLES IN BENIN

Benin has 125 km of Atlantic coast that is visited by leatherbacks, green turtles and olive ridleys. So far, the actual number of nesting turtles is unknown. Many turtles that come ashore in Benin are killed by local inhabitants. This is also the case for animals that are caught at sea in fishing nets. The turtles are used for their meat, oil and carapaces. Other threats to marine turtles in Benin are the poaching of turtle nests, and the coastal development that is just beginning in some areas.

In 1999, Nature Tropicale initiated the 'Program for protecting marine turtles at the Atlantic coast of Benin'. Protection committees were installed in each of the four coastal zones of Benin, consisting of locally selected ecoguards, and having the mission to protect sea turtles and to gather information on their status. In addition, several awareness seminars were held in order to inform the coastal population that it is forbidden to kill turtles or to take the eggs. Finally, two hatcheries, were installed. Because of the work of Nature Tropicale, the local population has started to participate in the conservation of turtles in several areas. Nevertheless, the slaughter of turtles still continues.

Next to the consumption of meat, eggs and oil, the carapaces are being used by local artisans. Also, turtle products like carapaces, heads and fat are used in the preparation of traditional medicine. This is also the case with many other animal products, some of which from protected species. On the biggest market in Cotonou (the capital of Benin), hundreds of skulls, heads, skins, hands, and wings of a.o. apes, leopards, lions, antelopes, snakes, chameleons, civets, dogs, tortoises, and birds are for sale. Also living animals like pythons, tortoises, chameleons and owls are sold. Most of these products are used for the preparation of traditional medicine. In some cases, they are used in voodoo rituals.

VOODOO

West Africa is the origin of voodoo, and we have noticed that turtles are sometimes used as a fetish, and that there are several myths that involve turtles. For instance, in Sèmè plage in east Benin, people are afraid of leatherbacks, and therefore, they do not touch them. They believe that, if you encounter a leatherback on the beach, you have to scream before the leatherback does, and if you don't, something bad will happen to you. Unfortunately, they are not afraid of the other species.

In the same village, we witnessed an annual voodoo ritual, and we were told that turtles were involved in the ritual. According to the story as we understood it, they collect olive ridley hatchlings, keep them in a 'convent', and after a week, at the end of the ceremony, they release the hatchlings. Unfortunately, we were not allowed to see the hatchlings. In Ouidah, we visited the 'King of Voodoo' and he told us that once a year, he goes at sea mounted on the carapace of a living marine turtle.

PART 3: WORKSHOP IN BENIN

The workshop lasted for a week, and was held at Grand Popo, one of the main nesting beaches in Benin. The aim was to train conservationists from Benin and neighbouring countries in the practical and theoretical aspects of marine turtle biology and conservation. The twenty-one participants from seven West African countries were representatives from NGO's involved in nature conservation, universities, or other institutions:

Benin Nature Tropicale, AVPN, BPL
Togo Universite du Benin Lome Togo
Cameroon Projet Campo
Senegal Village des Tortues
Sierra Leone Conservation Society of Sierra Leone
Liberia SAMFU Foundation
Ghana Ghana Wildlife Society
USA Peace Corps
France IUCN
The Netherlands Biotopic

During the workshop, the opportunity was used to create a regional network for sea turtle conservation in the West African region, with the main goal to exchange data, information and expertise within the region. This new sub-regional network is called WASTCON (West Africa Sea Turtle Conservation Network), and is integrated in the program of Kudu, that was created by the CMS and the IUCN, and that encloses the entire Atlantic region of Africa and Macronesia. It is planned to meet at least once a year in a West African country, and to collaborate on several subjects like a.o. the creation of a regional database, an inventory of the nesting beaches, and the determination of the number and species of turtles, and the number of accidental captured turtles. The next meeting is planned in Nigeria in July 2001.

CONCLUSIONS

So far, the international co-operation between The Netherlands, Benin and Costa Rica has been a very instructive experience for all parties, especially for Nature Tropicale and Biotopic. Like in most turtle projects, some things could be improved in Benin. First of all, it is important to determine the number of turtles that nest in Benin. Next, a way should be found to stop the massacre of turtles in collaboration with the local communities, and to facilitate this, awareness should be increased. It is also important to determine the impact of shrimp fisheries on marine turtles residing in Beninese waters. The international workshop was the first of its kind in the West African region, and it was a great success. It also provided a very good opportunity to start a regional co-operation in West Africa.

Finally, the possibilities for the continuation of sustainable co-operation between the Netherlands, Benin and Costa Rica are being evaluated.

Acknowledgments:

We would like to thank Ecooperation The Netherlands and the Centre Beninois pour le Developpement Durable(CBDD) for funding this project. Also many thanks to IUCN-France which made the participation of Dr. Jacques Fretey in the project possible. We are also very grateful to the Dutch Comité for the IUCN for their financial support in the organisation of the workshop.

A REGIONAL SEA TURTLE CONSERVATION PROGRAM FOR THE GUIANAS

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Sea turtles are an important natural resource shared by the countries of the Guayana Shield region. Four species nest on the region's beaches and forage in its the jurisdictional waters. These are the leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*) and hawksbill (*Eretmochelys imbricata*).

A regional sea turtle conservation program and strategy, funded by WWF-GFECP, has been developed for the Guianas (Guyana, Suriname, Guyane), with the participation of key stakeholder groups such as the relevant Government Authorities, NGOs, private sectors and local communities. This Regional Sea Turtle Conservation Program and Action Plan aims at lending impetus to action at all levels: local, national, and regional (tri-national and beyond). It integrates the contemporary conservation efforts in each of the three Guianas, including research, conservation, and management initiatives presently sponsored by Government, Academia, NGOs and indigenous communities. It provides a framework for national and regional scientific research and monitoring, conservation and awareness campaigns, and collaboration among local, regional and national entities in sea turtle conservation in the Guianas.

The regional program has four main components:

- Monitoring and research
Assessment of size and trends of rookeries
Population identification
Identification of critical habitats and main threats

- Direct conservation activities
Protection of nesting sites
Management of visitors
Reduction of fisheries by-catch

- Capacity building
Fostering the involvement of the national universities in sea turtle conservation
Development of training workshops
Promotion of linkages among local, national, and regional institutions

- Conservation support activities
Harmonized legislations and regulations framework
Public awareness, education and information
Coastal community support activities
Regional and international cooperation

A final review by the Widecast network is planned before the program implementation. The first part of this regional plan is expected to cover a five-years period.

MAPPING MARINE TURTLE NESTING BEHAVIOR AND BEACH FEATURES TO ASSESS THE RESPONSE OF TURTLES TO COASTAL ARMORING

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It is currently unclear what causes a sea turtle to emerge onto a specific beach, and upon emergence, what cues must be encountered for her to nest. In an effort to determine whether different structures in the primary dune influenced sea turtle behavior, the following study was undertaken on Jupiter Island, Florida.

Florida's Atlantic coast beaches are generally known for their large densities of sea turtle nesting. These beaches host 95% of all sea turtle nesting in the United States (National Resource Council, 1990). Additionally, these beaches are home to a large population of Florida residents, leading to extensive coastal development. This development, tied to continual beach erosion, creates demand for beach shoreline stabilization practices. Hard shoreline stabilization practices, also known as beach armoring, frequently occur on these beaches in the form of sea walls and/or rocks being placed on the beach, or implementation of groins, rocks, and/or jetties in the water. The latter structures interfere with the natural littoral drift, further exacerbating beach erosion downdrift of the structures and creating beach accretion updrift of the structures.

Few studies have examined the effects of beach armoring on sea turtles. Those studies that have been carried out demonstrate that the presence of armoring leads to fewer turtle emergences onto the beach, a higher occurrence of abandoned nesting attempts, and may also cause a reduction of nesting habitat (Mosier, 1998). The current study was undertaken in order to create a highly detailed map of the beach to show important beach attributes as they relate to sea turtle nesting. In addition, we were interested in documenting what turtles do and where they go on the beach with respect to these mapped attributes.

This study took place at Jupiter Island, a barrier island along the East Atlantic Coast of Florida, USA. This island experiences chronic erosion problems due to the presence of St. Lucie Inlet to its north and Jupiter Inlet to its south (Clark, 1992). In response to this erosion, as of 1985, approximately 80% of the shoreline was protected by some type of armoring (Aubrey, 1995). Only loggerhead turtles were included in the study as they were the only species to nest in large enough numbers to ensure adequate sample size for our statistical analyses. One reason Jupiter Island was selected was the large number of loggerhead nests found there. During the summer of 2000, within our study area of five kilometers, loggerhead nesting density ranged from 288-527 nests/km, making it one of the most densely nested loggerhead beaches in the world.

Jupiter Island was ideal for this study because it had many different kinds of armoring. The primary dune varied from simple vegetation to complex arrangements of sea walls, rocks and beach access cross-over structures. All data were collected with a Trimble Differentially Corrected Global Positioning System (DGPS). We walked along the dune and recorded DGPS positions and dune characteristics (i.e. vegetated dune, wall, rocks, etc.) found along the primary dune. Once a month, we collected DGPS positions along the spring high and low tidelines and measured the vertical height of features along the dune, as they would appear in an emerging turtle's field of vision (Figure 1). These measurements were collected at five meter intervals using a hand-held level, and then assigned to three discrete categories based on the angle measured: short (0-4^{o}), medium (4-15 ^{o}), and tall (15-75 ^{o}).

Turtle crawl data were collected by daily track surveys occurring over a period of 69 days in the middle of the loggerhead nesting season. For every turtle crawl encountered, two DGPS readings were recorded, one at the point of emergence onto the beach and one at the turtle's last decision before returning to the water. The point of emergence was defined as the point the turtle track crossed mean-high water, and the site of the last decision was the point the turtle decided to return to the water as indicated by the track. The last decision was recorded as apex of crawl, abandoned body pit, abandoned egg chamber, last turn, or nest. Beach data and crawl data were plotted in ArcView. The beach was divided into ten-meter segments and turtle crawls were assigned a feature height and dune characteristic based on the segment the crawl occurred in. During the 69-day study period, 3,061 loggerhead crawls resulted in 1,290 nests.

Initial statistical analyses were performed on the data set, but work is still in progress to fully analyze data collected. We tested the hypotheses that there was no significant difference in turtle emergence density or nest density with respect to dune habitat characteristics. Crawls were divided into categories based on dune characteristic, and categories were chosen to represent differences from the perspective of the turtle. The categories consisted of dune habitats that were 1) completely natural, 2) mixed natural and anthropogenic, 3) completely anthropogenic, yet still allowing the turtle access to the beach due to its landward location, and 4) completely anthropogenic, yet impeding a turtles access to the beach due to its seaward location.

Non-parametric Kruskal-Wallis tests were necessary as data did not meet the assumptions of the ANOVA, even upon transformation. Results indicate there was no significant difference in emergence density based on dune composition ($p=0.84$, Figure 2), but there was a significant difference in nesting density based on dune characteristics ($p<0.001$, Figure 3). A multiple comparison test indicated no significant difference between the first three categories, but those categories had significantly greater nesting densities than category 4, which represented anthropogenic structures located seaward of the dune system ($p<0.05$).

Based on initial analyses, only the most seaward structures affected sea turtle nesting. These structures increased the occurrence of nest-site abandonment, but did not affect the overall number of nesting attempts. Therefore, turtles still emerged onto portions of the beach where anthropogenic structures threatened to block access to optimal nesting habitat. However, upon encountering these structures, turtles then abandoned the nesting sequence and returned to the water. Management implications that arise from these findings suggest placement of armoring structures on the beach should be closely regulated, because their position relative to the dune system and ocean significantly impacts a turtle's decision to nest. Further analyses are currently underway to investigate detailed impacts of structure type, structure proximity, and feature height on sea turtles and their nesting behavior.

Many questions remain for beach armoring and its impact on sea turtles. Due to logistical problems, beach slope and elevation were not measured for this study, yet their importance to sea turtle nesting has been previously reported (Wood, 2000). Measuring these variables with the same level of accuracy and precision that the other variables were measured can prove difficult, due to the labor-intensive methods involved and cost of monitoring. More beaches also need to be evaluated to gain a better perspective on the overall impacts of beach armoring on nesting sea turtles. Beach erosion poses a continual problem, and stabilization practices will only increase in frequency and magnitude. We need to try to understand the impacts of beach stabilization practices while natural beaches remain, allowing us suitable control beaches, or our attempts to conserve and manage sea turtles may suffer.

Figure 1. Illustration of technique used to collect feature height, which is the visual angular height to 1) the top of the dune, or 2) the top of the tallest object behind the dune. Data were collected monthly at five-meter intervals within the study area.

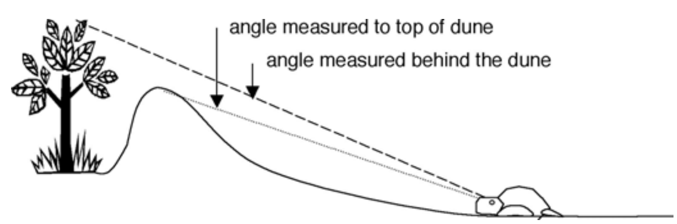

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Figure 2. Results of Kruskal-Wallis test indicating no significant difference in emergence density with respect to categorized structure types.

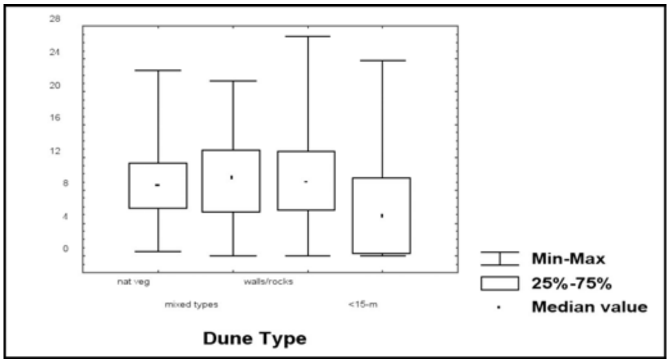
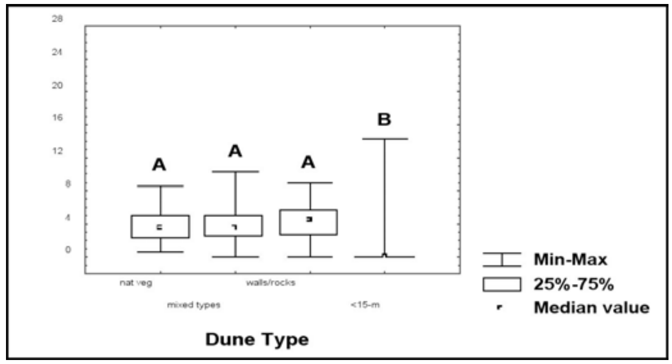


Figure 3. Results of Kruskal-Wallis test indicating a significant difference in nesting density with respect to categorized structure types. A multiple comparison test revealed that the first three categories were not significantly different from each other, but they were significantly different than the fourth category (anthropogenic structures located seaward of the dune, p<0.05).



SOCIAL NORMS AND COMPLIANCE WITH SEA TURTLE CONSERVATION POLICY: A CASE STUDY FROM ISLA HOLBOX, QUINTANA ROO, MEXICO

Sonja Macys

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Sea turtle harvesting continues along some beaches on Mexico's Yucatan Peninsula, despite policies that explicitly prohibit it. This type of poaching has been documented since the beginning of conservation movements. Early management responses were to increase restriction and intensify enforcement efforts. History suggests that these approaches alienated local stakeholders who depended on the resource, further exacerbating the problem (Campbell, 1998). Concerned with the threat poaching presents to vulnerable wildlife populations, managers have begun to take new approaches to deter it. Transforming poachers into protectors through nature guide training programs is an emerging response (Jacobson, 1992; Vieitas, 1999). If these programs are to succeed in protecting wildlife from poaching, they must address the factors that make it the most appealing option. This is particularly true in developing countries where wildlife and communities are expected to co-exist within the structure of protected areas.

In the Yumbalam Flora and Fauna Refuge the Mexican non-profit organization Pronatura Peninsula de Yucatan, (PPY) and government agencies SEMARNAP and PROFEPA have established an agreement for the co-management of sea turtles. Together these organizations are working to protect Loggerhead, Hawksbill and Green turtles. They have identified an obstacle to protection- a lack of social science data about fishermen and their interaction with sea turtles. Without these data, conservation efforts address only the biological factors of sea turtle monitoring and protection. They fail to address the human causes associated with mortality and the opportunities to improve monitoring and protection efforts. If managing agencies expect fishermen and sea turtles to co-exist in areas where turtles were once fished, they must understand fishermen's perceptions of sea turtles and orient their management actions towards them.

The present study, funded in part by the National Fish and Wildlife Foundation, was conducted with the intention of providing a better understanding of fishermen's perceptions towards sea turtle conservation. From September to December 2000 data were collected on non-compliance with the ban on sea turtle harvesting and fishermen's perceptions of sea turtles, conservation policy, and management actions on Isla Holbox.

METHODS

Ninety-four fishermen were interviewed in 2 phases. They represent 30% of each of the 3 local fishing cooperatives. Follow up interviews were conducted with local authorities, and employees in the sea turtle conservation and protection program. In the first phase, photographic interview techniques were used. Fishermen were contacted on randomly selected days while collecting their pay at local fishing cooperatives. They were shown 22 photos depicting marine life, fishing, freely roaming turtles, turtles and tourism, environmental education, protection, ritual use, and commercial use. They were then asked if any particular photo that called their attention and, if so, why they chose that photo. This method allowed for their free expression of salient beliefs about the photos seen (Harper, 1987). It also served to build rapport with the community and facilitate the acceptance of the study. After having reacted to these questions, fishermen were asked to sort photos in a way that made sense to them (Bernard 1995). They were asked to explain why they sorted these objects the way they did, thereby defining categories that would reveal their perceptions of marine life and sea turtles. As a final exercise, fishermen were asked to rank the photos of turtles from the most acceptable photo to the least and to explain why they chose this order.

In the second phase, semi-structured interviews were used. Lists of members and associates were obtained from the each of the 3 cooperatives. Subjects were selected at random from these lists, selecting every third or fourth member based on the necessary sample size. In order to maintain confidentiality, selection lists were destroyed once fishermen were contacted and interviewed. Semi-structured interviews were conducted with the goal of gathering responses to research questions defined in the first phase. Responses were elicited through open-ended interviews.

A preliminary analysis was conducted between phase one and phase two, using descriptive statistics to determine frequency of occurrence in terminology and responses that revealed norms about sea turtle harvesting. The same was done for perceptions of management actions. This analysis served to review project objectives and incorporate recurring points that fishermen made in phase 1. It is widely suggested that this type of iterative approach is critical, both to qualitative research and rapid appraisal methods, two approaches used by the study (Babbie, 1998, Beebe, 1995, Rubin, 1995).

In the field, all data were recorded and transcribed. After leaving the field, responses were entered into categories defined based on the project's objectives. Content analysis was used to determine similarities in responses based on these categories. Data were entered into SPSS version 10.0. Descriptive statistics were used to represent key findings and an analysis of mode was used to compare estimated rates of non-compliance, perceptions of fishing nets, and sea turtle populations.

RESULTS

Fishermen's language use provided important insights about how to approach them. It has been suggested that conservation is a Western term with little relation to developing countries. Do communities in developing countries really "get" the term conservation? Are there more appropriate terms that may be used to represent this concept? To describe the efforts of managing agencies, scientists use "protect" (25%) and "conserve" (17%), whereas 40% of fishermen used the word "cuidar", to take care of, to represent the same concept. Based on these findings, researchers learned that when discussing conservation efforts with fishermen, it was preferable to use the term "cuidar". When approaching a community or developing environmental education programs it is important to know the community's language use and develop materials with an appropriate vocabulary.

Regarding the photographic interviews, fishermen considered photos representing environmental education most acceptable. Photos representing commercial harvesting were considered the least acceptable. And while photos of turtles entangled in nets were not chosen as the worst, they caused a strong reaction with fishermen. In phase one, 58% reported nets to be a problem. Regarding knowledge of conservation policy, all but one of the fishermen interviewed knew that there was a ban on turtle harvesting and most could identify when it had been implemented within 5 years. The ban was interpreted flexibly and knowledge of it did not lead to compliance with it. Regarding compliance with conservation policy, the majority agreed that turtles were harvested once a year. Most found this limited harvest acceptable for a variety of reasons related to the community's traditional tie to turtles. Calculations based on fishermen's own reports indicate that annual turtle capture by fishermen in cooperatives can be estimated at 109 turtles. Regarding perceptions of conservation efforts, fishermen cited natural predators such as birds (77%) as serious threats to survival. Other concerns were lack of enforcement of international policy on sea turtle harvesting (40%); lack of funding for conservation efforts (11%); and that biologists arrived late in the season (7%) and didn't communicate with fishermen (7%). "Headstarting" was a common suggestion to minimize the impact of natural predators (20%). In the second phase, net entanglement was a concern with 68% of fishermen reporting having found an entangled turtle. If the turtle were caught alive 53% would take it and 47% would throw it back. If it were dead, 100% would cut it open and sink it to the bottom of the ocean. Fishermen offered information about how they helped sea turtle conservation efforts. Fifty-three percent helped by not capturing turtles. Thirty-five percent saved turtles entangled in nets, and 12% lent their boats or vehicles to biologists to patrol the beaches. Regarding conservation strategies, 26% recommended environmental education and 6% mentioned development planning on nesting beaches.

CONCLUSIONS

This study does not end here, though its goals and objectives were met. Through the analysis of data gathered we have begun to understand where sea turtles fit into the community's vernacular. We know that fishermen posses extensive knowledge of sea turtles and the conservation policies that exist. We also know that they interpret these policies as they find beneficial to them and that their social norm involves turtle harvest annually. Fishermen are supportive of environmental education and conservation. They exhibit and describe helping behavior. It is now the responsibility of managers to capitalize on these positive factors and move forward, towards greater community involvement in sea turtle conservation and protection.

There must be better communication between turtle biologists and fishermen. If turtle biologists do not gain fishermen's respect, friendship and trust, direct capture threatens to continue at current levels. One possibility for opening this communication would be to request their collaboration in projects designed to monitor turtles in the open ocean. If fishermen were encouraged to report on their turtle sightings, researchers could improve community involvement with turtle monitoring and collect data on turtles in the ocean with no cost. They may also be able to recover tags and therefore track migration patterns with greater success. Community involvement in monitoring efforts is one natural opportunity identified by this study. Environmental education is another. Fishermen place their hopes for the future in children. If we expect children to grow up with a traditional tie to turtles that represents conservation, we must continue environmental education efforts, both with children and their parents. Lastly, research and projects related to the mitigation of threats identified by this study must begin.

Three principal threats were identified by this study: direct capture, incidental capture in fishing nets, and unplanned development. Each of these threats has a corresponding mitigation strategy. Further research is necessary to determine the population dynamics of sea turtles and therefore provide a more accurate representation of direct capture and its effect on population dynamics. A study of at least one year in length is necessary to determine the impact of nets. Through such a study, researchers could gather data on the different types of nets used, seasonality of use and the number of users. They could also incorporate observer's reports and fishermen's reports as important complementary data in this process. Both direct capture and net entanglement affect juvenile and adult turtles, however, unplanned development primarily endangers nesting females. Research about the community's land use decision making process would provide the necessary understanding of community mechanisms that could mitigate the impact of development. Further implementation projects could then work with the community in planning development in such a way that it does not negatively impact turtle nesting beaches. In order to conserve sea turtles, we must work to counter the threats they face in all stages of their lives. By minimizing development pressures on nesting beaches, calculating incidental bycatch in nets, and striving to limit direct capture, we move one step closer towards this goal.

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PROJETO TAMAR-IBAMA: SHARING 20 YEARS OF EXPERIENCE CONSERVING SEA TURTLES IN BRAZIL

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The mission of Projeto TAMAR is to conserve sea turtles found in Brazil. The name "TAMAR" is a contraction of the words "tartaruga," which means turtle in Portuguese, and "marinha," which means marine. The program began its activities in 1980, when the government of Brazil attended an international meeting where strategies for sea turtle conservation were discussed. The country did not have any data to offer. At the time, there was no organized initiative for marine conservation in the country.

Since nothing was known in Brazil about sea turtles, the first step of the fieldwork was a survey to identify distribution, species, nesting periods, and conservation needs. This was conducted over two years (1980-1982) and covered approximately 4,000 km of shoreline, starting at Rio de Janeiro and heading north to Amapá. At this time a team of three people started a long journey by boat, by foot, by horse, interviewing fishing people from each small village along the coast and observing these areas for cues of the presence of sea turtles. As a result, the main threats were first defined: which were the collection of almost 100% of the eggs by coastal residents, the hunting and killing of nesting females, the use of shells for trade or decorative purposes, incidental capture by different artisanal fisheries, unregulated coastal development, and the impact of artificial lighting as a result of such development. One of the most important things was the identification of cultural habits in consumptive use.

After this two-year survey, the main nesting sites along the mainland that needed protection were identified. It was clear that the biggest challenge for sea turtle conservation in Brazil was the 8,000 km of coastline. The first TAMAR stations were established in Pirambu (Sergipe), Praia do Forte (Bahia), and Regencia (Espirito Santo), by combining the number of nests and the prevalence of different species.

There are 5 species occurring in Brazil. They are *Caretta caretta*, *Eretmochelys imbricata*, *Lepidochelys olivacea*, and *Dermochelys coriacea*, that nest from September to March, and *Chelonia mydas* that nests from December to May. *C. caretta* ("tartaruga cabeçuda") is the most common sea turtle nesting along the Brazilian mainland. *C. mydas* ("aruana") is the only nester on the oceanic islands, although there are rare nesting occurrences along the mainland. It is the most abundant species occurring in the country. It is also the most observed species feeding along the coast and found stranded. *E. imbricata* ("tartaruga de pente") nests mostly on the northern coast of the Bahia state and is found feeding in juvenile stage around the islands of Fernando do Noronha and Atol dos Rocas. *D. coriacea* ("tartaruga de couro") nests only on the northern coast of Espirito Santo state. *L. olivacea* ("tartaruga oliva") nests mainly on the coast of Sergipe state. (Refer to Table 1 for species specifics.)

During the past 20 years TAMAR has extended its conservation work to 20 stations (Figure 1), covering and protecting 1,000 km of shoreline in 8 different states, directly employing more than 450 people, 80% of whom are from the coastal communities. Forty percent of the stations operate all-year around and the remaining operate only during the nesting season. Each station is responsible for a minimum of 50 km of shoreline. The main ones are equipped with information centers, display tanks used only for educational purposes, and small museums adapted to the local circumstances. It is important to point out that each station has its own cultural characteristics that are respected when implementing conservation activities. Some are federal biological reserves or national parks established by the government due to the action of TAMAR. Each station has at least one biologist coordinating a team of interns and local people. TAMAR has also been working in the three oceanic islands. A station is located at the National Marine Park of Fernando do Noronha, located 200 miles from the mainland. Another station is on Trinidade Island, which is a naval station closed to the public, located 500 miles from the mainland. This is the only nesting site where there was no human impact due to the naval protection. The

Biological Reserve of Atol das Rocas, located 144 miles from the mainland, provides the third island station.

The activities conducted by the stations are divided into two aspects. Firstly, the protection of the feeding grounds, focusing mainly on the incidental capture in traditional fishing techniques, where number of incidental captures is high. Part of the feeding ground studies conducted on the islands include in-water work with the capture and recapture of juveniles, of *E. imbricata* and *C. mydas*, under the broader themes of biometrics, growth rates and tagging.

Secondly is the fieldwork in the nesting grounds, which goes from September to March in the mainland and from December to July on the islands. It consists of daily beach patrols by fishermen, interns and biologists. Of all nests monitored, 77.8% are maintained in-situ. The area is divided into "intensive study area" and "conservation area." In the intensive study area all the nests are kept in-situ, marked and monitored until birth. The information collected is recorded and entered in a standard national database, where in-situ nests serve as a control for nests that are relocated. In the conservation area, the beach is patrolled by the fishermen and supervised by the biologists. Each fisherman is hired to protect 5 km of nesting area. Some nests are relocated to another location on the beach, and others, when threatened by erosion, heavy human traffic, etc are relocated to an open beach hatchery near the station within 8 hours. Nest inventories are conducted on all nests and incubation parameters are recorded as a routine. Comparatives are made between hatchery and in-situ nests. In addition to the nests, whenever nesting females are found on the beach, they are tagged, measured, and identified.

TAMAR prioritizes applied research to improve its conservation techniques. Topics include demographics, morphometrics, nesting behavior, DNA, incubation parameters, temperature, satellite tracking, light pollution, incidental capture, and fibropapilomas. The important part of the program is the training offered to more than 60 students and young professionals of national and international universities, aimed at the formation of young conservationists.

Based on the fact that since the beginning it was clear that the main threat for sea turtles was direct use and lack of condition of the coastal communities, TAMAR decided as a first step to hire fishermen to develop sea turtle management and protection activities, not only on the beach. It was a way to create a new economic alternative as well as to provide training on a conservation program. It also understood that it was essential to change the habits of the new generation giving them better alternatives. This has been developed through educational programs, and community development, such as supporting local schools, organizations, and community gardens. TAMAR assists such initiatives with reaching financial agencies, NGOs, and the government to gain support for social projects, such as with health, education, and consequently environmental conservation.

TAMAR also uses ecologically sound economic alternatives. With this goal in mind, the establishment of small production centers (such as for paper recycling, t-shirt manufacturing, ecotourism, handicrafts, embroidery and lace-making) was stimulated with the aim of benefiting local people. However, for this it was necessary to plan for financial support to subsidize the beginning of these production centers, until they become self-sufficient. Another ecologically viable solution includes a change in the fisheries to non-traditional activities such as oyster culture (in which more than 10 families are directly employed).

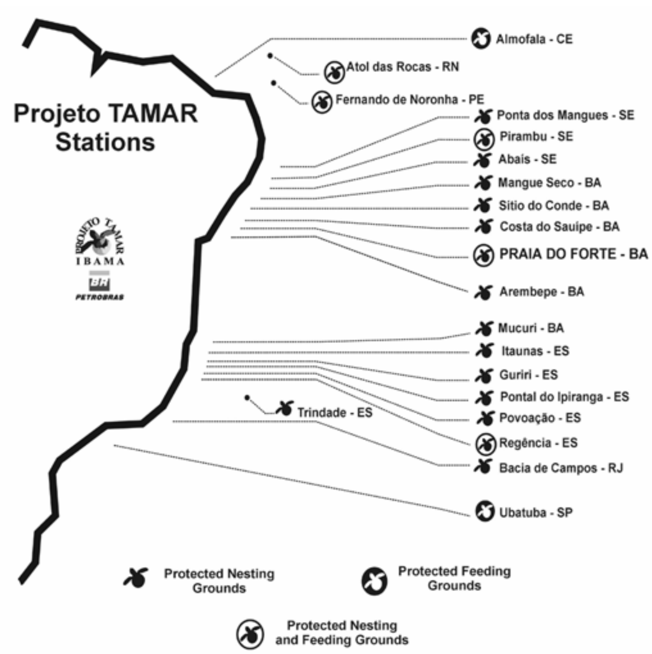
Whenever possible, permanent visitor centers are located in areas where the conservation programs are developed, to establish a direct connection between local people, visitors, and the turtle's world. In addition, they are important tools for fund raising and creating jobs for local people. Associated with these visitor centers, is an adoption campaign, which includes an oriented visit to TAMAR field activities. More than 1 million people visit these centers each year.

Table 1: Sea turtles occurring in Brazil.

Species	Carapace Length (CCL in cm)	Estimated No. Nests / Year	Peak Nesting Season
C. caretta	87 - 136	4000	mid Oct - mid Dec
C. mydas	90 - 143	5500	mid Jan - mid Mar
E. imbricata	82 - 110	500	mid Jan - mid Feb
D. coriacea	139 - 182	35	Nov - Dec
L. olivacea	58 - 81	600	Nov - Jan

To establish TAMAR it was essential to identify the different target groups to be reached, with the goal of sensitizing the general public. It was important to attract the participation of the leadership from political, private, and commercial arenas, and other representatives of the society. Making available field experiences for such leadership is a practical way to gain partners for our conservation program. We believe that gaining public support is a strong way of guaranteeing the future. TAMAR also uses all communication tools to promote and develop conservation programs, such as marketing, mass-media and other resources (TV, newspaper, magazine, exhibitions, home-page, publications, video etc.). Fund-raising activities are easier when sponsors are interested in financing and linking their logos and products with programs with mass information potential. One of the ways that has demonstrated to be very effective in terms of spreading the sea turtle conservation message is through bringing exhibitions to big centers. (From 1995 to 2000, TAMAR has had 37 exhibitions in 8 countries.)

Figure 1: Distribution of TAMAR stations in Brazil.



The operation of TAMAR is based on the cooperation between institutions. Projeto TAMAR is a government program linked to the Ministry of Environment, through IBAMA, which is the national environmental agency, and is comanaged by an NGO, Fundação Pró-TAMAR. The government component is responsible for laws and policy, enforcement, and federal protected areas, and generates 30-40% of the program budget. The non-governmental component is responsible for institutional development, fund-raising, community development and communication, and generates 60-70% of the budget. Nowadays, the sale of TAMAR products alone represents one-third of the total budget needed to operate the program. The end dream of TAMAR, as with any project, is self-sufficiency. TAMAR hopes to accomplish reach this end by improving local production, improving stores and visitor centers, improving team capacity, improving institutional capacity, and improving political autonomy and representation.

As with everything in life there is no ideal model for making conservation programs a success. TAMAR found its own way based on specific characteristics in its path, thus making it a respected and an accepted entity among different sectors. TAMAR learned that community involvement is essential along with the enforcement of environmental laws. It also learned the importance of involving governmental and influential political people in the decisions related to the environmental cause, and share with them the positive results.

We strongly believe that conservation programs isolated from public support often become fragile and vulnerable. The chance of having consistent results in the long-term, increase considerably with the support of the diverse sectors of the society, from ministers to fishermen.

Acknowledgements:

We thank the organizers of the symposium for inviting TAMAR to share our 20 years of experience and The David and Lucile Packard Foundation for travel support to the symposium. TAMAR is affiliated with IBAMA, comanaged by Fundação Pró TAMAR and officially supported by PETROBRAS.

INTERAMERICAN CONVENTION FOR THE PROTECTION AND CONSERVATION OF SEA TURLTES AND ITS REGULATION IN THE MEXICAN LAW

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Sea turtles as an endangered specie, need to be protected on a global basis due to its migratory behavior. Several international instruments could be applied for its conservation. But unfortunately, until the creation of the Interamerican Convention for the Protection and Conservation of Sea Turtles (IAC) none was considered to be effectively protecting the specie or its habitat, because they just covered certain aspects of its conservation, and not a whole protection like the one stated in the IAC. In other words, they do not provide overall specific protection of sea turtles and their critical habitats.

The IAC is the only treaty dedicated exclusively to the protection and conservation of sea turtles as a shared resource of many countries. It is founded in other international accords that have protected sea turtles on a general basis for a long period of time and before the IAC was implemented by some countries. These international instruments are: The United Nations Convention of the law of sea; The United Nations Conference on the Environment and Development (UNCED); the Agenda XXI; The Code of Conduct for responsible Fishing; The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); The World Trade Organization (WTO); The Convention on the Conservation of Migratory Species of Wild Animals; The Protocol concerning Specially Protected Areas and Wildlife (SPAW) to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (known also as the Cartagena Convention) and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST).

The IAC was born as an initiative of Mexico in 1993 during the Interamerican Conference of Responsible Fishing, as a response to the US annual shrimp certification process. The convention was negotiated between late 1994 and 1996, year in which Mexico hosted 24 countries of the American continent, as well as different non-governmental organizations dedicated to adopting a final text of the Convention.

The IAC was closed for signature on 31 December 1998, with 12 nations having signed. Today, 8 countries have ratified it and have deposited their instruments of ratification in Venezuela. As stated in article XXII of the Convention, 90 days after the 8th instrument of ratification is deposited the convention will come into force. The last country to ratify was Honduras in February 1, 2001, along with Venezuela, Peru, Brazil, Costa Rica, Mexico, Ecuador, and the Netherlands. It is expected to come into force on May 2 of the year 2001. The other four countries that have signed but not yet ratified are Nicaragua, Uruguay and the United States. It is important to mentioned that once the convention enters into force, other countries that did not sign at the beginning will be allowed to join, by depositing their instrument of ratification.(Article XXII).

The environmental measures adopted by the parties in the convention are:

· The Prohibition of capture, retention or intentional slaughtering, as well as domestic commerce of sea turtles, its eggs, products or subproducts;
· The Compliance to the obligations stated in CITES;
· The Restriction of human activities that could affect sea turtles;
· The Protection, conservation and restoration of sea turtle habitat, as well as the designation of natural protected areas;
· The Improvement of scientific research;
· The promotion of environmental education, and the development of the mechanisms for public participation;
· The Reduction in capturing and incidental slaughtering of sea turtles while capturing shrimp, as well as the development of new fishing technology; and
· The Promotion of bilateral and multilateral actions for the cooperation between the parties.

For a country like Mexico, the implementation of a Convention of this magnitude represents an important challenge: First, because Mexico is considered the 4th richest country in biodiversity worldwide and because it gathers the greatest diversity of reptile species in the world. It has been proven that 7 out of the 8 existing species of marine turtles worldwide, arrive on the Mexican coastline to nest. The "Lora" and "Prieta" subspecies only nest in the Mexican shoreline. Even though Mexico has been applying several rulings, for years, related with the protection of sea turtles, there has been an eminent lack of human, economic and cultural resources to ensure adequate protection of the species.

In general terms we can assure that the major factors that affect fauna are: hunting, pollution, environmental changes, habitat destruction, introduction of exotic species and the destruction of eggs, nests and hatchlings. In addition, to the factors mentioned above, Mexico, faces a series of obstacles related with the protection of this species:

Biological and environmental obstacles- there is a lack of knowledge and information about basic biology of sea turtles. Including its habitats of reproduction, migrations, average of exploitations and general aspects related with its cycle of life. Also, as an environmental problem, it is well to mention that several nesting beaches have been affected by tourist development, causing the destruction of nests and the slaughtering of sea turtles when arriving to the coastline to nest.

Socioeconomic obstacles - these are related with commercialization of sea turtles products and subproducts. The illegal exploitation of sea turtle products and their exportation, represent a major obstacle for its conservation. Also, and more importantly, we can mention the exploitation of local communities that have used the resource for a long period of time. The lack of employment, in local areas surrounding the nesting beaches are a fundamental cause of the extinction of the specie.

Educational obstacles -we should mention the lack of environmental education programs not only within the local communities but within the general population, to assure a culture of respect to other species cohabiting with us on this planet.

Institutional and private obstacles- There has also been a lack of coordination between educational institutions, social associations, fishery cooperatives and governmental agencies, to promote and develop joint programs of protection and conservation.

Finally, this is an international problematic, because as mentioned before, if sea turtles as a migratory species, are not protected on a global basis, they are in danger of being perturbed in one or more of its life cycles.

The regulations that have been adopted by the Mexican government in order to provide overall protection of the sea turtles and its habitats, and in order to forbid the human activities that affect sea turtles, such as Illegal exploitation and extraction of eggs in nesting zones; loss and degradation of critical habitats; direct and incidental captures; tourist and urban development; pollution and disposal of human waste, are the following:

· Quotas
· Prohibition of eggs exploitation
· Seasonal and permanent banning
· Exclusive capture rights granted to fishermen's cooperatives
· Prohibition of the use of nests in front of the nesting zones
· Implementation of sea turtle camps
· Mandatory use of turtle excluder devices
· Environmental education programs

It is important to mention that since 1993 there is a mandatory use of turtle excluder devices in all shrimp boats. In addition, since May 1990 there is a total banning of the capture or use of sea turtle products or subproducts. Other measures have been implemented during the past years, like the creation of sea turtle camps and the implementation of management programs with local communities.

As previously mentioned, even though a series of rulings related with the protection and conservation of sea turtles in Mexico have been adopted. The results show that other strategies need to be taken in order to comply not only with the IAC, but to assure an adequate protection of this migratory and threatened marine species. Therefore, we consider that a series of measures needs to be adopted by the Mexican government:

· Legal framework implementation.
· Program development and actualization. Mostly in local areas around the nesting zones.
· Funding search additional to the budget provided by the Ministry of Environment and Natural Resources.
· Information system development.
· Inspection and vigilance system implementation in coordination with the different agencies in charge of protecting nesting zones and marine habitats.
· Ecotourism development, instead of megatouristic development.
· Coordination of program development, with different sectors of society and government, including the different Ministries that have responsibilities regarding with sea turtle protection, non-governmental organizations, fisheries cooperatives, educational institutions.
· Public participation-openness.
· Strategies for habitat protection.
· Turtle excluder devices development and promotion.
· Sustainable development.

CONCLUSIONS

The negotiation and implementation of a Convention of this nature among American countries, that hosts sea turtles as a shared resource, is expected to begin a new era of conservation and protection on a worldwide basis, because in future years, this Convention could be implemented farther than just the American continent.

Mexico, like other Latin American countries, in order to comply with the convention has to work hard. Implementing strategies for its protection and finding new ways of managing programs in order to educate and offer local communities, that have used the resource for many years, a new way of earning a living. The different obstacles- environmental, biological, educational, socioeconomic, institutional, private and international, that have caused the decline of the sea turtle, must be mitigated. In order to reach a solution, decisions need to be taken on a global basis, and actions need to be implemented locally.

HATCHERY MONITORING: A ROLE FOR INTEGRATED MEASURES OF HATCHLING QUALITY

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In sea turtles, the nest environment is crucial to producing maximum quality and quantity of hatchlings. Emergence success of a nest depends upon a myriad of factors that control both the development and growth of the hatchlings and their escape from the nest. In many places, turtle nests are translocated to secure hatcheries to prevent poaching. From a conservation perspective, hatcheries should aim to be increasing the number of eggs in the region that result in healthy hatchlings entering the sea. With the aim of comparing hatchling quality (condition and performance measures presumed to be indicators of fitness), we collected data over two seasons at three hatcheries (Chendor, Geliga, Ma'Daerah) and an in-situ beach (Mak Kepit) in Peninsula Malaysia. We recorded hatchling scale counts, morphology, and physical performance measures between sites and clutches to gain an indication of hatchling quality. The performance measures were running speed and swimming speed/endurance. Hatchling size was similar between all locations. However, there were significant differences between locations in other hatchling quality measures. Scale abnormalities were significantly more common at hatcheries than the in-situ beach. Hatchlings emerging from natural in-situ nests also performed (ran and swam) better than those from hatchery nests. Although hatcheries with poorer nest success also had poorer hatchling quality, the reverse was not necessarily true. Chendor hatchery had equivalent nest success to Mak Kepit, yet the quality of hatchery hatchlings was lower. The data collected in this study indicate the need to assess hatchery management with an integrated monitoring system that includes both measures of both nest success and hatchling quality. In particular, hatchling quality measures may provide information on the survival prospects of produced hatchlings, and may respond more quickly to improvements or declines in hatchery management than nest success measures.

HUMAN-SEA TURTLE INTERACTIONS

INCIDENTAL CAPTURE OF SEA TURTLES BY HIGH SEAS LONGLINE PELAGIC FISHERIES IN COSTA RICA'S EXCLUSIVE ECONOMIC ZONE (EEZ) - A SECOND LOOK

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INTRODUCTION

Basic distributional patterns of sea turtles at sea are needed to evaluate the impact of longline fisheries on them, and thus develop methods or fishing policies that protect these endangered species. However, in Latin America, in spite of being acknowledged as one of the key issues to understand the current status of sea turtles, detailed and systematic information on interactions with industrial fisheries is rare (Frazier, 1998). A previous paper presented by the same author during the XIX Annual Symposium demonstrated a high capture of sea turtles, mainly olive ridleys, in Costa Rica's EEZ. However, the scope of this study was limited, as observer data was collected during a single fishing excursion on board a research vessel. The current study includes the results of a six month observer program on board commercial longline vessels classified by the Costa Rican authorities as "medium" artisinal. Participating vessels belonged to the Costa Rican company Papagallo Seafood, based in Playas del Coco, Guanacaste, northwestern coast. The main target species was mahimahi (*Coryphaena hippurus*).

DESCRIPTION OF FLEET

The "medium" artisinal fleet targets mahimahi and tunas within the EEZ of Costa Rica, while the "advanced" fleet targets billfish and tunas within and beyond the EEZ. As of 1999, 473 licenses were granted to vessels of lengths between 6 and 11.9 meters, 77 to vessels of lengths between 11.9 and 17.9 meters, 119 to vessels of lengths between 17.9 and 23.9 meters, and 9 to vessels of lengths between 23.9 and 29.9 meters, for a total of 678 registered vessels (INCOPESCA, 1999).

METHODOLOGY

Observer data were collected during nine longline fishing excursions (77 sets), from August 11 of 1999 to February 2 of 2000. Sea turtles were counted, identified, sexed, measured (Curved Carapace Length CCL, and Curved Carapace Width CCW), and notes were recorded on condition upon capture (alive or dead), situation of capture (hooked in mouth, neck, flipper or tangled in the line or gangeons) and condition upon release (hook removed or line cut).

RESULTS

Figure 1 shows the locations of each of the 77 sets carried out during 9 longline fishing excursions studied during the project. Table 1 shows gear and fishing practice specifications. In total, 39,284 hooks were deployed during 77 surface sets (excursion 8 targeted tuna, thus fishing gear was soaked during the night).

Sea turtle mortality upon fishing gear haul back was 0%. Condition of capture and condition upon release (hook removed or line cut) is presented in Table 2. The majority of olive ridleys captured were hooked in the mouth (87.4%), followed by being hooked in the flipper (10.5%), and the external neck region (0.4%). Of the 216 olive ridleys hooked in the mouth, most were released after hook removal (99.1%), except two occasions (0.9%) in which the hook was imbedded too deep into the throat and fishermen preferred to cut the line. Most of the Pacific green turtles were hooked in the mouth as well (66%), although the percentage is lower than for olive ridleys (87.4%). 100% of the hooks were removed before releasing the Pacific green turtles. The sex rate of captured olive ridley sea turtles was 1 male/ 2 females, while for Pacific green turtles it was 1 male/ 3 females. Average CCL for olive ridley females was 64.8 cm (SD = 7.3, min = 34, max = 77) and Average CCW was 69.1 cm (SD = 6.2, min = 34, max = 80). Average CCL for olive ridley males was 67 cm (SD = 3.8, min = 55, max = 79) and Average CCW was 71.5 cm (SD = 3.1, min = 64, max = 80). Average CCW for Pacific green female turtles was 54.9 cm (SD = 12.8, min = 35, max = 69.1) and Average CCW was 54.9 cm (SD = 12.8, min = 36, max = 71). Average CCL for Pacific green male turtles was 70 cm (SD = 1.5, min = 68, max = 71) and Average CCW was 73.3 cm (SD = 1.5, min = 72, max = 75).

The number of individuals captured, percentage of total catch and CPUE (# of individuals/1000 hooks) was estimated for each species captured either incidentally, complementary (sharks) or as the target species (Table 3). The most abundant species captured was mahimahi, with 2,485 individuals (72.4% of total catch) and a CPUE (# individuals/1000 hooks) of 63.26. Olive ridley sea turtles constituted the second most abundant species captured, with 250 individuals (7.28% of total catch) and a CPUE of 6.364. As a group, sea turtles represented 7.6% of the total catch.

DISCUSSION AND CONCLUSION

Turtles are captured by the artisinal longline fleet in very high numbers, constituting the second most abundant species. Judging by carapace measurements, juvenile olive ridley and Pacific green sea turtles are also captured. Even though mortality upon capture is 0%, serious injuries may be inflicted when removing hooks, or health may be seriously impaired turtles are released with a hook in the mouth or throat. Environmental Campaigns must be directed toward this sector of the Costa Rican population, as negative impact can be reduced if fishermen take the proper care to remove hooks. Active involvement of the fishery industry in research and tagging programs is likely to build a cooperative attitude. Observer programs are recommended to study distributional and seasonal patterns of sea turtle populations in the Eastern Pacific, and provide the basic knowledge needed to recommend proper conservation measures.

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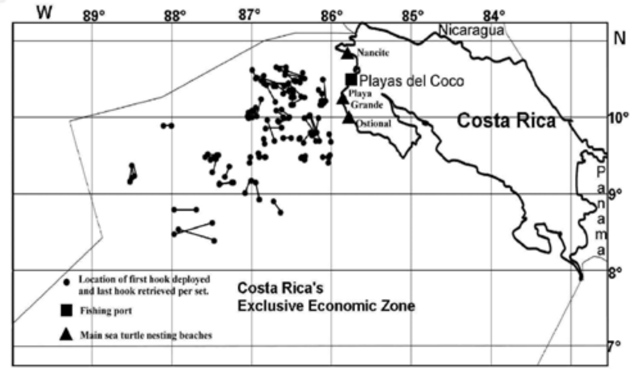

Figure 1. Location of 77 longline sets during 9 fishing excursions in the EEZ of Costa Rica, from August 1999 to February 2000.

Table 2. Species, condition of capture and condition released (hook removed or line cut), of 259 sea turtles captured in the EEZ of Costa Rica.

Condition captured	# individuals	%	hook removed	%	line cut	%
L. olivacea						
Hook in mouth	216	87.4	214	99.1	2	0.9
Hook in flipper	26	10.5	26	100	0	0
Hook in neck	1	0.4	1	100	0	0
Tangled in gangeon	4	1.62				
C. mydas agassizi						
Hook in mouth	8	66	8	100	0	
Hook in flipper	4	33	4	100	0	

Table 3. Number of individuals captured per species, percentage each species represents of the total catch, and CPUE (# of individuals per 1000 hooks) for each species.

Species	Excursions 1	2	3	4	5	6	7	8	9	# of indiv	%	CPUE
SHARKS												
Silky and Black tip *(Carcharinus sp)*	35	11	24	32	56	6	16	3	1	184	5.36	4.684
Thresher *(Alopias superciliosis)*	10	12	10	1	2	3	2	0	1	41	1.19	1.044
Blue *(Prionace glauca)*	5	6	6	0	3	2	7	0	0	29	0.84	0.738
Hammerhead *(Sphyrna lewini)*	2	0	0	0	1	0	1	1	1	6	0.17	0.153
Percentage Subtotal											7.57	
OTHER FISH												
Mahimahi *(Coryphaena hippurus)*	111	79	135	182	504	537	587	13	337	2485	72.4	63.26
Yellow Fin Tuna *(Thunnus albacares)*	81	20	7	9	0	1	0	65	11	194	5.65	4.938
Sailfish *(Istiophorus platypterus)*	23	57	41	8	16	3	2	0	3	153	4.46	3.895
Rays	9	1	0	1	9	7	15	0	1	43	1.25	1.095
Blue Marlin *(Makaira mazara)*	1	4	0	1	3	1	1	0	1	12	0.35	0.305
Skip Jack Tuna *(Katsuwonus solanderi)*	0	0	0	1	0	0	9	0	0	10	0.29	0.255
Unidentified Tuna	0	0	0	0	7	0	0	0	0	7	0.2	0.178
Swordfish *(Xiphius gladius)*	0	4	1	0	0	0	0	0	0	5	0.15	0.127
Big Eye Tuna *(Thunnus obesus)*	0	0	0	0	0	0	1	0	0	1	0.03	0.025
Sunfish *(Mola mola)*	0	0	0	0	0	0	1	0	0	1	0.03	0.025
Percentage Subtotal											84.8	
MAMMALS												
Spinner dolphin	0	0	0	0	1	0	0	0	0	1	0.03	0.025
SEA TURTLES												
Olive ridley *(Lepidochelys olivacea)*	23	57	49	50	21	12	14	1	23	250	7.28	6.364
Pacific green *(Chelonia mydas agassizi)*	4	4	1	2	1	0	0	0	0	12	0.35	0.305
Percentage Subtotal											7.6	
Total individuals										3434		

Table 1. Description of 77 longline sets within the EEZ of Costa Rica

Excursion dates	# sets	AVG (hrs:min) deploying	AVG (hrs min) haulback	AVG (hrs min) soaking	Length of line (mi)	Depth of set (meters	Length gangeon (meters)	# hooks deployed	AVG # hooks per set	AVG °C surface (morn)	AVG ° C surface (night)
11-18/8/1999	8	1:51	4:39	14:12	15	4	7.2	6400	800	27	27
19/9-3/10/1999	14	1:29	4:45	15:31	12	27	6.3	5355	382.5	26.6	26.6
6-17/10/1999	13	1:56	4:20	16:18	15	0	5.4	7600	584.6	27.1	27.3
10-14/11/1999	6	1:48	5:25	13:37	15	5.4	5.4	3300	550	24.3	24.2
21-28/11/1999	8	2:42	7:38	14:57	18	0.5	7.2	4591	573	26	26.3
10-14/12/1999	5	2:01	8:04	16:12	15	5.4	6.3	2570	514	24.4	24.8
11-18/12/1999	8	2:15	6:58	15:52	18	1.8	7	4301	538	25.3	25.4
14-19/1/2000	6	1:54	3:30	11:46	12	3.6	7.2	2003	333.8	24.9	23.9
25/1-2/2/2000	9	1:59	4:17	14:03	16	0	6.3	3164	351.5	25.8	25.4
Total	77							39284			

RESULTS OF AN EXPERIMENT TO EVALUATE EFFECTS OF HOOK TYPE ON SEA TURTLE BYCATCH IN THE SWORDFISH LONGLINE FISHERY IN THE AZORES

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The problem of sea turtle bycatch in longline fisheries has been recognized worldwide. The bycatch of loggerhead sea turtles in the swordfish longline fishery in the Azores has been well documented (Bolten et al. 1994, 1996, 2000). The waters around the Azores are an important developmental habitat for the oceanic-juvenile stage of the Atlantic loggerhead population (Bjorndal et al. 2000, Bolten et al. 1993). Because the source rookeries for this oceanic population are primarily in the southeastern USA (Bolten et al. 1998), the nesting population of loggerheads in the southeast USA is the primary population impacted by the swordfish longline fishery in the Azores.

The experiment evaluated 3 different hook types: J hook, offset J hook, and circle hook. A commercial longline fishing vessel from the Azores was chartered to conduct the experiment from July to December 2000. The experiment consisted of 93 sets and each set consisted of about 1500 hooks. The primary objectives were to evaluate the effect of hook type on rates of sea turtle bycatch and location of hooking (e.g., mouth vs. esophagus). Effect of hook type on target species was also evaluated.

Results from this experiment have broad application and can be applied to swordfish longline fisheries around the world.

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RECENT SURVEYS OF EXPLOITATION, TRADE AND MANAGEMENT OF SEA TURTLES IN THE NORTHERN CARIBBEAN

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Marine turtles have been exploited in the Caribbean for centuries. Caribbean peoples are thought to have used turtles for thousands of years without overexploiting the resource, which according to historical accounts was extremely abundant prior to European colonization in the region. Turtle eggs and most turtle body parts--meat, shell, skin, and viscera--have been valued for one attribute or another, and they have provided everything from basic sustenance to luxury items.

Direct exploitation has had a particularly strong impact on marine turtle populations in the Caribbean. Six species of marine turtles occur in the region: the loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), olive ridley turtle (*Lepidochelys olivacea*), and leatherback turtle (*Dermochelys coriacea*). Each of these species is classified by the World Conservation Union (IUCN) as either critically endangered (hawksbill, Kemp's ridley, and leatherback turtles) or endangered (green, loggerhead, and olive ridley turtles).

The once vast green turtle rookery in the Cayman Islands was rendered virtually extinct by the late 1700s after a century of intensive exploitation of nesting turtles, which were traded mostly for their meat. This population remains on the verge of extinction. The more recent exploitation of hawksbill turtle shell saw huge quantities exported to Japan up until the early 1990s.

In 1999, TRAFFIC North America* initiated a review of the exploitation, trade, and management of marine turtles in 11 countries and territories in the Northern Caribbean. This review, which combined desk research and field surveys, was undertaken to gather and synthesize information about harvest of marine turtles, use of and trade in their products, and the effects these activities may be having on marine turtle populations. Updated information of this nature had been lacking, and it was felt that an overview of current exploitation of marine turtles would be essential to the success of ongoing efforts to manage and conserve marine turtles in the region.

The overall picture revealed by TRAFFIC's study is one of extremes and contrasts that coincide roughly with the levels of development and poverty that separate the countries. Some countries have allocated significant resources to manage and conserve marine turtles, while next to nothing has been done in others. Marine turtle populations have stabilized or increased in some parts of the Caribbean, while virtual extirpation and catastrophic declines have occurred in others. A few countries/territories have made enforcement of relevant regulations an important part of their conservation efforts; in others, enforcement is virtually absent. Legislation is comprehensive in some countries while incomplete and outdated in others. Marine turtles are afforded complete protection in some countries, and there are conscious policies to regulate fisheries in others; at the same time, all countries are confronted with a latent market for marine turtle meat and eggs, and opportunistic take is reported throughout the region.

Exploitation and trade of marine turtles and their products appear to be in decline throughout the Northern Caribbean, perhaps due largely to the fact that past overharvesting reduced some populations to the point where their exploitation was no longer profitable. In addition, improved legal protection and law enforcement, education, decreased national and international demand, and changing cultural values are all thought to have contributed to a reduction in the use of marine turtles in the region. Most current exploitation of marine turtles appears to have become opportunistic rather than targeted.

Nevertheless, many populations have not yet rebounded from past exploitation, and they continue to be affected by current levels of exploitation. Though several range states in the region are apparently experiencing increases in nesting of certain marine turtles at some important nesting sites, most of these increases appear to be directly related to increased monitoring and enforcement, rather than a reduction in demand for meat and eggs.

All of the countries and territories reviewed have enacted legislation to regulate the harvest and trade of marine turtles; however, these have been national in scope, and vary widely in terms of the protection afforded various species, penalties set for infractions, and enforcement thereof.

Research, management, and protection are not, in most cases, coordinated among countries, despite the existence of shared turtle populations; bilateral and multilateral cooperation would be an enormous step forward. It is widely acknowledged that cooperation among range states is critical to ensure the conservation of marine turtles in the Caribbean region.

TRAFFIC's general conclusion from this research is that eight major areas of action need to be addressed by the countries/territories surveyed and the Wider Caribbean region. These are (1) filling information gaps and increasing information exchange; (2) expanding public education and awareness; (3) building national and regional cooperation; (4) increasing participation in international and regional conventions; (5) strengthening national legislation; (6) supporting training and capacity building; (7) enforcing laws that affect local and tourist markets; and (8) documenting and monitoring existing stocks of marine turtle products in the region.

Marine turtles feature among the priority species and taxonomic groups on which the international TRAFFIC Network will focus its efforts in the coming years. WWF's Latin America and Caribbean Program recently identified marine turtles as a flagship species group and will focus greater efforts on their conservation. TRAFFIC North America's report (Fleming, E.H. 2001. Swimming Against the Tide: Recent Surveys of Exploitation, Trade, and Management of Marine Turtles in the Northern Caribbean. TRAFFIC North America. Washington, D.C.) offers an informational foundation and a set of recommended actions that can help support the in-depth work that must be done to rebuild and conserve Northern Caribbean marine turtle populations

*TRAFFIC North America is part of the TRAFFIC Network, the joint wildlife trade monitoring program of WWF (World Wildlife Fund) and IUCN (The World Conservation Monitoring Center).

THE EFFECTS OF SEA TURTLE DEATHS AND CAPTURES AS A RESULT OF THE OPERATION OF U.S. COASTAL ATOMIC REACTORS

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This presentation is based on a comprehensive new study called Licensed to Kill: How the nuclear power industry destroys endangered marine wildlife and ocean habitat to save money. We have copies available on our web site at http://www.safeenergy.org if you are interested. Sea turtles are featured extensively in our report, perhaps because they are by far the most severely affected of aquatic endangered species at U.S. coastal atomic reactors.

We looked at what is known as once-through cooling reactors. There are 59 in the U.S. and we examined 11 for our study, all of them on the coast. These reactors draw in a tremendous volume of water from a river, lake or ocean, up to a million gallons a minute. The water acts as a coolant as it passes through the reactor system and is then discharged into the same body of water from which it was drawn but at temperatures up to 25 degrees Fahrenheit hotter than the surrounding water.

We know that sea turtles are "taken," (that is killed or captured) at the Diablo Canyon and San Onofre reactors in California, the Salem and Oyster Creek reactors in New Jersey, at Brunswick in North Carolina and at Crystal River and St. Lucie in Florida. Other sites where turtles could be taken are listed on our poster.

It is difficult to calculate how many sea turtles these reactors catch or kill as reporting is inconsistent. However, we found that among the 11 reactors in our study, more than 1000 turtles were taken in some years.

The Nuclear Regulatory Commission (NRC) is the federal agency responsible for enforcing the Endangered Species Act on behalf of the nuclear reactors it licenses. Unfortunately, we found NRC to be an advocate on behalf of the financial concerns of utilities rather than an enforcement agency acting for the well-being of endangered species. In every case we examined, NRC supported utility efforts to raise or eliminate sea turtle take limits and to reject protection and conservation programs.

Sea turtles mainly die at reactors through suffocation, described as "drowning" in most reports. Turtles suffocate after becoming trapped against intake structure velocity caps, barrier nets, underwater intrusion detection systems, trash racks and intake wells. Sea turtles may also be fatally injured during passage or entrainment through an intake tunnel. Some turtles die later at rehabilitation centers after sustaining entrainment injuries. These deaths are not counted against the utility's quota of permitted kills.

Sea turtles may also die later if released prematurely after insufficient supervision during the capture period. We found differing views among experts about the length of time captured turtles should be supervised prior to release. Experts did agree, however, that the animals should demonstrate the ability to swim, dive and catch food on their own. Concerns about blood chemistry changes during capture indicate that fatally high levels of lactate could occur, as the 1977 Lutcavage and Lutz studied showed.

A 1990 National Academy of Sciences study indicated that some sea turtle deaths at Florida Power and Light's (FPL) St. Lucie reactors "resulted from injuries sustained in transit through the intake pipe [and] from drowning in the capture nets." A 1985 FPL study on sea turtle entrainment at St. Lucie indicated "The potential for injury during passage through the intake pipe was also a concern. Approximately 7 percent of the sea turtles removed from the intake canal had recent lacerations, abrasions or other injuries that may have resulted from passage through the pipe."

These slides show an injured turtle captured at St. Lucie and later taken to the Marinelife Center in Juno Beach for rehabilitation. The Center's Larry Wood described the injury as "a deep slice-like wound that laid open the tail and severely cut the penis." The animal could not be saved.

At the Oyster Creek reactor on Barnegat Bay not far from here, NMFS has identified the trash rakes as dangerous to sea turtles. NMFS noted that when the tines are deployed the process "could cause serious injury to a turtle."

Perhaps the most well-known "take" at an atomic reactor is a human being, Bill Lamm, the Vero Beach scuba diver who was sucked through the St. Lucie intake pipe in 1989. Lamm survived but his wet suit was shredded and his steel scuba tanks gored. Lamm said "It just looked like somebody took a knife and started slicing all over the place." Bill Lamm is featured in our video, showing in the poster room.

The warm discharge water may cause turtles to linger too long near the plant. NMFS warned of this danger at the Oyster Creek reactor, stating: "Turtles may be attracted to the thermal effluent from the discharge canal that warms Oyster Creek, and could be cold-stunned when leaving the creek and returning to the colder water in Barnegat Bay in the late fall." NMFS has in fact now asked Amergen, owner of the Oyster Creek reactor, to provide stranding data for the entire state of New Jersey. It is to be hoped that NMFS will review this information in the context of captures and cold-stunning incidents at Oyster Creek.

Permitted take numbers are calculated by NMFS under Section 7 of the Endangered Species Act, but the scientific basis is questionable. For example, at St. Lucie, NMFS provides for an annual kill limit of 3 green turtles or 1.5% of all captures, whichever number is higher. Even this is too low for FPL who countered with a proposal for an annual kill limit of 6 green turtles or 3% of all takes, reasoning that more green turtles are around.

Utilities consider treatment requirements, such automatic veterinary attention, burdensome. A NMFS instruction to CP&L read: "injured sea turtles will be taken to a veterinarian," but CP&L diluted it, stating the utility "will make appropriate efforts to obtain medical treatment, including veterinary services, as warranted for turtle injuries."

So why don't reactor operators fix the problem? The answer is cost. At every opportunity to research or install prevention devices, or improve on the fallible ones in place, nuclear utilities cry poverty. Said FPL, for example: "The capital and maintenance costs for a physical barrier system would be prohibitive and could likely cause a reduction in intake canal flow." Flow would be reduced by the accumulation of debris on the barrier. This reduces output therefore lowering profits.

Our report found numerous other examples of utilities avoiding fixes including at Salem where Public Service Electric and Gas demanded "the ability to avoid daily trash cleaning" even though it is a site where sea turtles have died on the trash racks.

Sites such as St. Lucie advertise themselves as sea turtle sanctuaries and tout their nest protection programs. But a March 2000 St. Lucie Entrainment Study by Ecological Associates, found that "females comprised more than 85 percent of the adult loggerhead captures at St. Lucie between 1977 and 1998."

Most of these takes occur between June and August, the nesting season. St.Lucie markets a sea turtle-friendly image to the public because its reactors were constructed on land occupied by pre-existing loggerhead nesting beaches. This has about the same merit as calling a six-lane highway a wildlife sanctuary.

Although sea turtle captures and deaths at atomic reactors are not as numerically high as those caused by the shrimping and fishing industries, the cumulative effect must be factored into any assessment of the status of sea turtle populations. Sea turtle deaths at reactors in New Jersey cannot be assessed alone, but must be added to the deaths in Florida, North Carolina and potentially further up the coast. These deaths must also be evaluated in the context of other human-caused impacts on sea turtles as well as the fibropapilloma virus -- also likely of anthropogenic origins.

And, as many of you have pointed out to us, it is not just how many turtles but which ones. Scientists we interviewed stressed that it is the large juveniles and adults who are the key to the long-term survival of sea turtle species. It is these sea turtles who are the victims at atomic reactors.

In conclusion, we recommend that:

o NRC should vigorously enforce the Endangered Species Act at the nuclear reactors it licenses rather than work around the regulations.
o When NMFS requires nuclear utilities to conduct studies and evaluate mitigation options that will enhance our ability to protect sea turtles more effectively, NRC should support, not hinder and oppose such measures.
o The once-through cooling systems of nuclear reactors do not constitute a suitable mechanism for collecting sea turtles for scientific study. Nuclear utilities should not be permitted to advertise their facilities as beneficial to sea turtles in this regard.
o NMFS must look at the cumulative effect of kills and captures on sea turtle species, not set arbitrary kill limits at individual reactors that pay little attention to the status of sea turtles as a whole. The agency must then make public how it arrives at permitted take levels.

In the U.S. we face the very real possibility that the present Administration will support lobbying by electric utilities to roll back or even lift environmental protection laws. Of mutual concern is the potential for the Endangered Species Act to be further undermined. Therefore now, more than ever, it is important to throw the spotlight of public scrutiny on those same utilities to ensure that sea turtles are not made to pay the price for unfettered energy expansion.

TURTLE BY-CATCH IN SRI LANKA

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SUMMARY

This by-catch survey was carried out between September 1999 and November 2000 in order to assess the extent and nature of incidental marine turtle by-catch at fish landing sites within programme boundaries by collecting data on marine turtle entanglements. Information derived from this survey was then used to formulate an action plan to minimise turtle by-catch in Sri Lanka. Sixteen major fish landing sites were selected for this survey. The programme included an introductory seminar programme for fishermen at each fish landing site and the collection of by-catch data from each site. Between November 1999 and November 2000 a total of 5241 turtle by-catch was reported, this figure included all five species of turtle which nest on the beaches of Sri Lanka. A total of 13760 interviews with fishermen were carried out, which represented a sample of 39% of the total fishermen operating from the landing sites selected.

INTRODUCTION

Sri Lanka is an island nation situated at the Southern point of the Indian Ocean. It is located between the latitudes of 5°55N and 9°51N, and the longitudes of 79°41E and 81°53E, and is shaped like a teardrop falling from the southern tip of India, separated only by the shallow seas of the Gulf of Mannar. Five species of marine turtle come ashore to nest and inhabit the waters of Sri Lanka. All five species are listed by the International Union for the Conservation of Nature (IUCN) as either vulnerable or endangered (IUCN, 1995). Despite the protection by government legislation since 1972 their future is one in jeopardy, with many turtle populations declining to the point where they are no longer significant resources either materially or culturally. This is due mainly to the indiscriminate exploitation largely at the breeding stages (Frazier, 1980., Hewavisenthi, 1990) for their eggs and meat.

Marine turtle by-catch in Sri Lanka

Data and reports to date on the extent of turtle by-catch in Sri Lanka are confusing and provide little insight due to their contradictory nature. In 1984 Jinadasa estimated (via a series of calculations based on generalised assumptions) that marine turtle by-catch for the entire island was approximately twelve to fifteen turtles per week. Therefore, he estimated the annual marine turtle by-catch for the whole of Sri Lanka to be four hundred turtles (Jinadasa, 1984) as a realistic albeit conservative total. Hoffman also made a similar estimate in 1975.

However, it seems that these were probably gross underestimates when reports from other authors are considered. Gunawardane

(1986) estimated that ten turtles were landed and butchered per day in Kandakuliya, a small fishing village on the Northwest coast of Sri Lanka. Perera (1986) witnessed the butchery of 16 turtles over a three day period in May 1986, in Negombo, a fishing town approximately 110km due south of Kandakuliya. Both authors noted that the majority of the turtles caught in the region were Olive Ridleys (*Lepidochelys olivacea*). In early 1994, TCP staff witnessed the butchery of thirteen Olive Ridleys at Kandakuliya in one morning. When interviewed local fishermen confirmed that on average at least twenty turtles were slaughtered each week. Taking into account the observations of Gunawardana and Perera and those of the TCP staff, it is entirely feasible that the number of turtles landed and killed in Kandakuliya alone has been over 1000 per year for the last decade.

General objectives of the marine turtle by-catch survey:

Before solutions can be found to minimise marine turtle by-catch in Sri Lanka, the extent and nature of this threat must be investigated fully. The objectives of the programme were as follows:

· Assess extent and nature of incidental marine turtle by-catch at fish landing sites within programme boundaries by collecting data on marine turtle entanglements.
· Identify important marine habitats for marine turtles in Sri Lankan waters, e.g. feeding grounds, migration routes, breeding aggregation sites.

Survey sites

16 sites were selected for the by-catch survey along the Northwest, Western, Southwest, Southern and Southeast coasts of Sri Lanka between Kalpitiya and Kirinda (448km). These fish landing sites were: Kandakuliya, Chilaw, Negombo, Colombo (Modara), Panadura (Modara), Wadduwa, Beruwela, Moragalla, Galle, Weligama, Mirissa, Dondra, Kottegoda, Tangalle, Hambantota and Kirinda.

METHODS AND MATERIALS

1 Survey coordinator and 2 Survey Assistants (S.A's) were employed and trained to carry out initial introductory seminars each fish landing site. 16 monitors were employed, 1 from each of the fish landing sites who were expected in collecting marine turtle entanglement data on a daily basis. The SA's and the Survey Coordinator trained the monitor's in data collection and interview techniques within the first two months of the programme. For the following 12 months the monitors have collected turtle entanglement data from fishermen at each of the fish landing sites. The Survey Coordinator and the SA's made random visits to each site to evaluate the monitors performance and collect completed data sheets. Every 2 months the monitors, SA's and the Survey Coordinator met in Colombo to evaluate the survey progress. A data sheet was designed to collect the by-catch data.

RESULTS

According to the results, of the 5241 turtles recorded as by-catch (entangled), 1626 were Olive ridley turtles, 1310 were Loggerhead turtles, 908 were Green turtles, 431 were Leatherbacks and the remaining 148 were of unknown species (unidentified). The fate of these turtles is as follows. Of the 5241 turtles entangled, 1063 were either found dead, were killed or sold. The remaining 4178 were reported to have been released by the fishermen.

When the fish landing sites are considered individually, 2055 turtle by-catch was recorded over the survey period for Galle. This was the highest level of by-catch of all the sites considered. For Hambantota and Moragalle, 8 and 9 turtle by-catch was recorded respectively, representing the lowest levels of by-catch. In Negombo 654 turtle by-catch was recorded and in Kirinda it was 629. The various types of Gill nets can be considered to be the key threatening nets for turtles with regard to by-catch. Although the nestings of Loggerheads and Hawksbills are occasional in Sri Lanka, survey results demonstrate that by-catch of these two species was reported in surprisingly considerable numbers.

DISCUSSION

The total number of 5241 turtles caught by surveyed fishermen during this period is alarming given this was only a sample of the total number of fishing boats operating at any one time. TCP estimates that the sample size of fishermen questioned is around 39% of the total present. The figure of 5241 turtles caught can be considered the minimum of actual turtle by-catch due to likely survey bias in reporting the true number for fear of negative consequences. The numbers of each species caught also produced surprises, as the predominant nesting species in Sri Lanka is undoubtedly the green turtle, while large numbers of olive ridleys are known to inhabit offshore waters. Preliminary surveys have shown that loggerhead and hawksbill turtles provide rare nestings in Sri Lanka and yet according to the by-catch survey large numbers of these turtles are caught by fishermen. Loggerhead by-catch being actually higher than that of the green and almost equal to the numbers of olive ridleys caught. While hawksbill by-catch was almost the same as green turtle by-catch. This was extremely surprising and implies that the waters surrounding Sri Lanka might provide important feeding habitats for loggerheads and hawksbills. Furthermore given that hawksbills are classified on the IUCN red list as critically endangered the numbers of these turtles caught and possibly killed is a subject of grave concern. It is also possible that the Sri Lankan fishermen are confusing the loggerhead with the green turtle due to similarities in size and characteristics.

CONCLUSIONS

The figure of 5241 turtle by-catch was recorded as a result of interviews with 39% of the total fishermen operating between Kirinda and Kandakuliya, can be considered the minimum by-catch number for Sri Lanka (between Kirinda and Kanakuliya only). For example, if 100% of fishermen were interviewed we can assume that the true by-catch figure would be discovered to be in excess of approximately 13,000 (5241/39 x 100) turtles per year.Of these turtles caught as by-catch, not all die. Out of the 5241 recorded as by-catch approximately 20% (1063) are killed, found dead or sold. Olive ridley turtles are the most frequently entangled (total 1626). The largest proportion of this species being recorded as caught in Galle (597). Galle survey site has the highest overall number of by-catch (2055). Other significant survey sites for by-catch include Negombo (654), Kirinda (629), Mirissa (501) and Weligama (488).Those survey sites which proved to be the least significant in terms of turtle by-catch were: Hambantota with only 8 recorded by-catch; Moragalle with 9; and Panadura with 27 turtles recorded as by-catch.

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Table 1. Numbers of each species per each fish landing site.

Project site	*No. ?*	Cm	Cc	Lo	Dc	Ei	Uk	Total
1 Beruwala	*699*	13	28	36	36	7		**120**
2 Chilaw	*591*	1	25		1	2		**29**
3 Colombo	*881*	43	25	29	9	29	7	**142**
4 Dondra	*481*	4	8	9	6	24		**51**
5 Gale	*1421*	473	678	597	40	263	4	**2055**
6 Hambantota	*1395*	2	1		2		3	**8**
7 Kandakuliya	*608*			107				**107**
8 Kirinda	*655*	117	160	236	32	82	2	**629**
9 Kottegoda	*1176*	15	51	2	115	23	7	**213**
10 Mirissa	*922*	75	146	55	106	51	68	**501**
11 Morogalla	*885*	1		6		2		**9**
12 Negombo	*1429*	43	115	483	1	4	8	**654**
13 Panadura	*350*	5	4	1	14	3		**27**
14 Tangalle	*1030*	10	6	11	24	137	4	**192**
15 Wadduwa	*229*	2	2	4	1	7		**16**
16 Weligama	*1008*	104	61	50	44	184	45	**488**
Total	***13760***	**908**	**1310**	**1626**	**431**	**818**	**148**	**5241**

Key: *No.?* – Number of fishermen interviewed; Cm – Green (Chelonia mydas)
Lo - Olive ridley (Lepidochelys olivacea); Cc - Loggerhead (Caretta caretta)
Dc - Leatherback (Dermochelys coriacea) E; Ei - Hawkst bill (Eretmochelys imbricata)
Uk - Unknown

TRAVELLING TURTLES, MANY PEOPLES, ONE BIG STORY: INDIGENOUS MANAGEMENT OF SEA TURTLES IN NORTHERN AUSTRALIA

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Sea turtles have long been an important natural and cultural resource to the Aboriginal people of northern Australia. Western science dates Aboriginal occupation of northern Australia as far back as 40,000 or even 100,000 years, while Aboriginal people believe they have occupied the land since the creation beings first formed the landscape and bestowed law and knowledge. Regardless of differences in interpretation of the past, the association between Aboriginal people and turtles is a long one and has led to a rich culture of law, ceremony, oral history and detailed traditional ecological knowledge about turtles. Looking after sea turtles through the management of hunting and egg collection and the practice and performance of rituals, dances and songs remain an important aspect of contemporary environmental management by coastal Aboriginal people.

The Aboriginal people (Yolngu) of north east Arnhem Land of the Northern Territory of Australia are custodians of internationally significant rookeries of four species of sea turtle, including green (*Chelonia mydas*), flatback (*Natator depressus*), olive ridley (*Lepidochelys olivacea*) and hawksbill (*Eretmochelys imbricata*). Acting on their concerns about global and regional declines in turtle numbers and enacting their long-held responsibilities for looking after turtles, Yolngu through the Dhimurru Land Management Aboriginal Corporation, initiated a sea turtle (miyapunu) research project that combines traditional knowledge and law with contemporary scientific methods to develop a strategy for sustainable subsistence use of turtles (Munungurritj 1998; Yunupingu 1998).

A key component of the project is to use satellite telemetry to track the migrations of green turtles from nesting beaches to home feeding grounds and thereby locate other coastal communities with whom Yolngu share turtles. Twenty transmitters were deployed (5 in 1998, 15 in 1999) on post-nesting green turtles (*C. mydas*) at Djulpan beach near Nhulunbuy, Northern Territory.

Green turtles are known to migrate up to 2,600 km and to disperse widely from the same rookery to feeding grounds that may be thousands of kilometres apart (Limpus et al. 1992). Given this wide dispersal over long distances the results that all post-nesting green turtles radio-tracked from Djulpan traveled southward and remained within the Gulf of Carpentaria were surprising. All but one turtle "Dhimurru" migrated to feeding grounds in the south west Gulf of Carpentaria in the Limmen Bight and around the Edward Pellew Islands (Figure 1).

The shallow waters of the south west Gulf of Carpentaria are known to support large sea grass beds as well as large numbers of green turtles, including turtles from Western Australian and Queensland nesting stocks (based on tag returns). Results from the present study indicate that they also support turtles from the Arnhem Land nesting population, highlighting the importance of the Gulf of Carpentaria as critical feeding habitat.

The satellite tracking data coupled with the known fidelity of turtles to feeding and nesting habitats (Limpus et. al.1992), suggests that the majority of turtles nesting in north east Arnhem Land may not depart Australian waters and instead migrate faithfully between north east Arnhem Land and feeding grounds in the south west Gulf. This is an encouraging scenario for Yolngu and other indigenous communities in the Gulf region as they seek to develop strategies to ensure the sustainability of their subsistence harvest of green turtles and eggs. It means that the future of these turtles may be largely determined by the management actions of Australian indigenous people in conjunction with conservation authorities and other stakeholders such as the Australian fishing industry.

Encouraged by the results of this study, Yolngu and other Aboriginal people are seeking to establish a community network to share traditional and contemporary knowledge of turtles and promote cooperative management of turtles in the region. These community networks, coupled with ongoing meaningful collaboration between indigenous and non-indigenous Australians in research and management activities, will be critical for the survival of sea turtles in the region.

Acknowledgements:

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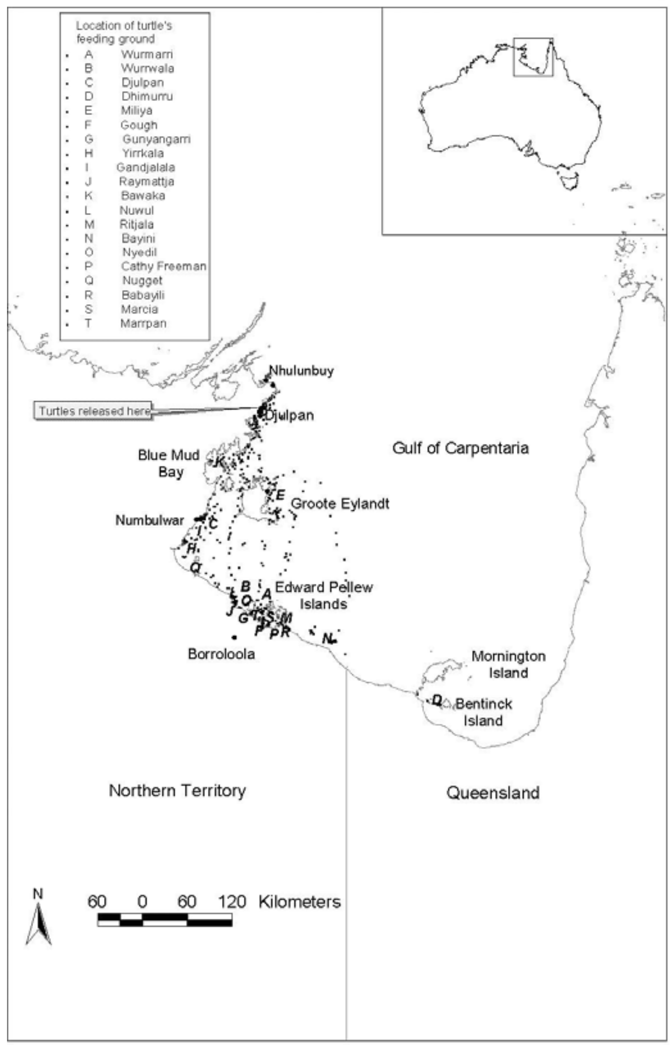
Figure 1. Migration routes of 20 post-nesting green turtles (*Chelonia mydas*) satellite tracked from Djulpan beach in northeast Arnhem land to feeding grounds (approximate location indicated by italicised capital letter) in the southern Gulf of Carpentaria in November 1998 and 1999. Turtle "Miliya" (E) was recovered by hunters on Groote Eylandt in early December 1998 and it could not be confirmed that it had reached its home feeding ground.



TURTLES AND PEOPLE: A CASE STUDY OF SIPADAN (SABAH, MALAYSIA)

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INTRODUCTION

Sipadan (04° 05'N, 118° 35'E) is an open-oceanic island located off the east coast of North Borneo. The island has a circumference of roughly 1.5 km and is approximately 123,000 m^2 (UKM, 1990) in size. It was designated as a bird sanctuary in 1933 under the Land Ordinance of 1930 as well as a turtle eggs' native reserve in 1964.

The turtles have been coming ashore for generations to nest on the island as well as to feed and reside in the waters surrounding Sipadan. Unfortunately, a few turtles have even lost their lives in the limestone caverns located underneath the northern end of the island. Turtles entering the caverns, perhaps to rest, may get disoriented and lost in the labyrinth of tunnels and caves (Wong, 1991). Sadly, they then run out of air and drown.

HUMAN-SEA TURTLE INTERACTIONS

Egg Harvest

The first encounter between turtles and man occurred when egg collectors first set foot on the island in 1918. Egg harvest was then deemed legal through permission granted by the Sultan of Sulu where all the eggs deposited on Sipadan shore were collected by a Bajau family living there. In 1990, eggs were set aside for the sea turtle conservation programme run by the Sabah Wildlife Department. Financial aid to purchase the eggs was provided by three dive resorts operating in Sipadan, namely Borneo Divers & Sea Sports (Sabah) Sdn. Bhd., Pulau Sipadan Resort and Sipadan Dive Centre. A total of 4612 natural nests were incubated until March 1997 (Palaniappan et al., in press). When poaching became too serious a problem, the department constructed a beach hatchery at the southern tip of the island to transfer all the eggs. In January 2000, a new hatchery located very close to the staff quarters was built. This enabled the wildlife rangers to keep a close watch on the nests at all times. The rangers also monitor turtle nesting and turtle watching activities. The techniques used in relocating the eggs and replanting them in the hatchery were improved following Miller (1999) and Mortimer (1999).

Resorts on the island

The presence of resorts helped decrease fish bombing incidents, a widespread destructive fishing method practised in the vicinity of Semporna, the closest district to Sipadan (Samson Shak, pers. com.) Strict enforcement by the Sabah Fisheries Department, Marine Police and Royal Malaysian Navy has reduced the number of fishermen practising these methods. The presence of the enforcement agencies has also led to a decrease in the number of incidental drownings of turtles in fishing gear. The Fisheries Act of 1985 (Act 317) states that fishing is not allowed less than 5 nautical miles from land, except for artisanal fishermen who are allowed closer to shore.

Unfortunately the resorts also brought about several negative factors. Two resorts built walls on the north-eastern and northwestern sides of the island. This is turn lead to a disruption of the sand transport causing an erosion on the northern side of Sipadan and deposition of sand on the southern end. The Semporna District Office, which is the authority on all terrestrial construction in the district, later ordered that these walls be torn down.

The sea turtles of Sipadan can be seen swimming or resting on the reefs in almost every dive. They would even swim up to a diver just to have a closer look. Harassment of turtles in their natural habitat soon became a problem. This was overcome by the resort dive masters briefing divers before entering the water and banning ignorant ones from diving if caught doing so. Even scientists have been recommended to NOT disturb the turtles underwater in order to prevent the turtles from shying away from the divers. It would be a shame if Sipadan – known as the Turtle Capital of the World – were to lose their charming and curious turtles.

By the mid 1990s, there were 6 resorts in Sipadan. This led to too many visitors to the island. Pollution from day-trippers and overnight visitors started piling up (UKM, 1990). Also, rubbish from the mainland and passing boats was being washed ashore. The first author has made personal observations of the efforts of the Semporna District Office to lug all rubbish from the island to be brought back to mainland to be disposed off. In 1999, the National Security Division enforced the ruling of limiting the number of guests to the island to 80 people a day. The number of staff in the resorts was also reduced. Fines were imposed for any offences relating to pollution or exceeding the permitted number of people on the island.

Foreign Intervention

The islands of Sipadan and Ligitan are being claimed by Indonesia and Malaysia. The International Court of Justice has been called in to settle this dispute and both countries have agreed to abide by its ruling. Hopefully, the case may be settled in the near future.

Sipadan received a lot of publicity from the hostage situation that arose in April 2000. Apart from human suffering, the turtles were also affected from this incident. Not only were the 4 wildlife rangers held hostage, all their applicators and tags, field log books and measurement tapes were also taken from them. This led to a disruption in the recording of turtle nesting data of the sea turtle programme conducted by the Sabah Wildlife Department and Universiti Malaysia Sabah. The department sent in replacement staff as soon as it could, but this took several days. Nests that were not transferred to the hatchery were stolen whereas hatchlings that had emerged could not be released immediately.

To overcome problems brought about by the hostage-taking incident and to reassure those planning to visit Sipadan, the Malaysian government dispatched military and police personnel to be stationed on the island at all times. Armed Navy and Marine Police boats can been seen patrolling the sea round the clock and the Royal Malaysian Air Force flies 2 aircrafts over the island several times a day. The Royal Malaysian Police helicopter is also dispatched to keep an eye on the island. As for the turtles, the Sabah Wildlife Department has ordered new tags and applicators, and these have since been used in the field. The rangers who patrol the island several times during the night inform the military personnel of their activities before each patrol.

Research and Conservation

Universiti Malaysia Sabah has been working closely with the Sabah Wildlife Department to manage and conserve the treasured turtle resources of Sipadan. The origin of these turtles are presently being looked into by conducting genetic studies, specifically microsatellites of the nesting females. At present a small scale disease monitoring programme is also being carried out. It is hoped that this programme will be expanded to include all sea turtles in Sabah. Efforts are also being made to have joint research programmes with foreign institutions to look into other aspects of sea turtle conservation and science.

CONCLUSIONS

The presence of human inhabitants has led to a decline of sea turtle landings in Sipadan. Egg collection, incidental drownings, and habitat destruction are among the more serious problems that have arose. The concerted efforts from the authorities, academic institutions and the private sector must be taken in order to undo the damage that has been done, and to ensure that the sea turtle population of Sipadan will not be lost to extinction.

Acknowledgements:

We wish to thank the National Security Council for permission to conduct research in Sipadan. Thanks also go to the Sabah Wildlife Department and Borneo Divers & Sea Sports (Sabah) Sdn Bhd for the their dedication in collecting data on the Sipadan sea turtles. The first author would also like to thank the David and Lucille Packard Foundation for travel assistance and to Universiti Malaysia Sabah for travel assistance and permission to present her work at the symposium as well partial funding and permission to conduct sea turtle research in Sabah. Logistical support in Sipadan provided to the first author by the Sabah Wildlife Department and Borneo Divers & Sea Sports (Sabah) Sdn Bhd is gratefully acknowledged. Special thanks also go to Assoc. Prof. Dr. Saleem Mustafa of the Borneo Marine Research Institute, UMS for comments on the draft of this manuscript.

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POST-HOOKING SURVIVAL OF SEA TURTLES TAKEN BY PELAGIC LONGLINE FISHING IN THE NORTH PACIFIC

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INTRODUCTION

Determining the post-hooking survival of sea turtles captured in longline fisheries is important for management and conservation of sea turtles worldwide. Injury and mortality of sea turtles resulting from capture in various commercial fisheries has been an issue for their recovery for several decades. Cases of sea turtles ingesting baited longline hooks, or becoming entangled or externally hooked, have been known to the scientific community. However, only limited data exist on numbers of turtles caught by longline fishing and the immediate or consequent injury and mortality that takes place. Deep ingestion of a hook by a turtle would intuitively seem to be devastating to the animal due to possible puncture of vital organs. However, preliminary work summarized by Aguilar et al. (1995) recording post-hooking survival of loggerheads caught in the Spanish swordfish longline fishery in the Western Mediterranean during 1986-1991 gave an unexplained contrary indication. Aguilar et al. (1995) documented that some turtles with deep ingested hooks, and some having ingested more than one hook, could take as long as 285 days in captivity to expel the hook. Many turtles survived and were released alive after 4 months without expulsion of the hook with no observable adverse affects.

Numbers of turtles caught and brought up dead or alive in the Hawaii-based pelagic longline fishery have been summarized by the National Marine Fisheries Service (NMFS). Impacts on turtle stocks due to incidental capture have been estimated through various modeling procedures. However, the level of mortality due to post-hooking injury is still a key issue of continuing concern and investigation.

Satellite telemetry was suggested by G. Balazs (1994) and also S. Eckert (1994) in 1993 as a means to determine survivability of post-hooked turtles after their release. From 1997 to mid-2000, NMFS observers attached satellite transmitters to pelagic loggerheads, olive ridleys, and green turtles taken alive as by-catch in the Hawaii-based longline fishery of the North Pacific. The post-hooking movements of these turtles were examined to determine survival differences between turtles lightly hooked and ones that had deep ingested hooks. This paper reports the results of transmission times and distances traveled, comparing the two hooking groups of turtles by species and for all species combined. Surface times for deeply and lightly hooked turtles are also compared.

METHODS

Turtles taken as by-catch in the Hawaii-based pelagic longline fishery were brought on board commercial vessels by NMFS observers, if possible with the aid of a large scoop net. Straight carapace length (SCL) was measured and hooking status determined for each turtle. The turtle was lightly hooked if solely entangled in monofilament line or if the hook was external or in the beak and could be easily removed. A hook was deeply ingested when lodged deep in the mouth or throat and removal might cause further injury. For such cases, the monofilament leader was cut as close to the hook as possible. Argos-linked Telonics ST-10/18 transmitters were attached to the turtles' carapace using fiberglass cloth and polyester resin. Turtles were released alive often in what was described as vigorous condition for both hooking categories.

Duration of tracking was calculated from the date of deployment to the day the last signal was received. Distance traveled was calculated with the most accurate positions (LC 1's, 2's and 3's) using a great circle distance formula. On average, one position every two days was used for the calculations, although one position per day was used if possible. For 13 transmitters with a duty cycle of 24-hours on and 216-hours off only one position every 10 days could be used. A tracking was considered to be "successful" if the tracking lasted more than one month.

The Student's t-test was used to determine significant differences in variables between lightly and deeply hooked turtles. T-tests were done by species and also for all species combined for both the duration of tracking and the distance traveled. T-tests were also conducted to determine if differences existed in carapace size between deeply and lightly hooked turtles. A Chi-squared test was also used to compare the duration of tracking between light and deep hooked turtles.

Percent time on surface was calculated using data received from the ST10/18 "surface time counter" (see Telonics website: http://www.telonics.com). The percent time on surface is just an estimate of the minimum time the turtle spent there as heavy seas and excessive wave wash over the transmitter might artificially lower this number. However, unless radically different environmental conditions persisted over the times of the tracks between turtles, the affect of this wave wash might be presumed to be similar for all turtles.

RESULTS AND DISCUSSION

A total of 54 transmitters were deployed from 1997-2000. As of February 2001, four of these transmitters are still transmitting and are not included in the analyses. Of the remaining 50 transmitters, 35 were attached to loggerheads, 12 on olive ridleys and three on green turtles. Fifteen transmitters produced few or no transmissions. Eleven of these were deeply hooked and four were lightly hooked. Thirteen of these 15 turtles were loggerheads and two were olive ridleys. For the 35 turtles with "successful" tracks, 22 were loggerheads, ten olive ridleys and three green turtles. Of these 35 turtles, 15 were lightly hooked and 20 had hooks deep ingested. As hooking site may be of some interest for the lightly hooked turtles, we determined that 15 turtles were hooked in the mouth or jaw, three in the front flipper, one was hooked in the neck, and one was entangled in the fishing line. Movements of post-hooked pelagic turtles against weak geostrophic currents were reported by Balazs et al. (2000) and Polovina et al. (2000) on a sub-sample of nine of the loggerheads. Subsequent analysis of the 22 loggerheads in this study showed that all of them from both hooking categories also swam against geostrophic currents occurring in the North Pacific.

For all species combined with successful tracks, the mean and standard deviations for duration of tracking was 4.2 ± 2.4 months for light hooked, and 3.7 ± 2.2 months for deep ingested hooks. Distance traveled by lightly hooked turtles was approximately 2500 km and 2600 km for deeply hooked turtles. There was no significant difference ($P>0.05$) between deeply or lightly hooked turtles in duration of tracking or distances traveled, whether the 15 turtles that produced few to no transmissions were included or excluded from the analysis. However, means and standard deviations were slightly lower for both hooking categories when all tracks were combined. This was true for analyses done with all species combined and for each species done individually. For loggerheads, using only successful trackings, the mean duration was 4.2 months for lightly hooked and 3.6 months for deeply hooked turtles, and the distance traveled for both hooking categories was approximately 2300 km. Olive ridleys had a mean duration of 4.4 ± 2.3 months for deeply hooked and 3.1 ± 2.6 months for lightly hooked turtles. Deep hooked turtles traveled a mean of 3600 km and light hooked traveled 2500 km, but the difference was not significant. Green turtles had a small sample size (N=3, 1 deep hooked and 2 lightly hooked) so a t-test to detect difference wasn't possible (deep = 1.8 months and 1800 km, light = mean of 6.7 months and 3200 km).

A Chi-square for 34 loggerheads and for all species combined (48 turtles) also showed no significant difference in the duration of tracking between lightly and deeply hooked turtles. The Chi-square was initially done because it seemed that deeply hooked loggerheads (42% of the 34) had a higher percentage of "failure" (those that transmitted less than one month) than lightly hooked loggerheads (27% of the 34). However, the Chi-square analysis supports the findings from the t-test analyses that there is no statistical difference between lightly and deeply hooked turtles in duration of tracking for loggerheads or all species combined.

Excluding the 15 "unsuccessful" tracks, there was no significant difference in carapace size between deeply and lightly hooked for species individually or with all species combined. Including the 15 turtles with few to no transmission in the analysis, there was no significant difference in size between light and deep hooked olive ridleys and for all species combined. But loggerheads showed a significant difference in carapace size between deep ingested and lightly hooked turtles ($P = 0.02$). These data indicate that larger loggerheads are probably more likely to ingest hooks than smaller loggerheads. This information may be useful in determining a hook size to use in the commercial longline fishery to reduce the incidental catch of loggerheads.

Comparison of transmitter surface time data was conducted on a sub-sample of 18 turtles yielding sufficient data for this analysis. The last 30 days of transmission was focused upon because differences in surfacing or submergence times from debilitation or death of the turtle might be expected during this time. However, no significant difference was detected in percent surface time between the nine lightly hooked (mean: 30.0 ± 14.5%, range: 12 - 53%) and nine deeply hooked turtles (mean: 34.1 ± 14.7%, range: 19 - 66%, P=0.6). Percent time on surface data collected by four satellite depth recording (SDR) transmitters (Wildlife Computers, Inc.) deployed during this study were compared to the surface counter data from the 18 turtles. These data show that the range and means calculated from the 18 turtles are within the range and mean of actual percent surface times measured. The actual mean percent time on surface from the four SDR's was 31.6+/-20.9% and the range was 15-61%.

Although there seemed to be a high percent of turtles which had few to no transmissions in the deeply hooked category that might be assumed as mortality, there was no significant difference between lightly and deeply hooked turtles in duration of tracking and distances traveled. Also one can not attribute all of these "failures" to turtle mortality. A small percentage of the "failure" of transmitters with few to no transmissions could be due to electronics failure of the batteries, possible factory defects in the transmitters, or shipboard conditions causing poor transmitter attachment. This latter category is suggested by NMFS observer records showing deployment of two transmitters on the same trip where the turtles had swam away vigorously, yet both transmitters produced few to no transmissions.

Currently, the study reported herein is the largest known data set of its kind. NMFS has taken into account the results of this study in the estimation of mortality rates for the U.S. longline fisheries. Aguilar et al. (1995) estimated a 20% mortality using Mediterranean data. Our data suggests a 20-40% mortality rate depending on hook status. Looking at a combination of duration, distance traveled, and time on surface may give a better indication of turtle survival if compared with data from non-hooked turtles. Studies should be continued using satellite telemetry to help determine the survival of turtles captured in longline fisheries and also with other fishing gear, such as shrimp trawls, where the turtles brought to the surface are often not dead.

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CAPTURE AND TRADE OF MARINE TURTLES AT SAN ANDRES, SOUTHERN PERU

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INTRODUCTION

The Pisco- Paracas area (13º 40’ - 14º 20’ S) has been recognized as a foraging ground for sea turtles in inshore Peruvian waters (Hays Brown and Brown,1982). Besides, a high mortality by interactions with fisheries have been reported historically at San Andrés port (13º 44’ S), also recognized as the main locality for the Peruvian marine turtle fishery (Frazier,1979; Aranda and Chandler, 1989; Vargas et al 1994).

Although protected since 1977, current studies reveal that mortality never stop at this location. In 1999 a program was established to monitor this interaction. The present study summarize results of a continuous monitoring on the hunting and trade of marine turtles at San Andrés port for the period July 1999 - June 2000.

MATERIALS AND METHODS

A systematic survey was conducted at San Andrés port (Fig 1). Direct observations and counts of complete individuals or carapaces found at beaches allowed estimation of a daily catch rate for each species, stratified by month, that led to estimation of catch levels and corresponding standard errors for the whole study period according to Cochran (1964). Remains were considered to be the result of fisheries interaction if they were found at port, beaches and places with evident human use of the meat, or if observed in fishing markets.

For each specimen, the basic data included date, species, number, measurements and, when possible, reproductive status, stomach contents, presence of barnacles and circumstances of death. Straight carapace length was taken in metric units with a tape meausure from nucal scute to the posterior tip of the supracaudals (SCLn-t, Bolten 1999). Stomach contents were identified by comparison with a reference collection. Algae items were identified following Acleto (1980) and Acosta (1977) and preserved in 10% formaline. Information on the trade of sea turtles was obtained through interviews with fishermen, middle people and owner of restaurants.

Direct observations at markets or restaurants by the authors allowed verification of the data.

RESULTS AND DISCUSSION

Mortality estimates

The estimated number of sea turtles caught at San Andrés between July 1999 and June 2000 was 204 +/- 17,6 for the total 276 day observation period. Catch composition by species (SE error and percentage of the total) were: *Chelonia mydas* 137 +/- 13,9 (67,8 %); *Lepidochelys olivacea* 57 +/- 7,5 (27,7%); *Dermochelys coriacea* 6 +/- 2 (2,9%) and 4 +/- 1,6 unidentified species. Numbers are considered minimum because butchering is not always done at the beach and several carapaces are taken for handcraft work. Most animals were caught in medium sized (600 m x 10 m) multifilament nylon drift gillnets set for small sharks and rays, with stretched mesh sizes up to 20 cm.

Figure 2 shows the mortality estimates stratified by month for each species. Although green turtles and olive ridleys were captured year round, a peak was observed during spring (October - December). Leatherbacks were only recorded in December and February. To evaluate corelation between monthly catches with superficial sea temperature, Spearman correlation index was used. There was no significant difference between these parameters (SPEARMAN = -0.38, P=0.01). Perhaps catch fluctuation between seasons was generated by the randomness of the fishing activity (ACOREMA 2000 a,b).

Biological data

The average straight carapace length (cm) for *Chelonia mydas* was 63,3 (mode= 70, n=59); Lepidocheliys *olivacea*, 60,9 (mode= 59,5 , n=30) and *Dermochelys coriacea*, 117,6 (n=3). Based on data from Aranda and Chandler (1989), carapace length analysis obtained in present syudy indicates a hunting pressure on immature green turtles (78% n=47) and mature olive ridleys (83%, n=25) (Figure 3).

Stomach content analysis for 13 black turtles (SCL=51-85 cm) and seven olive ridleys (SCL=51-66,5 cm) are shown in table 1. Plastic bags and net remains were found in the stomachs of both species. The presence of follicles with 4-10 mm in diameter was observed in four olive ridleys (SCL=59-63 cm). In the case of green turtles, eggs were found only in one specimen. Barnacles were found in 19% of green turtle shells and 10% of olive ridleys. Also, four carcasses showed evidence of old damage in the carapace, perhaps due to collision with boats (ACOREMA 2000 a, b).

Trade

An organized trade of sea turtle meat was reported at San Andrés. Fishermen sell sea turtles (sometimes alive) to middle people who offer the meat in the nearby market of Pisco. The price for turtle meat ranges from U$3,5 - US$4,3 /kg. Turtle-based dishes worth US$5 - US$10 in about 14 restaurants which offer the product. A major problem is the high demand for turtle meat among consumers from Lima, Peru's Capital City. Other products from sea turtles were sold or consumed locally. The oil, which is said to have medicinal properties, worths US$ 5,7 /liter, while the shells are offered as souvenirs at prices ranging from US$8,3 to US$14.

The high demand and in some cases their critical socio-economic situation led fishermen to keep for sale turtles taken alive in the nets, because they would earn additional money. Despite the legislation protecting sea turtles, there were no evidences of control by authorities.

Other Threats: Current and Potential.

Scallops farming has been increasing without control inside Paracas National Reserve, reducing habitat for sea turtles. In fact, interviews with fisherman reported entanglement of turtles in nets set to protect the farms. Pollution by plastic debris from both fisherman and visitors are widespread in the whole area, while in zones like the Paracas Bay, the operation of fishmeal plants are an unsolved problem for decades. Efluents from these industries are dumped directly to the bay, causing eutrophication and mass mortalities of algae, fish and invertebrates.

In some areas within the Reserve dynamite fishing occurs, with little control. Sea turtle strandings have been associated to the occurrence of this illegal fishing practice.

RECOMMENDATIONS

Authorities should be encouraged to include sea turtles in their list of priorities in order to enhance control measures. The inclusion of sea turtles in an environmental education program in Peru is considered a priority to help changing people's attitude toward Peruvian sea turtles. It seems essential that systematic boat survey be initiated to gather basic data on relative abundance of species, distribution, movements and habitat use. Participation of fishing communities in conservation activities for sea turtles should be promoted .

Acknowledgements:

We would like to thank Mariela Vinces, Liliam Morante and Alí Altamirano for their valuable help in the fieldwork. Financial support for the research was available from the World Wildlife Fund-Peru Program Office (WWF-PPO). Attendance to the STS was possible through a travel grant from the Peruvian Consejo Nacional de Ciencia y Tecnología (CONCYTEC-Peru).

Figure 1. Map of the study area.

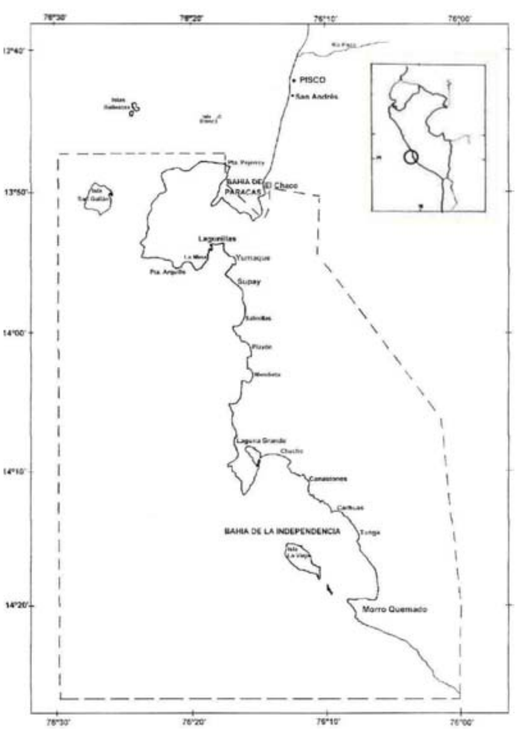

Figure 2.

Monthly catch composition of sea turtles at San Andrés. Period July 1999 - June 2000.

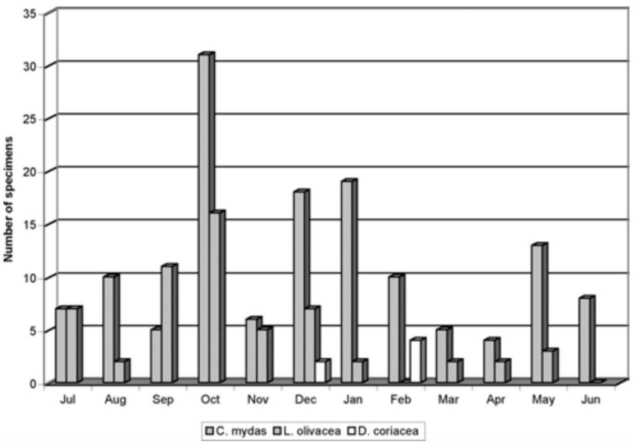

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Figure 3. Size composition of sea turtle catches at San Andrés port. Period July 1999 - June 2000.

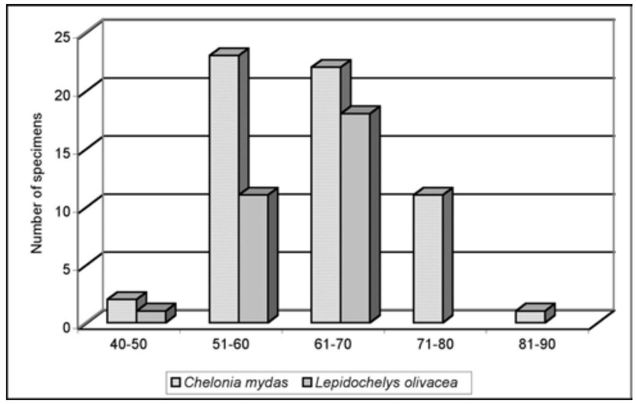

Table 1. Stomach content analysis of sea turtles captured at San Andrés, Peru (July 1999- June 2000).

Stomach content	*Chelonia mydas (n=13)*		*Lepidochelys olivacea (n=7)*	
	% of occurrence	Species	% of occurrence	Species
Algae	43	*Ulva sp., Porphyra, Chondracanthus chamissoi*	8	
Molluscs	29	*Tivella, Sinum cymba Semimytilus algosus*	25	*Tivella, Sinum cymba Protothaca thaca*
Crustaceans			26	*Platyxanthus orbignyi Hepatus spp., Euphylax dovii*
Plastics	14		8	
Bryozoa	3.5	Unidentified	8	Unidentified
Empty	3.5		25	
Sea grass	3.5	Unidentified		
Eggs	3.5	Molluscs (*Concholepas concholepas*), fish		

AUSTRALIAN TRAWL FISHERS MONITOR THE CATCH OF SEA TURTLES

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The use of commercial fishers to collect data is often overlooked as an alternative to deploying independent observers. A project that utilises fishers to monitor the catch of sea turtles in one of Australia's largest prawn trawl fisheries has been running since 1998 and concludes in December 2001. 'Monitoring the catch of sea turtles in the Northern Prawn Fishery (NPF)' is a joint project between government scientists, fisheries managers and the fishing industry. This project will be used to monitor the catch of sea turtles and evaluate the efficiency of management measures introduced to address the issue. It will provide a baseline on which to evaluate the effectiveness of Turtle Exclusion Devices (TEDs), which became compulsory in this fishery in April 2000. The project is funded by the Australian Fisheries Research and Development Corporation (FRDC).

The NPF runs from the top of Cape York in Queensland (142°E) around the northern Australian coastline to Cape Londonderry in Western Australia (127°E). The main prawn species caught are tiger and banana prawns with lesser numbers of endeavour and king prawns. In 2000, there were 121 vessels fishing over a total of 16 433 fishing days. Six species of sea turtles are found in these waters (*Natator depressus*, *Lepidochelys olivacea*, *Caretta caretta*, *Chelonia mydas*, *Eretmochelys imbricata* and *Dermochelys coriacea*). During the NPF fishing season sea turtles are occasionally caught, and sometimes killed. In an earlier study in 1990 it was estimated that around 5,500 turtles were caught annually and of these, around 40% were either returned to the water dead or comatose (Poiner and Harris 1996).

For the current project volunteers, to be trained as turtle taggers, were called for from the fishing fleet. These volunteers were assessed for their suitability for the project through interviews and included fishing masters, crew members and cooks. All were accepted due to their enthusiasm and their genuine interest in sea turtle conservation. Annual training workshops were conducted to teach the necessary scientific skills and increase the tagger's understanding and appreciation for sea turtles and awareness of the global nature of bycatch problems. The workshops also provided a forum for the taggers to discuss possible improvements to the project procedures and use their experiences to help clarify the results.

During the fishing season, taggers record data and tag all sea turtles that are caught by their trawler. They measure, identify, assess the health and collect other useful information on the sea turtle, for example past and present injuries on the captured turtle. Data on the position of the vessel, trawl time and gear details are also recorded. They photograph all turtles for identification verification with disposable cameras. Data sheets are faxed or sent to the researchers at the end of each season. The taggers are given incentives and enter prize draws for being part of the program – shirts, caps, cups and cash. Other fishers from the fleet that return information on tagged turtles also receive cash prizes.

There is a wide variation in the quality of species identification by the taggers. Most of the taggers, after training, consistently identify the species correctly. Others regularly confuse one species for another, most often the loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*) turtles. However, an occasional tagger frequently incorrectly identifies sea turtles while working in the field, irrespective of being able to correctly identify practice-shells. The verification of data, such as species, has been shown here to be vital when fishers are collecting biological data. For this project we virtually eliminated the problem of incorrect identifications by using the disposable cameras.

The proportion of the whole fleet's effort that was covered by the taggers did not vary greatly. In 1998 and 1999, prior to TEDs, the taggers were recording turtle captures over 2514 days. This is 8% of the effort for the whole fleet. In 2000, which is after TEDs were implemented, 920 days were recorded, or 5% of the whole fleet. If would have been preferable to have a higher coverage rate, but quality of data was considered more important than quantity.

The estimated number of sea turtles caught before TEDs were compulsory (1998 and 1999) was not significantly different to that estimated in 1990 of approximately 2 turtles per week per boat. This possibly resulted in up to approximately 5500 captures annually by the whole fleet. In 2000, after TEDs were implemented, there were very few turtles caught. The project will be continuing for another season so reasonable catch rate statistics, post-TEDs, are not obtainable at this stage.

There has been a considerable reduction in mortality rate. In the 1990 study, 40% of sea turtles were returned to the water dead or comatose. In 1998 and 1999, prior to TEDs, the mortality rate was 18%. Fishing techniques have not changed dramatically since the first study, but resuscitation techniques have. Sea turtles are now left on the deck in the recovery position until they are confirmed dead or seem healthy. During 2000, after TEDs were used, only one turtle caught by the taggers was classified as dead. Most captures were made using the try-gear (a small net used to sample the main gear's catch that is winched up every 15 minutes) or in the main gear as it was winched-up. For both of these cases, the sea turtle is only in the net for a short period of time, and consequently have a low probability of drowning. A very small number of turtles were reported as captured as a result of the grid in the TED being blocked or by being small enough to pass through the grid in the TED.

We believe the success of this project is due to a number of reasons. These include a good relationship with the fishing industry, an understanding of the issues by the participating fishers, an appreciation that the results would not ultimately negatively impact on their fishing operations and, most importantly, having fishers who are genuinely concerned about sea turtles. The team approach was adopted and participants have been involved throughout all stages of the project, from planning to the final report. The methodology has evolved throughout the project in response to fisher suggestions and advice and to changes in the fishery. There has been positive cooperation between the voluntary industry members and the scientific researchers.

To date we have shown that the use of TEDs in the NPF has resulted in lowering the mortality rate of sea turtles caused by commercial fishing operations. Researchers and the fishing industry continue to refine and improve TED design and usage, along with adapting their fishing techniques. There can be no doubt that the situation for sea turtles will continue to improve in the NPF.

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Poiner, I. R. and Harris, A. N. M. (1996) Incidental capture, direct mortality and delayed mortality of sea turtles in Australia's Northern Prawn Fishery. Marine Biology 125: 813-825.

METHODS AIMED TO REDUCE MARINE TURTLE INTERACTIONS WITH LONGLINE FISHING GEAR

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Interactions between marine turtles and longline fishing gear have reached unacceptable levels in the Pacific Ocean. As a result, Hawaii-based courts have severely restricted longline fishing in the central Pacific. Our current research aims to reduce hooking of threatened and endangered sea turtles so that time-area fishery closures can be most effective and minimized. Our main objectives are two-fold: First, to provide reliable estimates of delayed mortality and morbidity following longline-turtle interactions. Second, to identify a method to reduce or eliminate interactions between longline fishing gear and turtles.

To estimate delayed mortality, we will deploy pop-up satellite archival tags (PSAT) on incidentally-caught pelagic hard-shelled marine turtles. PSATs have a link that corrodes at a pre-set pop-up date, thereby releasing the tag from the base-plate mounted on the carapace. The transmitter will then float to the surface and transmit data (e.g. depth, temperature, geolocation) to an overhead satellite. The tags also has a fail-safe/ mortality sensor, whereby the link can be set to corrode if the tag is stationary for extended periods or if it exceeds a specified depth. Post-hooking mortality and morbidity (PSAT data) will be correlated with a standardized set of scored observations, such as hook location, severity of injury, and turtles' general health assessment. We are currently testing attachment methods on captive hard-shelled turtles. By using a marine epoxy, specifically Marine Fix® Fast, we have found that this method alone is sufficient for attachment for at least 6 months (figs. 1-3). The advantages of this method are ease and safety for use by observers at sea (see figures 1-4 below). Furthermore, because epoxy does not result in as permanent an attachment as fiberglass, use of epoxy alone would also allow for a turtle to shed a tag if it became entangled. Addition of fiberglass layers could increase tag longevity, thereby offering important information on the longer-term movements and behaviors of pelagic marine turtles.

Figure 1: Put all contents from both containers (A and B) in one box of Marine Fix® Fast (MFF). Stir and mix thoroughly for 1.5 minutes.

Our second objective is to identify a method to repel marine turtles from longline fishing gear. However, sensory mechanisms used by marine turtles that attract them to bait are currently unknown. We are currently conducting behavior experiments on subadult green turtles in tanks at Kewalo Research Facility (NMFS-Honolulu Laboratory) to provide information on the importance of visual and olfactory cues. We present both treated and untreated food for turtles on a simulated "longline", whereby bait on hooks is lowered into the water and turtles have a choice of baits. In testing the importance of vision in the "bite-no bite" decision, we first treated our squid bait with blue dye. This color was chosen as it has been effective in reducing seabird bycatch during longline fishing operations. Blue squid was initially rejected by all captive turtles. For turtles that had been fed squid (untreated) prior to introduction of blue squid, the rejection was short-lived, and turtles were willing to eat both untreated and blue squid after three days. In a second group of turtles that had been presented both blue and untreated squid from their initial feedings, blue squid was rejected for eight days. In combination, these experiments highlighted the confounding effects of conditioning, yet also provided evidence for heavy reliance upon visual cues in making the "bite-no bite" decision. More experiments with blue bait, using both captive turtles and field trials, are needed to determine the potential of this modified bait for reducing longline-turtle interactions.

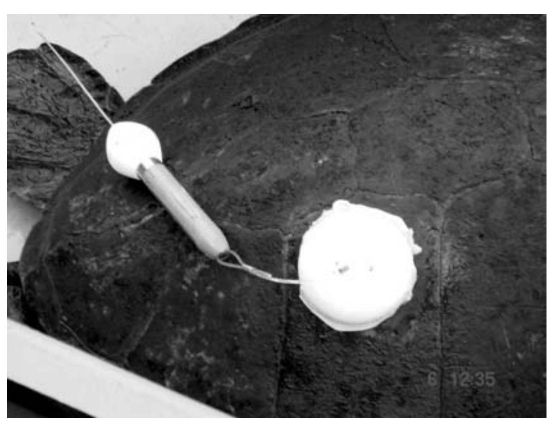
We have also marinated squid in a variety of chemical compositions to elucidate the importance of olfaction in the "bite-no bite" decision. Squid have been soaked in garlic, bitter and sour substances (e.g. citric and lactic acid), as well as substances that stimulate the trigeminal receptors (e.g. capsaicin, wasabi oil). Turtles were willing to eat squid soaked in all substances. While olfaction may be an important component to bait attraction, we have not yet discovered a repellent substance.

In an attempt to isolate the effects of vision and olfaction, we are also developing various artificial baits. Fish and squid-based baits are hardened by the use of gelatin and algenic acid. They are dyed the same color and shaped the same; they differ only by taste. Our results suggest that turtles use a combination of vision and olfaction in making the decision to bite. We have also learned that turtles have a memory; turtles that have previously been fed a mixed diet of fish and squid are willing to eat both fish and squid-based artificial baits, while turtles having fed on a squid-only diet will not eat fish-based baits. Once again, conditioning and social facilitation complicate our analysis and interpretation.

Figure 2: Apply a thick coat of the mixed epoxy onto the flat, bottom part of the white base-plate.

Any modified bait must also be effective for swordfish and tuna fishing. We have also been testing all modified baits on captive yellowfin tuna. Information on behavior studies will be integrated with our laboratory studies on marine turtle and tuna sensory mechanisms. Field trials with promising methods will be conducted in the near future. Our research methods can be transferable to a similar study with loggerhead and olive ridley turtles. We are currently investigating ways to adhere PSATs to leatherback turtles.

Figure 3: Place baseplate on clean and dry carapace. Press down firmly against the carapace for a few minutes to squeeze out any air pockets. Be careful not to press down too hard such that a significant amount of epoxy is displaced out from under the baseplate. Smooth out the excess epoxy that oozes out the sides with the stirrer or a wet (gloved) fingertip. Wait approximately 20 minutes for epoxy to harden completely.



GENETICS

THE MATING SYSTEM OF THE EAST PACIFIC GREEN TURTLE, *CHELONIA MYDAS*, IN MICHOACAN STATE, MEXICO: A GENETIC APPROACH

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Behavioral studies of the East Pacific green turtle (*Chelonia mydas*, a.k.a. the black turtle, *C. m. agassizii*), show that courtship and mating activity is intense in the vicinity of the principal nesting beaches off Colola and Maruata in Michoacan, Mexico. Copulation occurs throughout the nesting season, and in Colola, various male turtles are often observed competing aggressively for females, with up to 10 males at a time trying to displace a mounted male. Males show strong competition for mating, and thus more than one could fertilize the receptive female. Until now, however, it has not been possible to determine if the observed behavior results in effective fertilization by multiple males. Recent genetic studies on leatherbacks and Australian green turtles show that multiple paternity between and within nests surprisingly, is very rare, suggesting that female sea turtles have a capacity to store sperm. Given the relatively intense competition by males observed in eastern Pacific greens as compared with other populations, one would expect a greater degree of multiple paternity. This study reports paternity analysis for multiple clutches laid by several individual females, that may help to clarify this suggestion in the context of genetic mating system.

MULTIPLE PATERNITY IN A CAPTIVE POPULATION OF GREEN SEA TURTLES, *CHELONIA MYDAS*

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Multiple paternity was investigated to determine its role in offspring survival as part of a larger study focusing on factors that may contribute to poor hatch success at the Cayman Turtle Farm. In a captive population of green sea turtles (*Chelonia mydas*), 21 nests from 16 different females were examined for multiple paternity at four highly polymorphic flourescently labeled microsatellite loci. The microsatellites were either species-specific (Cm 72 and Cm 84) or known to be cross-reactive (Cc 7 and Cc 117). Between 11.5% and 69.6% of each nest was sampled, including live hatchlings and dead embryos, in an attempt to ensure detection of all fathers contributing to each nest. Green sea turtles are acknowledged to be promiscuous breeders both in the wild and in captivity, however, it was surprising to find a higher frequency of multiple paternity among the nests then that reported for the same species in the wild. These results demonstrate the physiological capability of green sea turtles to have as many as seven males contributing to a single clutch of eggs.

INTRODUCTION

A primary focus of sea turtle research is the recovery of seven species that have been in decline for decades, primarily from over-utilization and incidental anthropogenic mortality. By studying the mating system of sea turtles, researchers hope to optimize conservation efforts. Multiple paternity has been found to be an important part of the mating system with males reaping the most obvious benefits. Numerous couplings enable males to produce offspring at a greater rate. Benefits to females are less obvious and can be both direct (nutrients, parental care and freedom from harassment by other males) and indirect (fertility insurance, increased genetic quality of offspring) (Laurila and Seppa, 1998). In sea turtles, females are reaping indirect rewards, since males offer no nutrients or parental care, and females are commonly harassed by attending males during the breeding season (Commuzie and Owens, 1990, Green, 2000).

Using genetic markers to study mating systems allows for greater resolution than can be obtained by strictly visual observations in the wild. Molecular studies have demonstrated that female sea turtles can and do utilize the sperm of more than one male to fertilize a clutch of eggs (Kichler et al, 1999, Bollmer et al, 1999, FitzSimmons, 1998). The extent of the phenomenon occurring in populations under captive conditions (which can define maximum biological parameters) and links paternity may have to hatch success, have not been investigated. The goal of this study was to elucidate the genetic contributions males make to the next generation.

MATERIALS AND METHODS

STUDY SITE AND POPULATION

Samples for genetic analysis were collected at the Cayman Turtle Farm, Ltd. (CTF) on Grand Cayman Island, British West Indies. A captive breeding colony of 332 adult green sea turtles resides at the farm year round in a circulating seawater pond with wire mesh partitions separating original parental generation (P1) from first offspring generation (F1) parents. The population is a combination of green sea turtles from many origins, as listed in Table 1.

Table 1. Cayman Turtle Farm Breeding Stock.The origins of adults turtles in the breeding stock include those which were captured from the wild as adults between 1968 and 1980, animals raised from eggs collected in the wild, and the farm's own F1 and F2 offspring

Captive Wild Adults	
a	Ascention Island
cr	Costa Rica
g	Guiana
m	Mexico
n	Nicaragua
s	Surinam
Farm Raised From Eggs	
1&3	Costa Rica
2&4	Ascension Island
5	Surinam
f	Florida
Farm Raised Cayman F1 Generation	
Farm Raised Cayman F2 Generation	

BLOOD AND TISSUE SAMPLING

Blood and tissue samples were collected from 16 focal adult females, 87 males (candidate fathers) and a varying number of offspring from 21 nests laid by focal females during the 1998 and 1999 nesting seasons. On average, 33% of each nest was sampled (Table 2). Whole blood was stored in lysis buffer at a ratio of no more than 0.5:1 (blood:buffer; Dutton, 1996). All tissue was stored at room temperature in 70% ethanol. Genomic DNA was extracted from tissue using a Qiagen tissue kit.

Table 2. Multiple Paternity By Nest. Each nest is identified by the focal females tag number, the last two digits of the nesting year and A or B to indicate the order of nests laid within the same year. The number of paternal alleles was divided by two and used to estimate the minimum number of fathers contributing to a nest. N is the number of offspring genotyped from each nest.

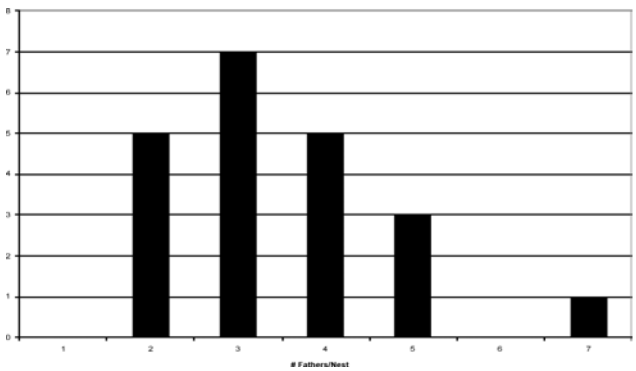
Nest	N	Number of Alleles	Minimum Number of Fathers
4-99 B	17	6	3
28-99	35	5	3
61-98	15	8	4
61?-99	49	5	3
87-99	64	13	7
130-98	67	8	4
202-98	39	9	5
202-99 A	29	8	4
202-99 B	45	9	5
216-98 A	21	5	3
216-99 B	39	7	4
237-98	15	6	3
237-99	43	9	5
267-98	41	6	3
268-99	12	3	2
270-98	30	6	3
270-99	48	4	2
272-99	39	4	2
280-99	45	4	2
293-99	24	8	4
314-98	7	3	2

MICROSATELLITE MARKERS

Four sea turtle primer pairs were used for analysis (Table 3). Two sets, *Chelonia mydas* (Cm) 72, and Cm 84, were species specific, and two were made for the loggerhead sea turtle, *Caretta caretta* (Cc7 and Cc117), but found to be fully cross reactive when tested on six of the seven sea turtle species (FitzSimmons et al, 1995). Forward primers were labeled with a fluorescent tag for visualization on an automated DNA Sequencer. Gels were analyzed using Genescan 3.0 and Genotyper 2.1 software.

RESULTS AND DISCUSSION

Analysis of four microsatellite loci yielded an average of 21 alleles per locus (range 17-25), demonstrating sufficient resolution to detect multiple fathers in all 21 clutches. Multiple paternity was found in all 21 nests studied (Fig.1). Ninety-five percent of the nests (n=20) showed a minimum of 2-5 males contributing to a nest, and 5% (n=1) indicated a minimum of 7 fathers. In this population, the number of nests with more than one father was greater than has been reported in wild populations. The results of the paternity study confirm promiscuous behavior in both male and female turtles. Many of the males at CTF were identified as fathers in clutches from more than one female.



By comparing the origin of mothers and fathers, evidence supports the idea that assortive mating is taking place. Females of a certain geographic and genetic origin are mating with males from the same origin, although not exclusively. Of particular interest was nest 268-99. One possible father was identified from the pool of males (m 104), matching the offspring alleles exactly at all loci. Female 268 was originally from Surinam, and male 104 was the one of three known males left in the breeding pond also originally from Surinam. The same trend was observed in nests from farm reared turtles; the majority of identified mates were farm raised as well.

Increased genetic diversity can be obtained by mating with multiple males, suggesting that the more males contributing to a nest, the better hatch success could be. This was not the case for the Cayman green turtles. A clear correlation between the number of males contributing to a nest and the hatching success of that nest was not found (Fig 2). More studies investigating a connection between paternity and hatch success should be done, especially in wild populations. Biologists must investigate other important stages of sea turtle life history and the interactions between them to ensure the best possible recovery for all species.

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Table 3. Microsatellite Primers. Primer sequences, allele sizes and variability came from *FitzSimmons et. al. (1995), ** FitzSimmons (1997) and *** FitzSimmons (1995). Other data on allele sizes, variability and working stock dilutions are from the current study.

PRIMER*	# OF ALLELES	ALLELE SIZE RANGE (BP)	SEQUENCE (5'-3')*	PRIMER DILUTION (from 100 nM stock)
Cc 7**	21	161-219 (179 -193***)	**(F) TGC-ATT-GCT-TGA-CCA-ATT-AGT-GAG **(R) ACA-TGT-ATA-GTT-GAG-GAG-CAA-GTG	1:10
Cm 72	32 (25*)	220-300 (226 -306***)	(F) CTA-TAA-GGA-GAA-AGC-GTT-AAG-ACA (R) CCA-AAT-TAG-GAT-TAC-ACA-GCC-AAC	1:05
Cm 84	18 (19*)	323-363 (325 -365*)	(F) TGT-TTT-GAC-ATT-AGT-CCA-GGA-TTG (R) ATT-GTT-ATA-GCC-TAT-TGT-TCA-GGA	1:10
Cc 117	16 (17*)	228-268 (228 -266*)	(F) TCT-TTA-ACG-TAT-CTC-CTG-TAG-CTC (R) CAG-TAG-TGT-CAG-TTC-ATT-GTT-TCA	1:05

TRACKING LEATHERBACKS FROM PACIFIC FORAGE GROUNDS IN MONTEREY BAY, CALIFORNIA

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Little is known about leatherback migratory behaviour or stock origin on forage grounds. Leatherbacks are often sighted in California waters and caught by fisheries in the North Pacific. It was proposed that leatherbacks that regularly appear from July to October each year in Monterey Bay, California belonged to the eastern Pacific nesting population and subsequently migrated down to nesting beaches in Mexico. However, recent genetic studies suggest that leatherbacks encountered in the central North Pacific, and in California waters are from western Pacific nesting populations (Dutton et al., 2000). Telemetry studies in the Pacific to date have been limited to post-nesting movements to the southern hemisphere, but have not tracked turtles in the north Pacific Ocean. This study combines genetic analyses with satellite telemetry to test the hypothesis that at least some leatherbacks foraging off California are in fact from the western Pacific. Further, the study intended to initiate our first look at the behaviour of non- post - nesting turtles at their foraging grounds. On the 8th and 9th of September, 2000, two adult leatherback females were captured at sea, sampled and satellite tracked from a forage area in Monterey Bay, California, USA. Genetic analysis revealed both animals were from western Pacific nesting stocks, which include Indonesia/Papua New Guinea, Malaysia and the Solomon Islands. Both animals travelled westward on parallel courses, passing south of the Hawaiian Islands by mid-November (Figure 1). The trajectory appears to be a direct route towards Indonesia/Papua New Guinea and suggests a possible migratory corridor for females that travel from the Monterey Bay forage area to these nesting beaches in the western Pacific. Transmissions ceased for one of the turtles on 17th November, when the turtle approached an area south of Hawaii where commercial high seas fisheries operate. The other turtle continues on her westward trajectory as of April 2001. The results have implications to conservation of Pacific leatherbacks and demonstrate the utility of combining two analysis techniques to determine population and stock boundaries of highly migratory sea turtle species. Dive data are being analysed and further telemetry work is planned for Monterey Bay.

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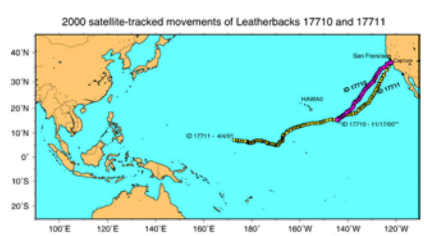

GREEN TURTLE (*CHELONIA MYDAS*) PHYLOGEOGRAPHY BASED ON MT DNA HAPLOTYPES IN THE GULF OF GUINEA, CENTRAL AFRICA

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Genetic analysis can now be used to describe organisms from the species to the individual level. Given the use of appropriate genetic markers, this is an invaluable tool in the conservation and management of endangered populations. Due to their high levels of philopatry, marine turtle populations are subdivided into geographically and genetically distinct assemblages. Management and conservation efforts can thus be directed at individual stocks and the entire range of habitats they occupy. Mitochondrial DNA control region sequences are the most appropriate markers to resolve the martilineal structure of sea turtle populations. Although several studies have already addressed the phylogeographic structure of green turtles (*Chelonia mydas*) in the Western Atlantic and Mediterranean, very little is known to date about the genetic characteristics of the rookeries in the Gulf of Guinea. A total of 89 tissue samples were collected from nesting female green turtles in Bioko Island and Corisco Island (Equatorial Guinea), Sao Tome and Principe, and Ascension Island. Sequencing of the D-loop of mitochondrial DNA revealed the presence of 8 different haplotypes, 4 of which are previously undescribed. In addition, preliminary results from the analysis of 109 samples from non-nesting individuals from the region show 10 different haplotypes, two of which are new. Interestingly, the nesting population of Sao Tome exhibits 7 different haplotypes, among them S1 which is highly divergent, being separated by 4 substitutions from the rest. A comparison with Atlantic rookery haplotypes from other studies shows that the haplotypes which had been previously described (V, VI, VIII and IX) occur at several geographically distant locations, and that haplotype VIII is the most common in the southern Atlantic. Two sample sets are available from Ascension, each reveals a haplotype which had not been found by the other. Overall, haplotype VIII occurs in 152 out of 198 individuals sequenced (nesting and non-nesting combined), most other haplotypes occur in few individuals and sites. Determining a genetic map of haplotype distribution in the rookeries of the region is a first step. Further analysis, using additional samples and genetic markers (ie microsatellites) will help us to define population management units for this endangered species.

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ECOLOGY

RELATIONSHIP BETWEEN SHAPE OF TSD PATTERN AND DEMOGRAPHICS OF SEA TURTLE NESTING POPULATIONS

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Temperature dependent sexual differentiation (TSD) exists in all marine turtles as well as many non-marine turtle species. This phenomenon is characterized by having a biased production of one sex as a result of certain incubation temperatures during development. For sea turtles, cooler incubation of eggs results in more males, warmer incubation results in more females, and the temperature which produces equals numbers of each sex is termed the pivotal temperature (Mrosovsky and Pieau 1991).

A new method to depict TSD traits in a standardized manner has recently been described (Girondot 1999). This method, based on maximum likelihood analysis, utilizes the following equation:

$$sr= 1+e(1/s*(p-t))$$

where p is the pivotal temperature, s is the slope of the transitional range of temperature which produces some offspring of each sex, and t is the constant incubation temperature. Standardization of the descriptors of TSD (i.e. p and s), facilitates comparisons among and across species (Chevalier et al. 1999). Here we describe the results of our analysis of comparisons among TSD traits and demographic characters (e.g. latitude, heterozygosity, etc.) in marine species only.

An important assumption is that TSD is an ancestral character for the turtle phylogeny, based on currently available evidence. As such, there is an inherent bias in cross species analyses using TSD traits, based on phylogenetic inertia (Felsenstein 1985). To correct for this bias, we used the Comparison Analysis of Independent Contrasts (CAIC) which accounts for disparate phylogenetic relatedness across the populations and species (Purvis and Rambaut 1995).

Using several different traits related to reproductive ecology of sea turtles, such as longitude and latitude of nesting beach, egg and clutch size, carapace length, and allelic heterozygosity, we searched for their correlations with p and s values. The data matrix used was not complete, due to lack of published details of sea turtle nesting populations. Based on the currently available data, we found no significant relationship between TSD traits and reproductive characters. This should not be taken as absolute evidence that there is no significant adaptive reason for the existence of TSD in sea turtles, since we analysed only a subset of traits of the reproductive ecology of nesting populations. Our conclusion is the existence of TSD in sea turtles remains unexplained, although we anticipate more analyses as more data, both from TSD experiments and from nesting populations, become available.

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A COMPARISON OF HABITAT, FORAGING ECOLOGY AND THE BIOTOXIN OKADAIC ACID IN FIVE FLORIDA POPULATIONS OF *CHELONIA MYDAS*

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INTRODUCTION

Green turtles forage primarily on seagrass and macroalgae. While foraging they are also subject to consuming organisms that are epiphytes on the vegetation. In reviewing the possibility that green turtles could be ingesting biotoxins associated with their foraging material, I focused on the toxic species of dinoflagellates called Prorocentrum. Species of the genus include P. belizeanum,, concavum, lima and mexicana (Faust, 1995). These species are generally less than 50 micrometers in size and have been associated with accounts of diarrhetic shellfish poisoning, ciguatara and red tide outbreaks (Landsberg, 1999). Many of these contain a biotoxin called okadaic acid. Laboratory experiments have shown okadaic acid to induce skin papillomas and carcinomas in mice when applied topically (Amtmann et al. 1983; Fujiki and Suganuma, 1993). Fibropapillomatosis (FP) has become an epidemic in many juvenile green turtle populations worldwide (Balazs, 1991). The disease manifests as neoplastic tumors on the eyes and soft tissues of the body. Recent hemo-analysis by Tomo Hirama at the University of Central Florida indicates a compromised immune system in turtles severely afflicted with FP (Hirama, masters thesis in progress). The objective of this study was to determine the possibility of a correlation between the incidental ingestion of Prorocentrum spp. and green turtle fibropapillomatosis. Dietary samples were collected from each population. Samples of available foraging material were collected seasonally to determine the presence of Prorocentrum spp. FP ratios were compared to consumption levels of Prorocentrum substrates.

METHODS

In cooperation with NASA contracted Dynamac Corporation, the University of Central Florida's Marine Turtle Research Group and Michael Bresette (Inwater Research, organization in progress), I was able to investigate five separate juvenile populations on the East Coast of Florida. The northernmost site under study by Dynamac Corporation is in Mosquito Lagoon at Canaveral National Seashore. The southernmost site is in Fort Pierce at Jennings Cove in the Indian River Lagoon (IRL). The University of Central Florida studies the three centrally located sites. They are the Trident Submarine Basin at Port Canaveral, an IRL site in Sebastian and the nearshore reef system approximately 1 mile south of Sebastian Inlet State Park. The Mosquito Lagoon and the two IRL sites are characterized as saltwater, brackish estuarine habitats. The Trident Submarine Basin is located just inside of Port Canaveral inlet and the nearshore reef site is part of a coastal Sabellariid worm rock reef system. Turtles were net-captured at all five study sites. Their esophagus and mouth areas were flushed using a standard veterinarian pliable tubing and stomach pump system (Balazs, 1980; Forbes and Limpus, 1993). This procedure is commonly called lavage. Samples were preserved in 5% formalin/seawater solution in the field. Turtles were weighed, measured, photographed and their FP status was documented. In the laboratory, the lavage sample was strained through a non-chlorinated coffee filter, wet-weight was recorded and the sample was placed across a 1600-grid counting dish to evaluate the percent volume of foraging items. To sample for Prorocentrum spp., 30 grams of all available vegetation and bryozoans was selected and the epiphytes were extracted by pouring 100ml of pre-mixed ambient seawater, shaking the vegetation and sea water mix vigorously in a ziplock bag for 20 seconds (Bomber, 1989; Ballantine, 1988). Fifty milliliters of the solution (with epiphytes) was poured off and preserved in a 5% formalin mix. Three-one milliliter samples were placed in a tissue chamber dish and scanned under a World Precision Instrument (WPI) inverted microscope at 200x power to determine the presence of Prorocentrum spp. Species identification was performed at 400x power.

RESULTS

The diet of the green turtle population at Mosquito lagoon consisted of the following five highest consumed items by percent volume (in descending order): Halodule wrightii, Gracilaria spp., animal, Syringodium filiformes and Chondria spp. Sample size was 13 individual lavage samples. The five largest items by percent volume at the Sebastian IRL site was Gracilaria spp., Halodule wrightii, Solieria filiformis, Syringodium filiformes and Bryothamnion seaforthii. The sample size for Sebastian was 11 individuals. At the Fort Pierce IRL study site, 51 individual samples have been reviewed with the following five highest percent volume results being: Gracilaria spp., Syringodium filformes, Halophila johnsonii, Halodule wrightii and animal matter (mostly ctenaphores). The nearshore reef results from 11 samples was: Bryothamnion seaforthii, Gelidium americanum, Laurencia poiteaui, Gracilaria spp. andChondria spp. Data for the Trident Submarine Basin population was determined from a previous study (William Redfoot, masters thesis). The five items that were the highest percent volume in consumption were: Gelidium americanum, Hypnea cervicornis, Polysiphonia subtilissima, Solieria filiformis and Ulva lactuca. There were 221 samples evaluated by Redfoot. Seasonal sampling of available vegetation revealed that less than three percent of the items that were consumed by the Trident green turtle population were also used as substrate for any of the toxic species of Prorocentrum. A comparison of the substrates (foraging materials) used by Prorocentrum and the amount of those substrates being consumed at the study site were compared (Figure 1). According to this analysis the nearshore reef population is likely to be consuming substrates utilized by Prorocentrum in 21% of their diet; at the Fort Pierce study site 70.0%, Sebastian IRL 75.4%, and Mosquito Lagoon 79.2 %.

DISCUSSION

Green turtle populations in the five study areas have an average straight carapace length (SCL) of 32.5 to 53.9 cm. Green turtles within this size range are considered juvenile individuals (Carr and Goodman, 1970). The population ratio of turtles with FP differ among the separate populations with the greatest variation between the oceanic and estuarine study sites. Water clarity, nutrient input and seasonal temperature changes impact the growth and production of epiphytes, macroalgae and seagrass organisms. The greatest variation among these factors is also between the oceanic and estuarine habitats. FP ratios of green turtle populations in estuarine habitats tend to be much higher at 70 to 79%. FP ratios of the coastal worm rock reef population averaged 18%. Interestingly, this site has been studied since 1989 and prior to 1997 there were not accounts of turtles with FP in the area. The Trident Submarine Basin, located just inside the Port Canaveral inlet has shown no sign of individuals with FP since the onset of the study in 1993. The green turtle population at Trident is still encountering toxic microalgae but in less than 3 percent of their diet. Environmental cofactors such as microalgae may play a role in the promotion and/or manifestation of diseases like FP in Florida's estuaries and coastal areas (Herbst and Klein, 1995). Further investigations based on the findings of this preliminary study appear to be warranted.

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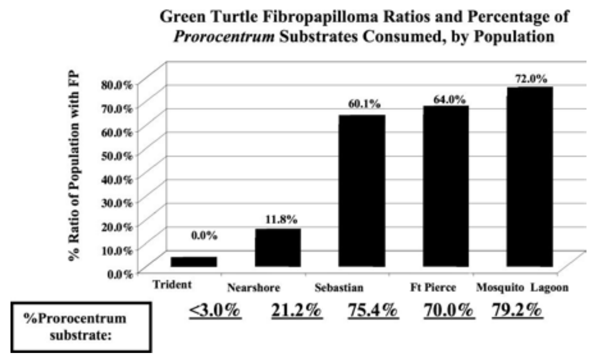
Figure 1. Percent volume of foraging items that are consumed by green turtles at each study site and are also used as a substrate for the toxic microalgae species of Prorocentrum.



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SAND TEMPERATURES AND SEA TURTLE NESTS: TRI-DIMENSIONAL MODELING OF HEAT FLUX

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INTRODUCTION

The islands of Linosa and Lampedusa are part of the Arcipelago delle Pelagie in Southern Mediterranean (35.5°N 12.5°E). Although they are only 18 nautical miles apart, their morphology and geology are completely different. Lampedusa belongs to the calcareous African platform while Linosa is a volcanic island belonging to the European continental shelf. Such large difference in the substrate, translates into a significant difference in the colour of the rocks and in the albedo of the island surface. Lampedusa has a few white beaches and one of those is known to be a loggerhead nesting sites since many years (Spiaggia dei Conigli). Linosa has only two small black beaches and one of those called Pozzolana di Ponente is normally used by loggerhead females for laying eggs. Long term surveys of the two nesting sites have been organised by the Hydrosphera Association and by Legambiente in Linosa and Lampedusa, respectively.

Recently, the European Commission (Directorate General Environment, Life Projects) funded a new project aimed at the study and protection of loggerheads in the Pelagie Islands. The project is coordinated by the Provincia Regionale di Agrigento and CTS (Centro Turistico Studentesco, Rome, Italy) and involves a number of Italian institutions like the National Research Council, The Universities of Turin and Milan and both Hydrosphera and Legambiente. One of the objectives of the project is to better understand how the temperature of the sand may influence hatchling success at the two nesting sites as well as the dynamics of heat transfer and accumulation in the sand and in egg clutches. This objective is at the basis of the work presented in this extended abstract that deals with the implementation and validation of a tri-dimensional model to calculate heat transfer and accumulation in the sand as a function of the external radiation input, air temperature and humidity, of the thermal and optical properties of the sand. This model uses heat transfer equation within a CFD (Computational Fluid Dynamics) framework.

MATERIALS AND METHODS

Beach surface albedo was measured in the year 2000 on sand samples using a portable spectroradiometer (GER 3700, USA). The reflectance curve for the sample was calculated as the difference between the reflectance obtained on a white reference panel and that obtained directly from the sample. The curve was constructed with a resolution of 1 nm for the entire spectrum ranging from 450 to 2500 nm. Albedo was calculated as the fraction difference between the reference curve and that obtained on the two different sand samples.

Sand temperature was monitored from June to mid-September in both nesting sites. Temperature sensors were placed at different depths at -20, -40 and -60 cm. In Linosa the thermistors were connected to a data logger (Mod.TXF5, Onset Computer, USA) powered by a 12 VDC battery. The data logger recorded hourly temperature averages of reading made every minute. In Lampedusa the temperature was monitored using integrated sensors/loggers (Hobo, Onset Computer, USA) at the same time intervals. The thermal properties of the sand in the two beaches were not measured but derived from data obtained from the literature.

The 3D model of the sand was constructed using CAD software. A tri-dimensional hybrid mesh (Hexa and Thetahedric) was generated for a sand volume of 2 x 2 m. The volume occupied by the egg clucth was also defined within the meshed domain for subsequent simulation of the effect of the presence of the nest on the thermal characteristics of the local environment. Heat flux, transfer and accumulation was simulated using unsteady solutions provided by the Fluent 5.4 CFD package using the following equation:

$$Hf = [(1-A) * R] – (es * Ks * Ts4) +(es * ea * Ks * Ta4)$$

where, Hf = heat flux at the sand surface, A = surface albedo, R = global radiation, es = emissivity of the sand, ea = emissivity of the atmosphere, which is a function also of its humidity, Ks = von Karmann constant, Ts = temperature of the sand and Ta = temperature of the air.

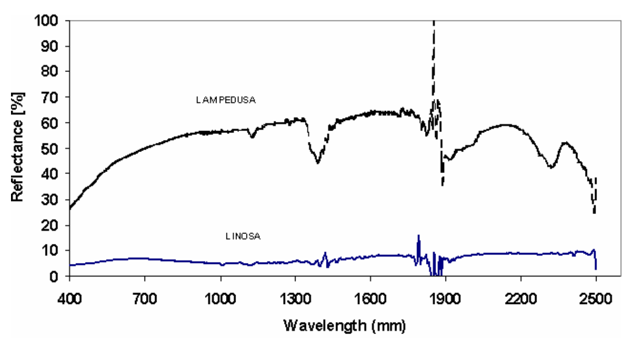

Figure 1 – Reflectance curves of the sand of Lampedusa and Linosa beaches measured using a portable spectroradiometer on sand samples.

RESULTS AND DISCUSSION

The measured albedo was significantly different among the two beaches. In Linosa most of the impinging radiation was absorbed by the black sand while most of it was reflected by the white sand in the beach of Lampedusa (Figure 1). Such large and striking difference in albedo caused a large difference in sand temperature that was consistently observed throughout the season (Figure 2). The CFD model simulated quite accurately the temperature of the sand in both sites (Figure 3).

The data show that there was a mean difference of approximately 6 degrees C at any depth in the sand of the two beaches and that the diurnal temperature fluctuations were much higher in the dark than in the white beach. This was an obvious consequence of the different reflectance of the sands (Kaska et al., 1998). Biological data collected over the years in the two sites are very consistent with these observations as the mean incubation period of loggerhead egg clutches was observed to vary from 40-50 days in the dark beach of Linosa to more than 60 days in Lampedusa (unpublished data). It is therefore very likely that the two sites have temperatures which are respectively above and below the pivotal value driving changes in sex ratio of hatchlings (Godley at al., 2001).

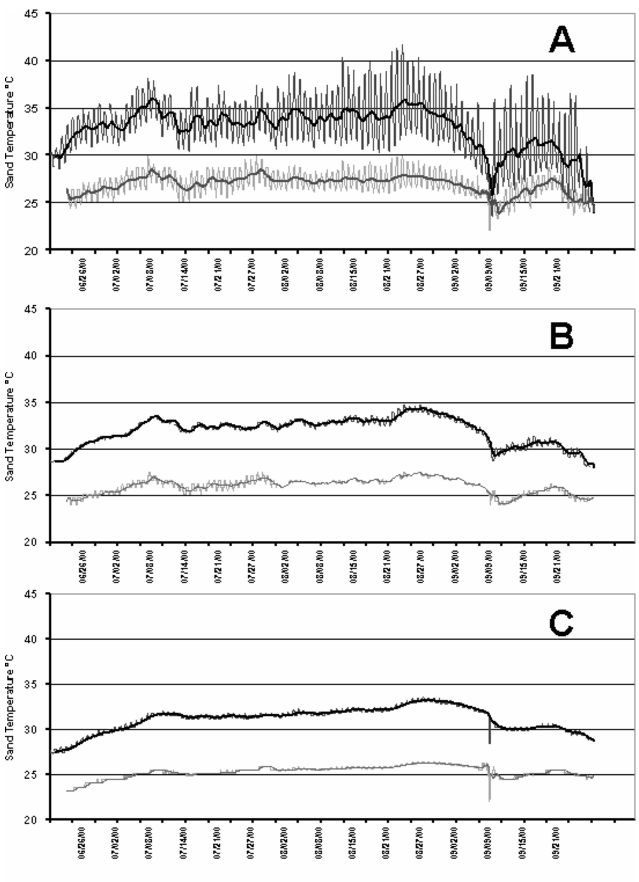

Figure 2 – Sand temperature measured in Linosa (upper lines) and Lampedusa (lower lines) over the summer season 2000 at three depths (-20cm, A; -40cm,B and –60cm,C).

The data and the model results indicated very clearly that the two Pelagie islands are providing, due to their different geological substrate, an unprecedented opportunity to study the effect of the climate and of sand temperature on reproductive biology of the loggerheads. The results obtained with the simulations indicate, on the other hand, that the temperature of the sand at various depth may be calculated and predicted on the basis of sun irradiance, air temperature and humidity that occur at any site. Information of the thermal properties of the sand and of surface albedo is also required to come up with reliable calculations. The new tools provided by Fluent CFD simulation package offer the possibility to perform simulation on a tridimensional domain with very high temporal and spatial resolution. The possibility to include a meshed volume describing the egg clutch is opening new opportunities to understand how heat generation by the developing eggs may affect the thermal environment of the developing embryos and with, this, the sex ration of hatchlings (Casale et al.,2000). There are interesting implications on this, as we may expect that rising atmospheric temperature and increasing emissivity of the atmosphere due to the rising concentrations of greenhouse gases, will affect the mean temperature of the sand in the years to come.

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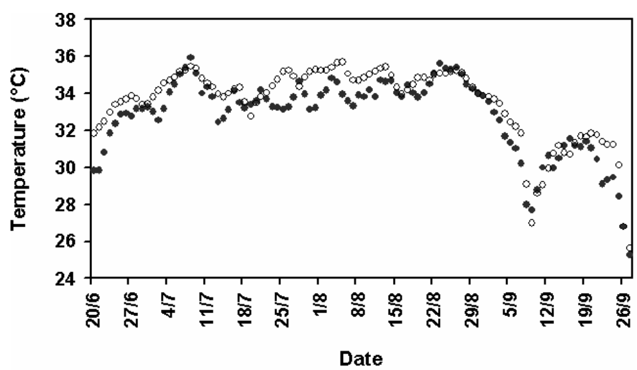

Figure 3 – Simulated (open symbols) and Observed temperatures (solid symbols) at –20cm depth in the sand of Linosa. The sudden drop in T observed in early September was caused by ranifall event associated to a reduction in the radiative input and a deecrease in air T. The model could simulate this effect very well. Minor differences between observations and simulations may be ascribed to effects of the local site topography that are not considered in the model.

INTEGRATION OF PHYSICAL OCEANOGRAPHY WITH SPATIO-TEMPORAL PATTERNS OF STRANDED SEA TURTLES IN NORTH CAROLINA

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Sea turtle carcasses occasionally drift so close to shore that they become stranded in shallow water or on beaches. Because the number of recorded sea turtle strandings represents a minimum estimate of mortality (Murphy and Hopkins-Murphy 1989, Epperly et al. 1996), and in light of the conservation status of turtle species, recent management guidelines have strongly recommended an investigation of landfall patterns of stranded turtles (Turtle Expert Working Group 1998). In addition to water temperature, tidal forcing, decomposition rates, scavenging rates, and the spatio-temporal distributions of turtles and mortality sources, wind and water current regimes can also play a major role in the stranding of carcasses on ocean-facing beaches.

Although coastal water circulation tends to be local and hence difficult to predict, due primarily to shoreline geography and topography (S. Lozier, personal communication), recent advances in current modeling have been made. In order to model near-shore surface currents, we transformed 15 years of hourly wind speed data, recorded off the North Carolina coast, into vector format. Resulting vectors were then converted into wind stress magnitude and direction values, and averaged by month. We then estimated near-shore surface currents for the South Atlantic Bight via a three-dimensional physical oceanographic model (Werner et al. 1999). Resulting current regimes were compared to the spatial locations of sea turtle carcasses stranded along ocean-facing beaches of North Carolina.
By using monthly flow fields predicted by the model and by relying on empirical evidence from surface drift-bottle experiments, this work can describe large-scale seasonal patterns in North Carolina. Several general trends were observed:

i. Spatio-temporal stranding patterns

The spatial locations of stranded carcasses demonstrated seasonal differences. Between 1995 and 2000, over 1300 turtles were recorded as having stranded on the ocean-facing North Carolina coast (R. Boettcher, unpublished data). Almost half of these strandings occurred in May and June. In contrast, less than 8% occurred from December to February. Carcasses could be more likely to strand from March to October due to the development and persistence of an along-shelf current parallel to the coast. Likewise, carcasses seem least likely to strand from November to February due to the presence of offshore flow.
Furthermore, the oceanographic model predicted onshore flow concentrated along the eastern edges of the Carolina Bays from late spring to early summer. During the peak stranding months of May and June, disproportionate numbers of carcasses stranded along the eastern stretches of Onslow Bay and Raleigh Bay (located approximately from 33.75°N, -78°W to 35.25°N, -75.5°W).

Using chi-square analyses, we tested the null hypothesis of uniform stranding distributions within these two cuspate bays. Statistical analyses of strandings aggregated from 1995-99 revealed that carcass spatial distributions differed from those expected with random stranding patterns. Inside Onslow Bay, over 4 times as many turtles stranded along its eastern half compared to the western side ($chi^2 = 22.93$, $chi^2critical = 3.84$ at $alpha = 0.05$). Similarly, for Raleigh Bay, we also found a significant difference in stranding patterns ($chi^2 = 4.83$, $chi^2critical = 3.84$ at $alpha = 0.05$), though it was not as prominent as for Onslow Bay.

ii. Spatio-temporal patterns of mortality

Relative to their recorded stranding position on the beach, sea turtles are more likely to have died "upstream" from the residual current, in areas to the south (from April to August) and to the north (from September to October), due to the net direction of along-shelf flow.

iii. Carcass landfall probability

Surface drift-bottle experiments (Harrison et al. 1967) revealed that 1.) percent recovery of bottles is correlated with distance released from shore (Table 1), 2.) there are seasonal patterns of bottle recoveries and 3.) most bottles are recovered within the first two weeks following release. It makes intuitive sense that an object released further from shore will have a lower probability of making landfall compared to an object released closer to shore. A reevaluation of oceanic drift bottle experiments may provide a reasonable upper bound to describe how far carcasses could theoretically travel and how likely those carcasses could make landfall from points offshore. The number of carcasses stranded on ocean-facing beaches may represent, at best, approximately 40%, 30% and less than 1% of the total number of available carcasses at-sea during the summer, fall/spring and winter, respectively. This evidence, in accordance with the spatial behavior of modeled lagrangian drogues, indicated that only those turtles killed very close to the shore may be most likely to strand.

Table 1. Percent recovery of surface drift-bottles inside the Chesapeake Bight as a function of distance released from shore (range: 18.5 to 111.2 km). Sample size refers to the number of bottles released at the beginning of the given month. Percent recovery is for bottles released at points located 18.5 km offshore. Data modified from Harrison et al. (1967).

Release date	r^2 value	sample size	% bottle recovery
October-63	0.93	636	25
January-64	0.66	618	0.6
April-64	0.93	660	31
June-64	0.97	660	43

Stranding analysis requires an interdisciplinary approach. Discerning how the number of turtles stranded on the beach is related to the number of carcasses at-sea will help sea turtle managers develop more accurate estimates of actual mortality rates. This research may at least be able to identify seasons when turtles are not likely to strand in North Carolina. It also provides evidence to sea turtle managers that Incidental Stranding Limits (ISLs) need to be calculated on a seasonal basis, in light of oceanographic conditions. Such information could then be applied to create more accurate time closures or area closures for fisheries with historic turtle bycatch interactions.

This project does not imply that it can predict the locations of specific stranding events or specific mortality sources. However, patterns of marine turtle strandings throughout the South Atlantic

Bight and, in particular, coastal North Carolina may reveal much about the physical locations of mortality and the probability of stranding as a function of spatial location. Population biology and physical oceanography have, until recently, been scientific fields with little crossover. Hopefully, collaborative projects such as this will continue in the future. Though qualitative, this research a.) provides a starting point for more robust analyses and b.) demonstrates that stranding research requires an understanding of ocean physics in addition to sources of mortality.

FOLLOWING REDWOOD LOGS, RUBBER DUCKS, AND DRIFT BOTTLES: TRANSOCEANIC DEVELOPMENTAL MIGRATIONS OF LOGGERHEAD TURTLES IN THE NORTH PACIFIC OCEAN

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New technologies now allow us to answer some standing questions regarding the life history of Pacific loggerhead turtles. Mark and recapture data, combined with results from satellite telemetry, remote sensing, oceanography, and molecular genetic studies, provide a fundamental understanding of the distribution and movements of loggerhead turtles as they make a vast developmental migration around the Pacific Ocean.

Previous studies indicate that the majority of loggerhead turtles occurring along the coasts of California, USA, and the Baja California peninsula, Mexico, are immature and of Japanese origin. Their movements follow patterns that can be partially explained through comparisons with surface currents, primary productivity levels, and water temperatures.

Wild-captured and captive-raised loggerhead turtles were tracked along the west coast of the Baja California peninsula using satellite telemetry. These results combined with mark-recapture data, demographics, diet analysis, and oceanographic patterns suggest a general pattern for the life history of loggerhead turtles utilizing the eastern Pacific Ocean.

Generalized Life History of North Pacific Loggerhead Turtles

1. North Pacific loggerhead turtles are born primarily on nesting beaches in southern Japan.
2. The strong Kuroshio Current, which runs from south to north along the east coast of Japan transports hatchlings and juvenile turtles into the North Pacific.
3. Over the course of two to six years, loggerhead turtles move from west to east, feeding along convergence and frontal zones (based on recent tag returns). Counter-current movement has been recorded during this pelagic developmental phase.
4. Drift bottles, satellite-linked buoys, surface current models, and debris have been used to document the surface current patterns in the North Pacific. These flow patterns are similar to those of the developmental migrations of Pacific loggerhead turtles.
5. Loggerhead turtles are encountered along the coast of the Californias at a minimum SCL of 27 cm. Turtles larger than 85 cm are rare.
6. Along the Baja California coast loggerhead turtles feed primarily on pelagic red crabs (*Pleuroncodes planipes*), which are extremely abundant nearshore during the spring and early summer months.
7. At maturity, loggerhead turtles begin a homing migration, returning to natal beaches in Japan, which may span an entire year. The homing migration crosses a region in the central Pacific known as the “garbage patch” where marine debris is known to accumulate. The transpacific track approximates a simulated, two stage track using a constant swim speed of 29.5 cm/s and an initial headings of 270º (due west) and a secondary heading of 295º.
8. Mature loggerhead turtles appear to remain in the western Pacific, migrating annually between nesting beaches and feeding grounds in the South and East China Seas.

This synopsis emphasizes the importance of upwelling and convergence areas along the central Baja California coast and throughout the Pacific as pelagic feeding areas and migratory corridors for Pacific loggerhead turtles, underlining the importance of these regions to the recovery of Pacific loggerhead stocks. Loggerhead turtles utilize virtually the entire North Pacific Ocean during their lifetimes. Anthropogenic impacts and conservation efforts in one region will affect distant ecosystems. For example, the proposed fishery for pelagic red crabs along the Baja California coast may interfere with foraging loggerhead turtles, resulting in declines in loggerhead turtle numbers on western Pacific nesting beaches and reefs. Likewise, a reduction in mortality rates in Baja California may result in marked gains on Japanese rookeries. These connections emphasize the importance of international collaboration and communication among researchers.

LONG-TERM SEA TURTLE NESTING CYCLES IN THE GUIANAS

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Sea turtle biologists and conservationists sometimes find themselves in the position of having an opportunity to visit a remote sea turtle nesting ground for a relatively short period. While on site, they seek to maximize the information that can be obtained, which usually includes counting and identifying the turtles that nest each night. Ideally, they will publish a short report, documenting what they have learned. If the site is extremely difficult of access, this report may be the only window of information on the turtle colony in question for decades to come, and the implicit assumption is made by all parties that the nesting activity documented in that brief sample of a single season is typical of all subsequent seasons, at least until the withering hand of mankind causes some alteration.

Such faith in data from a single point in time is dangerous. In those cases where the site can be revisited or even monitored regularly in subsequent seasons, it is usually found that annual nesting numbers are very variable. One season is unlikely to be quantitatively typical of all seasons, and it is likely that sharp ups and downs will occur in the case of multi-annual nesting species (*Chelonia*, *Dermochelys*, *Caretta*), whereas there will probably be gentler, progressive trends in species (including *Lepidochelys olivacea* and *L. kempii*) in which many individuals nest in successive years. However, more drastic changes, not just in the numbers of individuals but in the actual species present, may also occur. For example, at Rancho Nuevo (Tamaulipas, Mexico), only Kemp's ridleys nested several decades ago, and in the mid-Atlantic coast of Florida there were only loggerheads. Today, both sites have thriving co-mingled green turtle colonies as well, of uncertain origin, where none existed before.

The Guianas, on the north coast of South America, represent a particularly interesting test case to investigate the customary assumption of long-term stability of sea turtle nesting populations, because the beaches in all three of these nations are subject to extraordinarily marked cycles of erosion and accretion. It has been postulated by Augustinus (1978) that the beaches along the coast of the Guianas – Surinam in particular but in effect the whole region – return to their original configurations after a cycle of approximately 35 years. However, the question of whether the sea turtle nesting colonies will return at the end of the cycle with the same dominant species and overall species mix in the same places has not been demonstrated.

Obviously, this demonstration is not a task for one in his middle years or beyond. But the author undertook surveys of turtle nesting beaches in all three of the Guianas during the years 1964-67, and a second series of surveys was undertaken approximately 35 years later, in 1998-2000. The initial study was undertaken by Pritchard alone in Guyana, but with the cooperation of the late Dr. Joop Sculz in Surinam and French Guiana. By the time of the follow-up survey, ours was still the only program in Guyana, although by then a responsible in-country NGO, the Guyana Marine Turtle Conservation Society, had been formed. However, various new agencies had conducted extensive field work in Surinam and French Guiana, notably STINASU in Surinam, and formerly Greenpeace, subsequently SEPANGUY, Association KWATA, WWF FRANCE, and others in French Guiana. Thanks are extended to all members of the three-nation program for kindly and unstintingly sharing monitoring data. All national programs were brought together and received funding from the Guiana Shield Program of WWF based in Paramaribo, Surinam (director: Michelet Fontaine).

RESULTS OF INITIAL SURVEYS, 1964-66

GUYANA: In Guyana, nesting only occurred west of the Essequibo River, with some nesting on the river islands themselves (Tiger Island, Wakenaam, Leguan), and on mainland beaches between the Essequibo and the Venezuelan border. The primary nesting site was "Shell Beach," a beach about 10 km long and at its northwest end about 0.5 km wide, and located about 50 km southeast of Waini Point. This beach, like all along the open sea coast of northwestern Guyana, was composed entirely of seashell material (pulverized in some areas, intact in others), with huge adjacent mud flats but no siliceous material. The 1964 survey consisted of a single, brief visit in the course of which analysis was made of the large number of carapaces of recently slaughtered turtles; in 1965, three weeks were spent on the beach in late season (July), with nightly patrols. Combining the findings of the two years (Pritchard, 1969a), 43 green turtle carapaces were measured (nearly all those of slaughtered females), as well as 35 olive ridley carapaces (plus three live females). Twelve live and 11 slaughtered hawksbills (total 23) were also found, about equal numbers live and slaughtered), and six slaughtered leatherbacks (none live). The general conclusion that the three cheloniid species were of comparable abundance, and the leatherbacks much fewer, was confirmed by interviews with hunters.

SURINAM: The Surinam beaches were and are composed of silica sand. Some were on the open sea coast in the 1960s, including Bigisanti, Motkreek, and Krofaja Pasi, while others (Eilanti, Pruimenboom, Baboensanti) were on the western (i.e. Surinam) coast of the Marowijne River mouth. Detailed nesting patterns during the 1960s and early 1970s are described by Pritchard (1969a) and Schulz (1975). They may be summarized as follows:

Chelonia mydas. 1968-1975: 750-1438 nests per annum (no trend) at Bigisanti. 105-861 nests per annum east of Eilanti and at Dap-Eiland (no trend). 2190-10545 nests per annum on the Galibi beaches (rising trend until 1975).
Lepidochelys olivacea. 1964-1975: 75-284 nests per annum at Bigisanti (upward trend). 531-2598 nests per annum at Eilanti (severe downward trend). 48-465 nests per annum at Galibi beaches (strong downward trend) some recovery in 1974-75).
Dermochelys coriacea. 1964-75: 67-948 nests per annum at Bigisanti (very strong upward trend). 9-636 nests per annum at Galibi (very strong upward trend).
Eretmochelys imbricata. 1967-75: 3-29 nests per annum at Bigisanti, no trend.

During these years, leatherbacks and greens, with a few ridleys, dominated the open-sea beaches (Bigisanti etc). Greens dominated throughout the Marowijne beaches (see Schulz, 1975: map 3), with just a few leatherbacks at Baboensanti, but large numbers of olive ridleys (and very few other turtles) at Eilanti, where nesting occurred in small arribadas (e.g. 260 on June 13 1967; 654 from 11-15 June; nightly peaks of 298, 377 and 510 in 1968).

FRENCH GUIANA: In the 1960s the nesting beaches in western French Guiana were almost inaccessible. An exploratory visit was made to the eastern part of the nesting zone via the Organabo River in 1967 by Pritchard, Schulz and W.F.Greenhood, and on July 22 1968 the same crew conducted an overflight from the mouth of the Mana River almost to the Organabo mouth. They concluded "From the number of unmistakable fresh tracks observed, there is now no question that, for this rare species [i.e. the leatherback], the coast between these two rivers is the most important nesting area in the hemisphere, if not the world" (Pritchard, 1968).

Subsequently, Pritchard was able to develop an access route to this beach through the coastal swamps and dead mangrove forests, and established that an average of about three hundred leatherback turtles nested nightly on the approximately 10 km of coast patrolled in the western sector of this coast (Pritchard, 1969b). Evidence of further leatherback nesting was obtained on the beaches of the Ile de Cayenne, in eastern French Guiana.

CHANGES IN THE 1970s AND 80s

During the 1970's good numbers of green turtles nested at Shell Beach, many of them being slaughtered (Mariculture Ltd., pers. comm.) but subsequently a general nesting shift occurred and nesting became concentrated near Waini Point, at Almond Beach. Leatherbacks became more numerous and olive ridleys and hawksbills became scarcer. Profound changes occurred in the beaches. The principal beaches during this period were Luri and

Kamwatta (developing in the area formerly occupied by Shell Beach), Tiger Beach, Three Pile Beach, Iron Punt Beach, and Gwennie Beach. Sand buildup occurred at Waini Point, with new nesting habitat appearing, but this was followed by mud flat development, making turtle access to the beaches difficult.

In Surinam, the beaches within the Wia Wia Reserve shifted progressively out of the reserve boundaries. Bigisanti disappeared and nesting shifted to Krofaja Pasi and Matapica. Despite conservation efforts, nesting of ridleys at Eilanti continued to diminish and eventually almost ceased. Leatherbacks increased and came to dominate the Galibi beaches.

In French Guiana, the open coast beach, known as Silébache, virtually disappeared, and with its disappearance the sea penetrated into the coastal swamp. The large leatherback colony shifted and nesting started to occur in large numbers at Les Hattes or Ya-Lima-Po beach, in front of or close to the Carib Indian Village of Aouara. A meandering sand peninsula, "Presqu-Ile Kawana," formed at Point-Isère (Fretey, 1981), was quickly commandeered by nesting leatherbacks, and then disappeared. In 2001 it showed signs of reappearance.

COMPLETION OF THE 35-YEAR CYCLE: 1997-2000

By the end of the millennium, the 35-year cycle was complete. While the configuration of the beaches was not an exact replica of that of the mid-1960s, the beaches in Guyana that corresponded in location to the old Shell Beach were once again productive nesting habitat (i.e. Kamwatta and Luri Beaches), and Eilanti – not the first beach to form on this western corner of the Marowijne Estuary, as evidenced by older sand ridges visible inland from aerial surveys – had become muddy and stagnant, and sported dense growth of young mangroves. In front of Eilanti, a new beach called Samsambo had formed. So lost beaches had re-formed on the western French Guiana coast, and other Surinam and French Guiana nesting beaches – Baboen Santi, Pruimenboom, and the Ile de Cayenne beaches, had returned. On the open coast of Surinam, Matapica may be considered the replacement for Bigisanti. All-in-all, the geomorphology of the coast had completed its 35-year cycle.

But the turtles were not the same. In Guyana, all nesting was dominated by leatherbacks, and greens, hawksbills and olive ridley had become scarce – the last almost disappeared. In Surinam, there were also significant changes. The arribadas at Eilanti were gone, and only a few ridleys nested at the eastern end of Samsambo and a few at Matapica. On the other hand, the count of 25 or so green turtles per night at Galibi, typical of former times, was maintained, but now there were great numbers of leatherbacks on these beaches later in the season. In 2000, two thousand leatherback nests were found at Lobin Beach, and 2200 at Samsambo in January to March alone.

In French Guiana, many leatherbacks were once again nesting on the open sea coast (Plage Farez), but there were still 10,000 nests per year at Ya-Lima-Po, so the extraordinary numbers of leatherbacks that nested in Guyana and Surinam in 2000 (literally a tenfold increase over any previous season in Guyana), a phenomenon that also occurred on Trinidad, were not derived from a collapse of the enormous population in French Guiana.

Most of the ridleys in the region also nested in French Guiana, having virtually vacated the other two Guianas. 1100 nests were reported in 2000 at Iracoubo + Iracompapy, and up to 36 per night were reported at Montjoly Beach, on the Ile de Cayenne; there were 450 nests on the Ile de Cayenne as a whole in 1999 and 550 in 2000; perhaps more near Kourou. Further to the southeast, the best beach for ridleys in Brazil is in the state of Sergipe, where there have been 400-500 nests per year since 1982.

CONCLUSIONS

Marine turtles can adjust their nesting in response to profoundly changing coastal geomorphology. In the Guianas, changes from 1964 to 2000 were as follows: 1) Leatherbacks, formerly nesting mostly in western French Guiana, nested abundantly throughout the region. 2) Olive ridleys, mostly nesting at Eilanti, Surinam, in the 1960s. shifted eastwards to French Guiana. 3) The green turtle became scarce in Guyana and French Guiana, but continued to nest in abundance on the Galibi beaches in Surinam; and 4) The hawksbill remained rare throughout the region, but Guyana remained the primary nesting area.

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STUDIES ON THE OFFSHORE ECOLOGY OF THE OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) IN THE GAHIRMATHA MARINE SANCTUARY, ORISSA, INDIA

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We studied the olive ridley mating assemblages in the offshore waters off one of the most important mass-nesting rookeries for *L. olivacea*. Data was collected over a 4-year period from 1996-2000, during which 3325 (1,689 males and 1,636 females) turtles were captured and tagged. Males exhibited fidelity to a particular courtship area. Our recaptures indicate that females tagged while mating in this breeding unit tend to nest in the nearest rookery. The males (CCL=69.9, S.D. ± 2.96, n=1529; CCB=68, S.D. ± 2.7, n=1527) were on average smaller than the females (CCL=71.2, S.D. ± 2.5, n=1484; CCB=69.3; S.D. ± 2.56, n=1484) in the sampled population. We estimated the number of pairs present in these assemblages using line transect methodology. Mating pair surface density in 1999-2000 was 26 pairs (CV=11.4%) per sq. km. with an encounter rate of 3.9 pairs/km. Sex ratios of turtles stranded during the breeding period were skewed more towards males (1.47:0.68). Capture locations pooled over a 3-year period suggests that the size of the assemblage does not vary significantly between seasons. The size of the breeding patch, estimated using capture/sighting locations was 57.8 sq. km. In this paper we present the results of our offshore study and suggest that the area may be an important mating ground and that it would be beneficial to monitor these mating areas on a regular basis to assess trends in population over the short term.

ESTIMATION OF TAG LOSS AND ANNUAL SURVIVAL RATES IN LEATHERBACK TURTLE, *DERMOCHELYS CORIACEA*, IN FRENCH GUIANA

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BACKGROUND

World-wide, many conservation and management programs have used tags to study turtle populations. Most tag studies have focused on turtle migration, and on the assessment of a few life history parameters such as nesting periodicity and inter-annual remigration. But several essential parameters have been less studied such as survival rates, population size, and population stability. However, these specific parameters could also be estimated with tagging data. Nevertheless, tag loss is known to occur in all sea turtles species, at different rates, and this can introduce bias in such estimations. In order to correct for bias due to tag loss, we have developed a new method of estimating tag loss which is not based on the number of individuals that retain two vs. one tag but on the retention time of each tag.

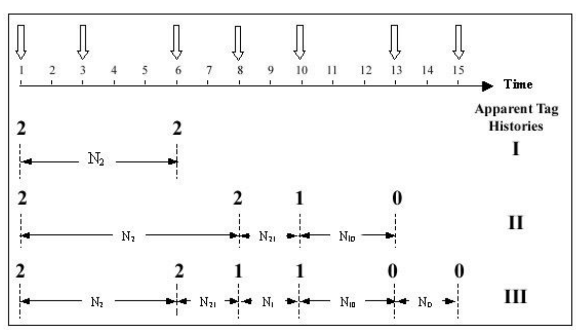
METHODS

Our method is based on the maximum likelihood method. We have estimated the probability of daily tag retention (called "pt" function) that best fits a given tagging data set. This method requires a double tagging experiment. For each capture event (figure 1), the number of tags carried by each animal is monitored (figure 1). The individual likelihood function, for the individuals exhibiting apparent tag history II and III, is given by equation 1.

$$Li=\prod_{j=1}^{N2} p_t^2 \times \sum_{k=N2+1}^{N2+N21}\left[p_t^{2\times(k-(N2+1))} \times 2 \times p_t \times (1-p_t) \times \prod_{l=k+1}^{N21+1} p_t \right]$$

Where pt is the probability of daily tag retention, N2 is the duration in days from the date of tag application to the date of last observation with two tags and N21 is the duration in days from the last observation with two tags to the first observation with one tag.The overall likelihood is the product of all the individual likelihoods estimated for individuals that exhibit apparent tag histories II and III. The maximisation of likelihood was calclulated using Profit 5.5.2 (Quansoft). The major advantage of this method is that it allows testing among several pt modelling functions (constant, time linear, second degree function of time…). The pt model that best fits the tagging data set is selected by the likelihood ratio test.

Figure 1. Double tagging experiment and apparent tag histories.(white arrows: capture events, bold characters: number of tag carried at capture event, roman characters: apparent tag histories).



Example

We have examined tag loss in the population of leatherbacks nesting in French Guiana. In 1994, a double-tag project was initiated. During this season, 2261 females were double-tagged with monel tags. Only 356 females have been subsequently seen with one tag (apparent tag histories II and III confounded). The following results are based on observations from 1995 to 1999.

The daily tag retention function that best fits the data is a second degree polynomial function of time. The probability of daily tag retention has been extrapolated for 10 years (figure 2). This extrapolation highlights that the tag loss is very high for monel tags applied on leatherbacks in French Guiana: only 58 % of the tag remains viable after one year and no tag is still attached after seven years.

Tag loss application in survival rate estimates

The high tag loss estimated on leatherbacks nesting in French Guiana introduces bias in life history parameter estimates such as survival rate. Without correction for tag loss, the survival rate is under-estimated because an individual that has lost its tags will be considered as dead. Because of the bias that this can introduce, tag loss quantification is essential for estimation all life history parameters. However no correct model for survival rate estimation is currently available for *Dermochelys coriacea*.

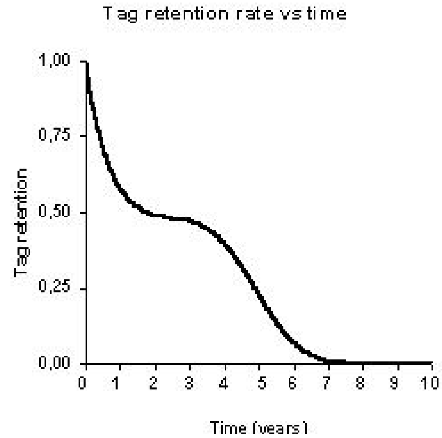


Figure 2. Tag retention during from 1994 to 2004.

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MOVEMENTS OF JUVENILE GREEN TURTLES IN AND FROM A SOUTH TEXAS DEVELOPMENTAL HABITAT

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A multi-faceted investigation of green turtles (*Chelonia mydas*) was conducted on the Texas coast. Sea Turtle Stranding and Salvage Network stranding records from Texas were queried for years 1980-1998 (Shaver, 2000; in press). Most of the 607 green turtles documented were located in south Texas, particularly in the Laguna Madre. A year-round, entanglement netting study was conducted at the Mansfield Channel jetties from 1989 through 1997 and a relatively high overall CPUE of 3.63 green turtles/km hour of netting and recapture rate of 32.6% were found (Shaver, 1994a; 1994b; 2000; in press). Data collected from stranded and netted green turtles expanded knowledge of several biological parameters and supported the hypothesis that south Texas waters, including the Mansfield Channel, provide important developmental habitat for juvenile green turtles. However, these studies provided little information on the dispersal of green turtles from the Mansfield Channel.

Satellite technology was employed to gather additional data on long-term and long-distance movement patterns, seasonal and yearly variations in movements, and habitat usage in the Mansfield Channel, Laguna Madre, and Gulf of Mexico. The study area for this work is the western Gulf of Mexico, particularly along the southern coast of Texas and northern coast of Mexico. The Mansfield Channel is located at the southern end of Padre Island National Seashore, Texas. It cuts through Padre Island and the Laguna Madre to the mainland. The Mansfield Channel is one of only three water exchange passages between the Gulf of Mexico and the Laguna Madre, with the other two being the Aransas Pass Ship Channel (through Corpus Christi Bay) and the Brazos Santiago Pass. A pair of 700 m long jetties armor the Gulf of Mexico entrance to the Mansfield Channel and several algae species grow on the jetty rocks. Green turtles use this man-made area for foraging and resting.

From April 1995 to December 1997, 30 juvenile green turtles were outfitted with satellite (UHF) radio transmitters. These platform transmitter terminals (PTTs) were configured in a backpack style and affixed to turtles with thin layers of polyester resin and fiberglass cloth over the second neural scute of the carapace. One PTT was applied on a green turtle that was found cold stunned near the Brazos Santiago Pass and released there and 29 were applied on green turtles that were netted at the Mansfield Channel jetties and released there. Turtle movements were monitored via satellite until transmitters were removed or transmissions ceased due to transmitter detachment or failure. PTTs were programmed with two different transmission (duty) cycles to extend the life of the battery; these two cycles were 6 h on/6 h off (n=22) and 8 h on/52 h off (n=8). The PTTs ceased transmitting between 8 and 434 days after being affixed to the turtles.

All data were extensively screened using location rejection criteria described by Plotkin (1998) to eliminate land locations, duplicate points, points where the rate of movement of a turtle between two consecutive locations exceeded 6 km/hour, and locations that were obviously inaccurate. After data screening, 940 locations remained from ARGOS class codes 3, 2, 1, 0, A, and B and at least one location was identified for 28 of the 30 PTTs. However, if only locations from class codes 3, 2, and 1 were considered, no locations would have been available for 15 of the 30 PTTs.

The stranded turtle that was tracked ventured into and out of the Brazos Santiago Pass and thus remained in the vicinity of its original stranding and release locations through the duration of the tracking period. Virtually all of the other turtles tracked that had been netted at the Mansfield Channel were located in the vicinity of the Mansfield Channel on at least one occasion after PTT deployment and many were located there several times. A variety of movements were documented. All locations for two turtles were within 35 km of the Mansfield Channel jetties, but both were only tracked for 1-2 months. Turtles tracked for longer time periods dispersed to waters within the Laguna Madre or Gulf of Mexico; some dispersed within a few days, while others were located in the vicinity of the Mansfield Channel for months. The vast majority of locations were in south Texas.

Twenty-five of the tracked turtles entered the Laguna Madre. Most of the located positions were within the Lower Laguna Madre, near the Mansfield Channel. However, some of the locations were in the Upper Laguna Madre and some in the Lower Laguna Madre near the Brazos Santiago Pass. Some turtles moved extensively within the Laguna Madre, while others made only brief excursions into the Laguna Madre from pass areas. All 25 appeared to have used the Mansfield Channel as a passageway between the Gulf of Mexico and the Lower Laguna Madre.

Eight of the tracked turtles were located at the Brazos Santiago Pass at some time during the tracking period. Only a few locations were noted at the Brazos Santiago Pass for some turtles, but for others, numerous locations were noted there. Twenty of the tracked turtles traveled southward into waters off the coast of Mexico. Some traveled just a few km south of the United States/Mexico border, while others traveled a few hundred km south of the border. Of these, seven remained south of the United States/Mexico border through the end of the tracking period. However, the other 13 later traveled northward and re-entered waters off the United States. Sixteen of the tracked turtles traveled more than 30 km north of the Mansfield jetties. However, fewer locations were noted and less time was spent north of the Mansfield Channel than south of it.

There were seasonal and yearly variations in movements. Turtles displayed a higher degree of site fidelity to the Mansfield Channel area during the spring, summer, and fall than during the winter. Virtually all tracked turtles left the Mansfield Channel area at some point during the winter; some only left for a few days, while others were not detected returning during the tracking or netting periods.

Water temperatures cool in south Texas during the winter and a drop in temperature preceded movement of tracked turtles southward during the winter. Movements away from the Mansfield Channel during the winter may be an adaptive mechanism to avoid cold water temperatures and mortality due to hypothermic-stunning. Hypothermic stunning is a significant threat to green turtles in Texas inshore waters, particularly in the Laguna Madre. Two-hundred-thirty of the 607 green turtles found stranded in Texas from 1980-1998 were located during or shortly after periods of freezing air temperatures and were probable hypothermic stunning victims (Shaver, 2000).

Movements of turtles during the winter of 1995-1996 differed from movements during the winter of 1996-1997. Nine turtles yielded locations from December 1995 through at least January 1996 and movements of these nine turtles differed. One turtle remained in the vicinity of the Mansfield Channel throughout this time. However, all others left for a period of time; some entered the Lower Laguna Madre, some Gulf waters off the south Texas coast, and some Gulf waters off the coast of Mexico. Some returned to the Mansfield Channel after temperatures warmed, but others did not return during the tracking period. The lowest temperatures recorded by PTTs during this study (as low as 5 C) were during the winter of 1995-1996 and movements were erratic and variable during this winter than during the winter of 1996-1997.

Seven turtles yielded locations from December 1996 through at least January 1997. In contrast to those tracked during the winter of 1995-1996, all seven tracked during the winter of 1996-1997 left United States waters and migrated southward along the Gulf coast of Mexico. All left United States waters at approximately the same time, roughly 12 January 1997, and traveled parallel to the coastline. All seven ventured at least 60 km south of the United States/Mexico border and all but two remained in waters off the coast of Mexico until transmissions ceased. After PTT temperatures dropped to 10-15 C during the winter of 1996-1997, all tracked turtles made more direct movements southward than during the winter of 1995-1996.

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THE RISK OF HATCHLING LOSS TO NEARSHORE PREDATORS AT A HIGH-DENSITY LOGGERHEAD NESTING BEACH IN SOUTHEAST FLORIDA.

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INTRODUCTION

Sea turtles, like other long-lived vertebrates exhibit extreme iteroparity (Heppell et al., 1999). Females produce numerous small offspring in several clutches. Over time, evolutionary pressures have selected for a life history strategy in which investment in individual offspring is minimal and survival of young is generally very low. Many authors have recognized that mortality prior to maturation is probably extremely high in sea turtles (Stancyk, 1982; Frazer 1986), but few studies have attempted to quantify and partition mortality associated with various life stages. Specifically, no demographic baselines have been established for pelagic stages, which may last for 6.5-11.5 years (Bjorndal et al., 2000). It is estimated that one in 500-1000 hatchlings survive and grow to be a reproducing adult (Frazer, 1986).

Gyuris (1994) estimated that most of the first year mortality of green turtles could be attributed to aquatic predation within the first hour of life off Australian beaches at the Great Barrier Reef. Others (Witherington and Salmon, 1992; Witham, 1974) documented predation on hatchlings by aquatic predators but an empirical value for survival was not determined in these studies. Quantification of mortality for different life stages is important to our understanding of the basic life history of loggerhead sea turtles as well as to managers charged with formulating recovery plans for threatened and endangered species. Empirical data become the baselines against which to measure future trends.

The objective of this study was to assess the relative risk that loggerhead hatchlings face in their first few minutes in the water, at the commencement of their offshore migration. We provide empirical baseline values for the survival of loggerhead hatchlings in the water for one subpopulation, and document the importance of Juno and Jupiter beaches as an important sea turtle rookery.

MATERIALS AND METHODS

Juno Beach and Jupiter Island, both in Palm Beach County, Florida, USA were chosen as the study sites because of the high density of sea turtle nests there. From 15 km of beach, a total of 6 sample sites were chosen; 2 each of sand bottom substrate, reef substrate and transitional substrate (combination of rock and sand).

Turtles were collected from marked nests the night they were due to emerge, following Salmon and Wyneken's (1987) protocols. Hatchlings were followed individually at night by investigators in kayaks as they migrated offshore. Each hatchling was tethered to a streamlined balsa wood float (Witherington and Salmon, 1992) so that they could be tracked offshore. The hollow black float contained a green cold-chemical glow stick that was visible only from above the water. The float itself did not attract fish when it was towed offshore without a hatchling tethered to it. The weight of the float in water was negligible (1.9 g in air). Using these floats did slow the progress of a hatchling, but not significantly (Witherington and Salmon, 1992). The hatchling, once fitted, was allowed to crawl down the beach, enter the water, and begin swimming. Each turtle was followed by kayak at a distance of 5-20 m to avoid disturbing it, attracting fish or disturbing potential predators. After 15 minutes, if a predator had not taken it, the hatchling was recaptured, released from the harness and allowed to continue migration. On occasions when the hatchling was taken by a predator, we attempted to identify the predator species. Turtles were followed offshore from the 6 sites according to the randomly ordered schedule between July 5th and September 27th, 2000, when weather and wave conditions would allow.

As a supplement to quantifying survival of hatchlings, angling was done on nights after we had followed turtles, and stomach contents of all predatory fish caught were examined to see if they had eaten hatchling loggerheads.

RESULTS

A total of 217 loggerhead hatchlings were followed for 15 minutes as they migrated from nearshore waters to deeper waters (4.5 m) offshore. Aquatic predators took 11 hatchlings during the 15-minute trial. Of these, tarpon took 4, a Carcharhinid shark took one and 6 hatchlings were taken by unidentified predators. Predator attacks came without apparent warning and hatchlings taken by fish along with the float apparatus, were submerged immediately. Often the float and thread bobbed to the surface shortly after the attack and was recovered. On three occasions, the piscine predator (tarpon) was observed leaping out of the water.

There were no significant differences found in hatchling survival between pairs of sites or among rock (68/74 – 91.9%) transitional bottom (72/74 - 97.3%), and sandy sites (66/69 - 95.7%). Data were then pooled and an average survival rate of 95% was used for subsequent calculations. Chi-square tests did not detect a significant difference in survival among study months (p=0.058;a =0.05), but September hosted a lower average survival rate (35/40 - 87.5%) than July (96.1% - 74/77) or August (97% - 97/100).

Surprisingly, of the predatory fish caught, only one (hardhead catfish - Arius felis) had eaten loggerhead hatchlings.

DISCUSSION

The average hatchling survival in the water at the beginning of the offshore migration, for hatchlings leaving the 6 sample sites at Juno and Jupiter beaches, was 95%. This is the first quantification of in-water survivorship, for hatchlings at any natural high-density nesting beach.

Our presence on the water appeared to have no detectable effect on either hatchling (Frick, 1976) or fish behavior. Hatchlings were taken by predators when they were close to the kayaks (<5 m) or when the boats were at maximum distance (>20 m) from the turtles. Because of this, previous observations and the large sample size of this study over the course of the season, we are confident that our presence had no measurable effect on hatchling survival.

A trend of decreasing survival over the season was evident; 87.5% in September compared to 97% for August. This is an important observation because, during the month of September we caught about 30% more predatory fish in the angling component of the study, than in July or August. The high survival rate observed in this study is encouraging from the perspective of when the most hatchlings are entering the water. The peak time for hatchling emergence during 2000 was August 15th –31st. So, at Juno and Jupiter beaches, 80% of hatchlings had already emerged and swam past predators in nearshore waters by the time the highest concentrations of predators were in the nearshore waters.

On a natural high-density nesting beach (Juno/Jupiter), 95% survival is very high in comparison with other such studies. Gyuris (1994) documented a mean survival rate of 69% for green hatchlings leaving Heron Island, Australia. Wyneken (2000) found hatchling survival in the water at the hatchery was only 71%. The hatchery (located just 60 km to the south of our study site), effectively had more than 6000 nests per kilometer on the beach, however the total length of the hatchery was only 1/10 km, holding around 600 nests. In a hatchery, many nests from the same day are placed in close proximity and as a result of similar beach conditions, tend to hatch around the same time. At Juno/Jupiter, there are 600 nests/km, which is an order of magnitude lower than the hatchery, but this density is consistent over the entire 15 km. At hatcheries, nests are spatially and temporally concentrated, while at a natural beach they are not, and this may partially explain differences seen in hatchling survival rates. Any predators in the water may be able to cue in on a hatchery site as one that spatially and temporally concentrates a predictable source of food. On adjacent stretches of beach, there are few or no sea turtle nests (because they have usually been relocated to hatcheries) and so predators have a very small area in which to concentrate their efforts. The timing of prey entering the ocean becomes much more predictable as the spatial arrangement becomes more simplistic.

To calculate productivity, we multiplied offshore survival rate (95%), emergence success (86.5 hatchlings/nest) and number of nests (7,200) and found that more than half a million (590,000) hatchlings left Juno and Jupiter nearshore waters during the summer of 2000, presumably recruiting to the pelagic stage. Not only is this beach one of the most important beaches for nesting in the state of Florida, but because hatchlings have such a high survival rate here, it could also be one of the most important beaches for recruitment of hatchlings into the pelagic stage.

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PHYSIOLOGY AND BEHAVIOR

COURTSHIP AND MATING BEHAVIOR IN *CHELONIA AGASSIZII*: SPATIAL-TEMPORAL PATTERNS, AND SEX RATIO

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Little is known about the temporal and spatial patterns of activity of *Chelonia agassizii* during the mating season and the operational sex ratio of the species. Knowing this information can be useful to determine management actions, as well as understanding the intriguing reproductive system of the species, in which several males simultaneously attempt mating with a single female. We studied the use of space of *C. agassizii* during the mating season (October-December 1999) at the main continental nesting beach (Colola, Michoacán, México).

We considered turtle group composition and daily and seasonal activity patterns and estimated adult sex ratio. We used two sampling methods: (1) point counts along the 4.8-km-long beach, with sampling points every 200 m (n=282 points); and (2) ad libitum observations from a 40m-tall rock on the edge of the sea (n=202 hours), collecting data during 4-hour periods, with a balanced sampling effort from dawn to dusk. In each case we counted the number of individuals of each sex and their behavior. There were no differences in the seasonal use of space, but there were turtle concentrations in certain areas during some days. There was a positive correlation between the number of females in the sea and the number of nesting turtles during the night. Courtship behavior was observed throughout the daytime, and there were no differences in the number of individuals observed. Sex ratio during the season was 4 males for every female, with proportionally more males at the beginning of the season than at the end.

THE EYES HAVE IT: MANIFESTATION OF OCULAR TUMOURS IN THE GREEN TURTLE OHANA OF HONOKOWAI, WEST MAUI

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Each July and August since 1989, we have photographed and videotaped the turtles at Honokowai, West Maui, Hawaii. The resulting images are used to identify turtles and track the effects of fibropapillomatosis (FP) (Bennett et al. 2000, Bennett et al. In press). FP has long been closely associated with the eyes of the Hawaiian green turtle (Balazs & Pooley, 1991). We decided to examine this relationship. Another goal was to document both the pre-eruptive stage and the fully regressed stage of this disease in cases where this would occur. A third objective was to gain insight that might be useful to others attempting to assess the status of FP in a given area.

METHODS

To identify individual turtles, we capture facial profiles on videotape and film and catalog them in a database, as described at the 19th Sea Turtle Symposium (Bennett et al. 2000). Once a turtle is identified, we count and evaluate tumours from our images. Tumour scoring is based on the Hawaiian severity scoring method (Work & Balazs, 1999), but this system has been extended in both directions by adding two more stages: pre-eruptive and scarred, terms that are explained below.

The objective was to determine what happens to eyes as the disease takes hold. It is easy to recognize a true tumour, but do the eyes signal problems before tumours erupt? Is there a recognizable pre-eruptive stage-a precursor of FP?

Because the database contains the history of FP for many individuals, we had the luxury of tackling these questions by working backwards. The technique was to take turtles with newly erupted eye tumours and examining earlier images of those animals. This revealed some commonalities, as the results show.

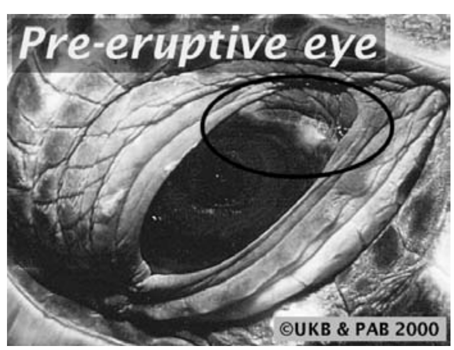
RESULTS

As of summer 2000, we have identified 418 turtles. Of these, 245 (58.6 %) have had tumours. We used a simple database query to determine how many of our FP-afflicted turtles have had ocular tumours. The result was stunning: 237 (96.7%) of the tumoured turtles had tumours in the eyes. 177 turtles (42.3%) have been sighted in more than one year. 130 resights (73.4%) had tumours. 87 resights (66.9%) were classified as "FP-progressive" because their condition worsened after the first sighting. 100% of these FP-progressive resights had ocular tumours.

Figure 1. Normal eye, showing pleating of the posterior conjunctiva.

These results posed a dilemma. Although we have images of eyes that are free of tumours, FP is so prevalent at Honokowai that none of them could be used as a standard normal eye. Fortunately, co-author George Balazs provided photographs to use for this purpose.

Figure 2. Pre-eruptive eye, showing discolouration.



The photographs showed the eyes of turtles found along the Kona/Kohala Coast of the Big Island of Hawaii, an area still free of

FP. They served as examples of normal eyes. Note that the posterior conjunctiva in a normal eye is uniformly dark with several folds or pleats, an important point that is further discussed below. (Figure 1.)

Using these eyes as a baseline, the Honokowai images could be examined for departures from a normal eye. We were able to document both the pre-eruptive stage of FP and the stage of regression that we call "scarred", in which the tumour has disappeared. Pre-eruptive eyes have anomalies that are consistent with the onset of FP. The earliest of these is a whitish discolouration that forms a line along the leading edge of the conjunctiva, or forms spots on the conjunctiva, or a combination of both. (Figure 2.)

In our experience, the white discolouration along the leading edge advances to swelling, and discolouration on the conjunctiva also expands. Eventually, these abnormalities turn into protuberances that manifest as tumours, as was the case in this example. While it can't be proven that these signs always indicate the onset of FP, every turtle that was documented with this condition has developed ocular tumours.

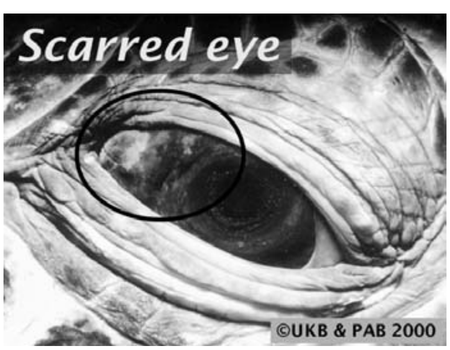
Tumours almost always first erupted in the posterior of the eye. If both corners erupted simultaneously, the posterior tumour was usually the larger. As tumours progress, they appear to be primarily white or pinkish in our images, with a fibrous, wart-like surface, and a polypoid or peduncular form, consistent with the histologic description of ocular tumours prepared by Brooks et al. (1994)

If the animal is lucky, the eye tumours will eventually start to regress. The size stabilizes and starts to decrease. The colour takes on shades of grey, which darken with time. The surface becomes smoother. Eventually, the tumour recedes and darkens so much that it is hard to observe from a distance. This is the condition we refer to as a "black pearl."

Eye tumours usually grow and persist for years, but for four lucky turtles, a remarkable thing happened: the tumours regressed almost immediately. The cycle, from onset to advanced regression, took about a year, demonstrating the possibility of a low level, quickly regressing course for the disease.

The stage that we call "scarred" means that the eye has anomalies consistent with those known to have undergone complete regression. (Figure 3.) It is possible for an eye tumour to disappear entirely, or it might leave a discoloured conjunctiva similar to that of an incipient tumour. It is distinguishable from the onset of FP, however, because there is an important difference: the conjunctiva of an eye that has recovered from FP appears to be scar tissue, and no longer has the pleats characteristic of a normal eye.

Figure 3. Scarred eye, showing loss of pleating.



This lack of pleating is seen in every regression case for which we have macro photos. Unfortunately, the history of every animal with this anomaly isn't known, hence the term "scarred" rather than "regressed." It is important to note here, however, that most turtles with eyes classified as scarred also have body tumours that look like they are regressing.

DISCUSSION

Until now, pre-eruptive or scarred eyes would not be scored as FP. The relationship of these stages to FP was not demonstrated. We believe that we have documented these relationships, however. Certainly, other conditions might account for these anomalies, but in all cases for which there is sufficient history, we can show that the anomalies called "pre-eruptive" do lead to tumours, and the anomalies called "scarred" did result from regression.

It follows that FP is underreported. A normal catch-severity score-release program conducted at Honokowai would inevitably include turtles with no tumours but with pre-eruptive eyes. We believe that these turtles will almost certainly get FP, since we have yet to find an exception. Additionally, the sample would also include turtles that have had FP and regressed to the point where tumours are no longer visible. We know this because we have documented the history of FP in many of these animals, and Honokowai is home to a number of completely recovered turtles (Bennett et al. 2000).

To illustrate this effect, we looked at the videotapes of two dives by the authors at Honokowai on August 27, 2000. During those dives, there were 18 identified turtles. Using the Hawaiian tumour severity scoring system, eight of these turtles would be scored with tumours, yielding 44% FP prevalence. Seven of the eight tumoured turtles manifested ocular tumours. The eighth turtle is a confirmed regression case who still has a body tumour and once had eye tumours.

The records show that four of the turtles without visible tumours are actually regression cases who had ocular tumours. They also show that two of the animals have pre-eruptive eyes and almost certainly will have tumours by next summer. The depth of FP shoots up to 78% (n=14), all of them with some involvement of the eyes. These additional insights give a much clearer picture of the dynamics of FP at Honokowai.

To get an idea about how useful the Honokowai observations might be, we looked at the tumour severity scores for 100 tumoured turtles from long-term research conducted in Kaneohe Bay, Oahu, Hawaii (Balazs et al. 2000) during the years 1998-2000. 87% (n=87) of these animals, predominantly juveniles and sub-adults by size, had ocular tumours. For comparison, all FP-afflicted juvenile and sub-adult turtles (by size) from the years 1998-2000 were selected from the Honokowai database. This yielded 111 turtles. 91% (n=101) of these animals had ocular tumours. Five of the remaining turtles were regression cases, confirmed by photos or videotape, and five fell into our scarred category. This strongly suggests that at least some of the 13 Kaneohe turtles without ocular tumours are regression cases.

The similarities between these Honokowai and Kaneohe Bay data lead us to believe that, yes, the experience gained at Honokowai can be useful when assessing other sites, at least in the Hawaiian archipelago. From our observations, we have derived some basic lessons. We offer them here in the hope that they might have value to a researcher attempting to assess the scope and magnitude of FP at another site.

The first lesson of Honokowai is: ***Examine the eyes.*** White discolouration and swelling in the posterior of the eye are the forerunners of FP. A scarred conjunctiva without the pleats characteristic of a normal eye is a sign of FP regression-the "FP signature". Eye examinations are important because body tumours often regress completely and leave no trace, but this is not true for ocular tumours.

The second Honokowai lesson is: ***Progressing tumours can be distinguished from regressing tumours.*** Graying, smooth, regressing tumours are visually different from "hot" progressing ones--most of which appear an angry white underwater, with a notably different rough, fibrous, or papilloform texture.

This leads to the third lesson: ***A turtle with body tumours but no eye tumours is almost certainly a regression case.*** In our 245 turtles with FP, just eight were never seen with eye tumours. Two of these turtles were confirmed regression cases. Six of the turtles had eye anomalies consistent with regression, and all eight had body tumours that appeared to be regressing.

Lesson four: ***Eye examinations give a better understanding of an individual's FP status.*** If a turtle has tumours, it is possible to determine whether they are active or retreating. If tumours are completely absent, normal eyes suggest an animal has never had the disease. Black pearls or an FP signature indicate that it has battled the disease and survived. Pre-eruptive eyes suggest a battle that's yet to be fought.

Lesson five: ***Eye examinations give a better approximation of the actual FP dynamics for an area.*** This is particularly relevant in Hawaii, because honu demonstrate strong site fidelity (Bennett et al. In press). The number of turtles who have fought FP successfully--regression cases--will eventually mount up in an area while those who lose the struggle die. It seems likely that the greater the percentage of regression cases, the longer the area has hosted the FP contagion. Similarly, an area that includes primarily tumoured turtles and tumour-free turtles with normal eyes strongly suggests that the disease is newly arisen, probably within the previous five years.

CONCLUSIONS

We have shown that at Honokowai, ocular tumours are invariably a part of progressing FP. In addition, we have identified anomalies in the eyes that can reveal both pre-eruptive tumours and completely regressed FP. Plans to take samples from pre-eruptive eyes for histopathologic and viral testing are already in the works.

Examination of the eyes therefore provides a more accurate assessment of FP status in an ohana of Hawaiian green turtles. In comparisons between Honokowai and other Hawaiian sites, there is enough agreement to convince us that our lessons can be useful at those sites.

An old English proverb reads, "The eyes are the window of the soul." We don't know whether sea turtles have souls, but we do think that the FP history of the honu is writ large in their eyes. The tragedy is that the story of erupting FP is read almost exclusively in the eyes of the juveniles. On a positive note, our observations suggest that the eyes provide insight, not just into an individual's FP status, but also into the way FP works its Evil on an entire population of honu. Can this narrative be found in the eyes of non-Hawaiian turtles? We implore you to look.

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PRELIMINARY RESULTS ON THE SEX RATIO OF NORTH ATLANTIC JUVENILE PELAGIC LOGGERHEADS ASSESSED THROUGH SERUM TESTOSTERONE

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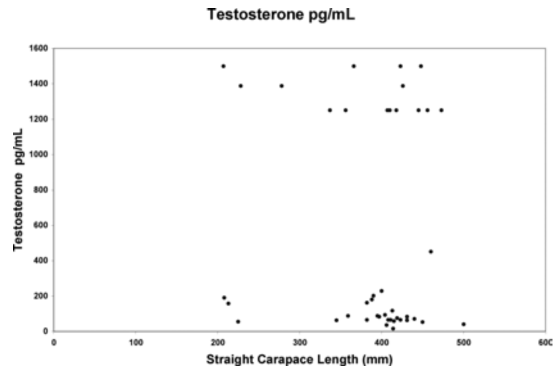
Serum testosterone concentrations were measured on juvenile pelagic stage loggerhead sea turtles, *Caretta caretta*, captured in the open ocean using a scoop-net, off Madeira Island, Eastern North Atlantic (32°N/16°W).

Blood samples were mostly taken during the 1st hour after capture from the dorsal cervical sinus as described by Owens & Ruiz (1980). Samples were kept refrigerated for less than 3 hours, centrifuged and the plasma stored at –20°C until assay. Testosterone levels were determined through specific radioimmunoassay.

Results showed a bimodal distribution of testosterone concentrations, suggesting a clear distinction between sexes, with no overlap between groups. Individuals considered immature females had testosterone levels below 500 pg/mL. Individuals considered to be immature males had testosterone levels higher than 1200 pg/mL). On the basis of testosterone levels the estimated sex ratio for the sample was 1 male for 2 females. Confirmation of our results through laparoscopy is underway.

Turtles caught off Madeira originate in southeastern US nesting beaches. The main Western Atlantic nesting beaches produce hatchlings at a male to female ratio of 1:6, while the adult ratio in the same region is 1:2. Since the sex ratio we find is the same as in the adults and, on the basis of carapace length, our turtles are estimated to be older than 6 months, differential mortality must occur very early in the juvenile phase, probably within the first 6 months of age.



REPRODUCTIVE SEASONALITY AND REVERSE SEXUAL DIMORPHISM IN GREEN TURTLES

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The temporal distribution of nesting and mating in green turtles (*Chelonia mydas*) at Ascension Island (7º57' S, 14º22' W) in the South Atlantic is described. Mating was observed to start before nesting and follow a pattern consistent with a modelled seasonal influx of suitable females into the annual breeding population. When available data on male size is compared with that of females from the same breeding population (n=12 populations) a pronounced and consistent reversed sexual dimorphism is highlighted in all populations. The possible mechanisms behind this are discussed.

ACKNOWLEDGEMENTS

This work was supported by grants from the Department of the Environment, Transport and Regions (DETR) Darwin Initiative Programme for the Survival of the Species, the Foreign and Commonwealth Office Environment Fund for the Overseas Territories, Natural Environment Research Council of the UK (NERC). We are grateful for the additional logistical support of Ascension Island Services, Cable and Wireless, Computer Services Raytheon, Merlin Communications Ltd., Royal Air Force, United States Air Force. The authors thank the Symposium Overseas Travel Fund for assistance in attending the symposium.

REGULATION AND MAINTENANCE OF REPRODUCTIVE CONDITION IN FEMALE GREEN SEA TURTLES.

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Sea turtles are seasonal breeders, and reproductive data from Heron Island in Australia indicates that female's lay on average five clutches of 115 eggs per season. It is presumed that once a female has migrated to her breeding area she will not feed for the duration of the breeding season. This represents a possible period of several months of aphagia, a period by which energy supplies must be met by alternative means. One such mechanism is the mobilization and metabolism of stored lipids. We collected plasma, yolk and fat tissue samples from females at a variety of stages during the nesting season to investigate how females mobilize and allocate stored energy during the breeding season. In-vitro incubation of fat tissue indicated that both corticosterone and catecholamines induced lipolysis, and during the nesting season there was a weak correlation between plasma triglyceride and corticosterone. Concentrations of both were relatively high throughout the nesting season, declining to lowest levels after the last clutch. During the nesting process, plasma triglyceride was highest in turtles digging a nest and similar in both turtles that failed to oviposit and those that completed oviposition. The uptake of lipid by ovarian follicles was completed prior to the nesting season and during extreme events such as high percentage of unsuccessful nesting, females can mobilize the lipid from mature ovarian follicles to re-supply the stored energy available for metabolism. We suggest that one mechanism that may regulate the length of an individuals nesting season is her level of stored energy and her ability to mobilize lipid from ovarian follicles back to the liver and muscle for metabolism.

REGRESSION/PROGRESSION OF FIBROPAPILLOMA SEVERITY IN GREEN TURTLES IN THE INDIAN RIVER LAGOON, FLORIDA, BASED ON RECAPTURE RECORDS

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Between January 1998 and December 2000, we captured 41 previously tagged green turtles. Changes in GTFP status were examined by comparing photographs and/or tumor drawings of initial captures with those from subsequent captures. There was no change of GTFP status if the recapture period was less than 10 months.

Of 17 individuals without GTFP at initial capture, 11 (64.7%) remained unaffected at subsequent recapture over more than a 10 month period. Six of 17 (35.3%) non-GTFP turtles at first capture were afflicted with the disease by the second capture. Of 24 green turtles with FP at the first capture, 21(87.5%) showed clear regression or complete absence of GTFP by the second capture. None of the turtles that showed regression of GTFP tumors was severely afflicted at the first capture (76%=mildly afflicted, 24%=moderately afflicted). Three out of 24 (12.5%) green turtles with FP tumors present at the first capture showed progression in the severity of GTFP. The longest recapture record (4 years) was observed in an individual which showed mild affliction at the first capture and absence of GTFP at the second capture. No turtle classified as severely afflicted has been recaptured more than 7 months after the initial capture. This may indicate reduced survivorship in the most severely afflicted animals.

EVIDENCE FOR BEHAVIOURAL EFFECTS ON DAILY PROFILES OF MELATONIN AND CORTICOSTERONE IN MARINE TURTLES

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In addition to biophysical cues such as light and temperature, the circadian system of vertebrates may be regulated by non-photic cues such as behaviour. This influence of behaviour on the circadian system can be assessed by measuring the response curve of particular circadian rhythms including hormone cycles. In this study we examined the effect of induced and spontaneous nocturnal behaviours on the daily profiles of the melatonin (M) and corticosterone (B) cycle in captive and wild green turtles, *Chelonia mydas*. First, we examined if captive juvenile turtles exhibited the predicted nocturnal and diurnal profiles in plasma M and B. Second, low- and high- intensity nocturnal behaviours were induced in captive turtles to ascertain any effect of behaviour on hormone profiles of M and B. Third, the effect of three spontaneous nocturnal behaviours- nesting, mate searching by males and feeding/swimming in wild turtles were investigated to determine the effects of natural behaviours on the expression of circadian hormone cycles. In captive turtles, a distinct nocturnal and diurnal profile in M and B was expressed. Induced and spontaneous field based nocturnal behaviour caused a marked decrease in nocturnal levels of plasma melatonin compared to inactive turtles. Nocturnal behaviour prevented the nocturnal decrease in corticosterone. Our findings provide evidence for an association between daily profile variation in melatonin and corticosterone and various nocturnal behavior in green turtles.

LOGGERHEAD NEST SITE FIXITY IN THE ROOKERY OF LAGANAS BAY, ZAKYNTHOS, GREECE

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INTRODUCTION

Researchers have found that (loggerhead and green) sea turtles are 80% faithful to particular rookeries (Kikokawa, 1999), 70% faithful to 3 km clusters of beaches (Mortimer & Portier, 1989) and 71% faithful to their 1st nesting beach of the season (Wang & Cheng, 1999). This means that about 30% of turtles move between different beaches. Nest site fixity is assessed by calculating how close turtles nest to their previous nesting site. This study primarily assesses nest site fixity of loggerhead turtles to a particular beach in the rookery of Laganas Bay in one season, and degree of exchange between the six nesting beaches. Secondly, nest site fixity is assessed with respect to one beach, the high-density nesting beach of Sekania.

THE STUDY SITE

Zakynthos (37.38'°N x 20.37'°E) is one of the Greek islands situated in the Ionian Sea in the Mediterranean. The island is 406 km^2 with 155 km of coastline. Laganas Bay, in the South East of the island, is 20 km in length with a 12 km opening, and constitutes part of the National Marine Park of Zakynthos. The Bay holds a highly important loggerhead sea turtle rookery consisting of 6 discrete nesting beaches totalling about 6 km in length. This rookery can hold up to 2018 nests per year (Margaritoulis, 2000). Nesting density ranges from 55 nests per km (East Laganas) to more than 1000 nests per km (Sekania) (ARCHELON data). Five of the beaches occur at irregular intervals along the coastline of the Bay, and are separated by rugged promontories. The 6th beach is on Marathonissi, one of 2 islets occurring in the Bay. Each of the 6 beaches ranges in length, orientation, wave action, beach slope, vegetation cover, sand sorting co-efficient, sand colour and content, and human disturbance (light, noise, habitation).

METHODOLOGY

ARCHELON, the Sea Turtle Protection Society of Greece has been monitoring systemically all 6 nesting beaches in Laganas Bay since 1984. The nesting activity is determined by morning surveys. In addition turtles were tagged throughout every night during the 2000 nesting season (June 1st- July 31st) on four of the beaches. All turtles encountered nesting, with one or no tags, were tagged with "Rototags" on the front flippers. All turtles camouflaging or returning to the sea were checked for existing tags on all four flippers and the tag number(s) recorded. In addition, the subsector location of every observed emerging and nesting turtle was recorded.

Data were collected during 2000 on the precision of nest site fixity of loggerhead turtles within the Bay with respect to three types of re-nesting emergence patterns: a) following abandoned nesting attempts in 2000; b) after intervals separating consecutive egg clutches in 2000; c) after remigration intervals of one or more years. Re-emergences within 2000 were also examined in the degree of nest site fixity between 10-20 metre subsectors located on the beach of Sekania. 'Neophyte' and 'remigrant' turtles were also compared. Neophytes were distinguished as being newly tagged turtles with no previous scars or tags on any of their four flippers. The inter-seasonal re-migratory data covered a period from 1993-2000 and was obtained from the ARCHELON archive.

RESULTS

The data shows the degree of nest site fixity of 132 tagged individual turtles recorded emerging on the nesting beaches more than 2 times during the 2000 nesting season. An important finding was that re-migrants were never recorded using more than 2 nesting beaches, whereas neophytes were recorded using up to 3 nesting beaches. The data shows turtle exchange rates between nesting beaches within the rookery, during the 2000 season. There is a flow of turtles moving away from Sekania to alternative nesting beaches, which occurred primarily in the 2nd 3 weeks of June, after the first nesting flux. The data indicate that the beaches to which most turtles are moving to is Laganas and secondly Gerakas.

Additional analysis of nesting exchange between beaches across consecutive seasons strongly indicated that adjacent beaches expressed positive exchange correlations. Certain beaches have negative nesting relationships with other nesting beaches within the rookery, i.e. when Marathonisi has an increase in nesting numbers Gerakas will have a decrease, and vice versa. The data suggests that between seasons there is a movement of turtles to Sekania, and from Laganas - which produces a surprisingly inverse trend to that observed within one season.

Nest fixity data trends can be linked to trends in the nesting density figures for the overall rookery. Between 1984-2000 the nesting density has remained stable within the rookery. But for 5 of the beaches within the rookery nesting density is either increasing or decreasing, yet that of Sekania remained on a plateau (ARCHELON data).

Annually, an average of 54% of nests in the rookery are located on Sekania beach, which is one of the densest loggerhead nesting beaches in the world. However, data collected over the last 6 years indicate, no matter what the volume of nests, the majority of emergences and successful nesting attempts occur within the same specific range of beach each year. Sekania beach is physically divided into two main sectors: East and West. East Sekania (365 m) with a clear offshore approach, holds 65% of all nests laid on Sekania annually. 65% of nests laid on East occur on just one third of this sector, in 3 distinct 'clusters'. An inverse correlation to nesting density and hatching success rate was recorded. West Sekania (276 m), fronted by underwater reefs, and holds 35% of nests on Sekania. Regions of both sectors of Sekania beach receive very low emergence numbers and very low nesting numbers, yet inter-seasonal beach exchange shows turtles moving to nest on Sekania, while intra-seasonal beach exchange shows that 15% of turtles in 2000 moved to alternative nesting beaches within the rookery. In 2000, nest site fixity was assessed for 98 turtles recorded emerging on more than 2 occasions on Sekania beach. Table 5 shows that both neophytes and re-migrants "appear" selective, with respect to the sectors (East vs. West), where failed emergences occur (60% & 80% respectively). Both neophytes and re-migrants seem less selective about where they eventually nest (53% & 46% respectively). 50% of the turtles emerged only on one sector (East or West). Of these, all turtles showed nest site fixity within a range of 2 to 14 poles (median 7) around specific subsectors of the beach (out of a total of 26 poles on each sector) (Figure 1). The figure shows that emergences appeared to be random within this range for both neophytes and re-migrants, i.e. turtles were as likely to emerge within a 2 pole range as they are within a 14 pole range around specific subsectors of the beach, but never in a greater range. This supported by daily morning survey data that clearly indicated that areas of each sector are 'preferred' for emergences. Furthermore a positive correlation was observed for subsectors of beach showing greater emergence rates with areas of greater nesting success.

Laganas Bay rookery displayed an average of 84% nest site fixity to specific beaches in 2000 nesting season. In addition, of the 84% of turtles that remain faithful to a particular beach, 50% expressed nest site fixity to within a specific region of beach. The information collected demonstrates that the nesting population in Laganas Bay depend on all six beaches existing as in interconnecting network. Mass tourism has already led to the loss of about 2 of the 8 kilometres of the original nesting beach. For Zakynthos all nesting beaches are now protected, however this is not happening worldwide. It is therefore essential to investigate why and which turtles move between beaches, and what factors influence these turtles to select one beach over another. The mechanisms for beach selection must be linked to nest site fixity and hence nest site selection processes. Is beach exchange and nest site fixity connected to the individual turtle, environmental cues or as a result of anthropogenic pressure?

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LIFE THROUGH LEATHERBACK EYES

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We used new remote video imaging technology to record at-sea behaviour and diving of eight female leatherback turtles nesting at Parque Nacional Las Baulas, Costa Rica. The "Crittercam" camera system simultaneously recorded up to 6 hours of video from the turtle's point-of-view and 12 hours of dive profile data. Our objectives were to obtain visual information on the undersea environment, to observe any feeding behaviour, to determine if social interactions took place, and to measure the frequency and duration of dives.

We used a suction cup to attach the camera to the female turtle's carapace, with the camera mounted between the longitudinal ridges. The suction cup was released from the turtle by means of a small magnesium nut that corroded at a predictable rate and allowed water to enter and release the suction. The camera housing was positively buoyant and contained a VHF transmitter to permit recovery of the camera at sea.

We successfully deployed and recovered the camera on eight occasions, with deployment times ranging from 4 to 12 hours. Most cameras were recovered within 10 kilometres of the nesting beach, with one camera recovered approximately 20 kilometres offshore. Study turtles returned to nest after the camera recovery and there were no observable marks on the carapace caused by the suction cup. Dive profile data showed that the turtles made short, shallow dives for the first few hours after leaving the nesting beach, with dive duration ranging from 15 seconds to 10 minutes. Thereafter the dives became deeper and longer, to a maximum depth and duration of 50 metres and 35 minutes. Dive patterns were consistent between turtles. Surface intervals were typically around 30 to 60 seconds, with the turtle taking two or three breaths during that time.

The undersea environment appeared relatively barren, with few areas of vegetation or coral. Some soft corals were observed, but the majority of the bottom was sandy and with no observable plant life. We did not observe any obvious feeding behaviour, although several turtles showed movements of the head that suggested drinking of seawater, presumably to rehydrate after spending time nesting.

The most startling result we obtained was the frequent observation of male turtles interacting with the study females in what appeared to be attempted mating behaviour. Sex of the turtles was determined by relative tail length. Male leatherbacks had never previously been observed near nesting beaches. Three of eight females were observed to interact with males, one female interacted with three separate males over a two hour period. It appeared that females actively attempted to avoid males, and they were observed to swim rapidly to the bottom and remain motionless when seeing a male. Male turtles circled and attempted to copulate with females, but it appeared that these attempts were unsuccessful because of the body position adopted by the female. Interactions were very physical, with males frequently striking females with the body or front flipper. Interactions typically lasted 15 to 20 minutes, during which time the turtles did not surface to breathe.

Our main conclusions were:

1) There are distinct phases in dive and swim behaviour that change with proximity to the nesting beach, 2) Female turtles do not appear to feed in the 12 hours after nesting, either through choice or because of a lack of suitable prey, 3) The sea floor within 20 kilometres of the nesting beach is relatively barren and does not contain much variety of animal or plant life, 4) Male turtles are present near the nesting beach and attempt to mate with females after nesting. The presence of these males had never previously been suspected and this result profoundly changed our understanding of the mating and migration of leatherback turtles. We infer that male turtles migrate from remote locations and hence are potentially exposed to the same risks during migration as female turtles. The attempted mating of males with already reproductive females suggests that the mating system of leatherbacks may be more complex than previously believed.

SECONDARY SEA-FINDING CUES IN OLIVE RIDLEY (LEPRIDOCHELYS *OLIVACEA*) AND LEATHERBACK (*DERMOCHELYS CORIACEA*) HATCHLINGS

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It is well known that light is the primary cue which hatchlings emerging from the nest use to find the ocean. The first several hours after leaving the safety of the nest challenge these vulnerable neonates with numerous predators making efficient ocean finding abilities a necessity. Leatherback and olive ridley hatchlings at Playa Grande, Costa Rica were used to study the effects of geomagnetics, geotropism, and sound on their sea-finding behavior. All three of these cues did influence the behavior of the hatchlings. In both species, naïve hatchlings, collected directly from the nest, were greatly attracted toward negative geotropic (uphill) cues (*D. coriacea*, $p=0.001$; *L. olivacea*, $p=0.03$). However, when imprinted, leatherback hatchlings relied on geomagnetic cues for orientation ($p=0.03$) and olive ridley hatchlings favored positive geotropism ($p=0.07$). In the presence of multiple conflicting cues, geotropism verses geotropism and surf sounds, leatherback hatchlings no longer show a geomagnetic preference ($p=0.37$). When testing hatchlings outfitted with a 0.5 gauss magnet, leatherback hatchlings significantly deviated from their original orientation ($0.01>p>0.005$), while olive ridley hatchlings did not ($p>0.5$). When increasing the magnetic strength to a 1.0 gauss magnet, both species significantly deviated from their original orientation (*D. coriacea*, $0.025>p>0.01$; *L. olivacea*, $0.05>p>0.025$). Hierarchy of geomagnetic and geotropic cues was dependent upon time and experience since hatching. The additive effects of two simultaneously presented cues (surf sounds and geotropism), was found to disrupt a singular cue (geomagnetism).

EFFECTS OF SEASONAL TEMPERATURE VARIATION ON METABOLISM, HEART RATE, AND BLOOD FLOW DISTRIBUTION IN GREEN SEA TURTLES

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Environmental temperature profoundly affects the physiology and behaviour of ectothermic vertebrates. Low environmental temperatures may result in reduced metabolism, heat-conserving cardiovascular adjustments, or behavioural thermoregulation, such as basking. For an air-breathing diver such as the green sea turtle (*Chelonia mydas*), these basic adjustments to cold temperature may have a large effect on dive performance.

Green turtles typically inhabit tropical to sub-tropical waters, yet some populations experience temperature fluctuations of 9 C or greater from season to season. Seasonal changes in temperature were simulated under laboratory conditions at the University of British Columbia Animal Care Facility (Vancouver, BC) so that we could investigate the effects of temperature on physiological variables in 5 immature (20 – 35 kg) green turtles. The thermal regime was designed to mimic seasonal temperature changes that occur at Moreton Bay, Queensland, Australia where there is a year-round population of green turtles. Turtles at UBC were typically kept at 26 C. During exposure to the thermal regime the turtles experienced a gradual decrease in water temperature (Tw) of 3 C every two weeks until Tw was 17 C. Tw was maintained at 17 C for 16 weeks and then gradually increased to 26 C. Metabolic rate (measured as oxygen consumption, VO^2), heart rate, and global blood flow distribution were measured in turtles at 26 C and at 17 C.

VO^2 of fasted turtles was measured with open-flow respirometry. During respirometry trials the majority of dives consisted of periods of rest combined with periods of activity, therefore it was impossible to separate resting VO^2 from active VO^2. VO^2 for the entire trial was dependent on the overall level of activity during the trial. Data show that mean VO^2 after 8 weeks (0.2759 ± 0.0651 ml min-1 kg-1 STPD, mean ± SE) and 16 weeks (0.2821 ± 0.0313 ml min-1 kg-1 STPD) exposure to 17 C was lower than, but not significantly different from, mean VO^2 at 26 C before (0.3798 ± 0.0376 ml min-1 kg-1 STPD) or after (0.4145 ± 0.0749 ml min-1 kg-1 STPD) cold exposure (Fig. 1). The Q10 value for VO^2 was only 1.42. Results suggest that turtles are capable of metabolic compensation with prolonged exposure to cold environmental temperatures or have decreased thermal sensitivity.

Heart rate was monitored at 26 C and at 17 C (16 weeks exposure) using electrodes implanted above the right front flipper and left rear flipper. Electrodes were hardwired to a data logger capable of recording ECG with a sampling frequency of 50 Hz. Only resting heart rates were used for analysis, as ECG traces during periods of activity had a high level of EMG noise from the active muscles. Mean resting heart rate at 17 C (10.18 ± 0.90 beats min-1, mean ± SE) was significantly lower than mean resting heart rate at 26 C (19.57 ± 1.50 beats min-1) ($P<0.01$) with a Q10 value of 2.14 (Fig. 2). Comparisons between the heart rate results and results for metabolic rate are complicated by the fact that only resting heart rates could be analysed, whereas measures for VO2 included resting and active periods. However, the results suggest that heart rate is more sensitive to temperature changes than is metabolic rate. Turtles may alter stroke volume during cold exposure to maintain cardiac output and support metabolism despite the decrease in heart rate. If this is the case, then heart rate is not a good indicator of metabolic rate in green turtles.

Blood flow distribution during resting dives was qualitatively assessed by injecting a radioactive tracer (Tc99m-MAA) into the cervical sinus through a catheter. Sea turtles have an incompletely divided ventricle, so the tracer was distributed to both the pulmonary and systemic circulations. The tracer was attached to a large protein (MAA=macro-aggregated albumin) so that it would stay lodged in the capillaries until the protein degraded several hours following injection. Turtles were taken to the Nuclear Medicine Division at the UBC Hospital for gamma camera imaging. Global blood flow distribution after long-term exposure to 17 C was similar to blood flow distribution at 26 C. The majority of the blood was sent to the heart and lungs during resting dives, although perfusion to the pectoral muscles, pelvic muscles, and brain was also apparent. Temperature-dependent alterations in circulation to keep blood in the core and retain metabolic heat would only be expected if turtles maintained elevated body temperatures in relation to their environment. Turtle body temperatures were not significantly different from Tw at any time during the temperature regime.

This study demonstrates that immature green turtles are capable of making metabolic and physiologic adjustments to remain activity during periods of prolonged cold exposure. However, given the trend towards decreased heart rate and metabolic rate, it is likely that dive patterns may vary from winter to summer, with decreased activity levels and longer submergence intervals during seasonal cold exposure. Ecological factors, such as food availability, may play a large role in determining the physiological response to cold exposure in different populations. Field studies to investigate the effects of seasonal temperature variation on diving behaviour and metabolism of immature green turtles in Southern Queensland are underway.

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I would like to thank the 21st Annual Symposium on Sea Turtle Biology and Conservation for providing travel funds. We thank Stephane Lair, Caroline Reichert, Tony McClintock, Michael Pearson, Manuela Gardner, Gunna Weingartner, Bill Milsom, Kim Borg, Katrine Sonne-Hanson, and Russ Andrews for their advice and assistance. The Cayman Island Turtle Farm generously donated the turtles used for these laboratory studies.

Figure 1. Oxygen consumption (mean ± SE) at 26 C and after prolonged exposure to 17 C. Data are plotted alongside the predicted values for VO^2, given a Q10=2. VO^2 does not differ significantly between the treatment groups.

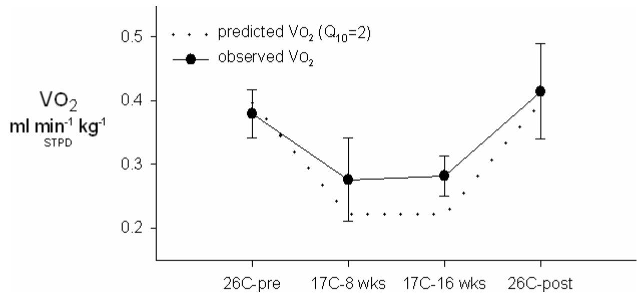
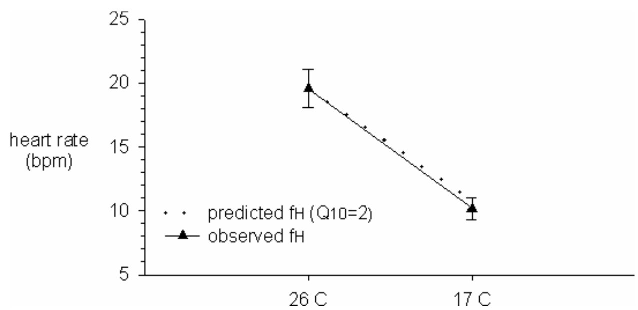


Figure 2. Resting heart rate (mean ± SE) at 26C and during prolonged exposure to 17 C. Mean heart rate at 17 C was significantly lower than mean heart rate at 26 C (P<0.01). The Q10 value for heart rate was 2.14, close to the predicted Q10 value of 2.



ENERGETICS DURING THE DISPERSAL OF OLIVE RIDLEY SEA TURTLE HATCHLINGS (*LEPIDOCHELYS OLIVACEA*) USING THE DOUBLY LABELED WATER METHOD.

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This is the first time that the doubly labeled water (DLW) method has been utilized to determine free living sea turtle hatchling metabolic rates. The mean resting metabolic rate obtained with a closed-circuit respirometer for olive ridley hatchlings (n = 8) was 0.244 (0.1SD) ml O2 g-1 h-1 (2 kJ day-1). The field metabolic rates using the DLW method for hatchlings digging out of their nest (9.88 (3.5SD) kJ day-1), crawling at the sand surface (12.13 (8.7SD) kJ day-1), and swimming (14.53 (4.1SD) kJ day-1), were significantly greater than the mean resting metabolic rate. These values corresponded respectively to aerobic scopes of 5, 6 and 7 fold the resting value. The average body water volume determined by the oxygen isotope dilution was 74% of total hatchling body mass. The rate of water flux for the swimming hatchlings (676 ml kg-1 day-1) was significantly higher than the rates of water flux for the crawling hatchlings (288.5 ml kg-1 day-1) and the digging hatchlings (292 ml kg-1 day-1). The greater water flux for the hatchlings that were swimming was due to drinking seawater (average weight gain = 0.2 g day-1). This study validates the use of the DLW method to estimate water relationships and energetic costs of free living sea turtle hatchlings.

PART II. POSTER PRESENTATIONS

TEMPORARY SEQUENCES AND DESCRIPTION OF THE EMERGENCY OF NEWBORNS OF LOGGERHEAD IN THE CAPE VERDE ARCHIPELAGO

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INTRODUCTION

Sea turtles bury their eggs in the sand of the beach, where they incubate. After a period of approximately two months, hatchlings break the eggshell and remain inside the chamber for three to seven days (Hays & Speakman, 1993). Then they leave the nest and emerge to the surface of the beach, going quickly towards the surf, to begin their pelagic and developmental stage (e. g., López-Jurado & Andreu, 1998).

Hatchlings usually do not emerge from the nest as a single group. They emerge in groups at different moments, resulting in more than one emergence per nest during some days (Whitherington et al., 1990; Hays et al., 1992; Peters et al., 1994).

Nesting population of *Caretta caretta* in Boavista (Cabo Verde, Western Africa, FIGURE 1) has recently been discovered and it has been the object of management and conservation effort since 1998 to do research on the most significant aspects of their reproductive biology. Below we present the pattern of emergence of hatchlings from the nests in Boavista, in natural nests and in artificially incubated ones.

MATERIAL AND METHODS

During the 2000 nesting season, a total of 234 nests of *Caretta caretta* were marked and monitored in three beaches of the southeastern coast of the island between 7th July and 27th August. One hundred of these nests were relocated from the original beach to a hatchery to safeguard the survival of the hatchlings, because the fate of the hatchlings in the places where they were laid by the female (flooded sand or compressed substrate) could be uncertain (see Material and Methods in "Hatching success between natural and relocated nests from loggerhead in the island of Boavista (Cape Verde, Western Africa)" in this Symposium).

The eggs from these nests were incubated in similar conditions to those in situ on the beaches, and hatchlings were released in different closer beaches to avoid predators feeding stations in the incubation beach (Mortimer, 1999).

From the 45th day of incubation, a plastic net was placed around the nest to retain hatchlings during their emergence to the surf. After each emergence event, hatchlings were counted and measured (straight carapace length), and released immediately, leaving untouched the nest waiting for subsequent emergences. When the number of hatchlings emerged matched (or was similar to) the total number of eggs lay by the female, or after 70 days of incubation, the nest was excavated with caution checking for new hatchlings (Miller, 1999).

RESULTS

A total of 234 nests were marked and 139 of them were included in the analysis (84 from hatchery and 55 natural ones), excluding nests with doubtful results and those in which the marks were lost due to tides and rain.

Incubation period for *C. caretta* in Boavista averages 59.0 days (N=178), without significant differences between nests incubated in the hatchery and those on the beaches ($t=-0.636$, $p=0.52$).

Number of emergence events per nest

In the hatchery, the number of emergences (Mean=2.54 emergences/nest, Range=1-8, N=84) was significantly higher than on the beaches (Mean=1.36 emergences/nest, Range=1-4, N=55; $U'=1079.0$, $p<0.0001$).

Interval between the first and last emergence

An average of 3.68 days passed between the first and the last emergence (Range=1-20, N=139). Also, this was significantly higher ($U'=1155.0$, $p<0.0001$) in the hatchery (Mean=4.77 days, Range=1-20, N=84); than in the beaches (Mean=2.01 days, Range=1-12, N=55).

Percentage of hatchlings per emergence

The great majority of hatchlings emerge in the first event, this value diminishing in subsequent emergences. Thus, in the first event, the percentage of hatchlings that emerged from the nest was 88.1%. If we compare this result between nests incubated in the hatchery and those let in the beaches, we observe how the percentage is significantly higher in situ, averaging 90.7% ($U'=3390.0$, $p<0.0001$) in front of those incubated in the hatchery (86.3%). This difference changes in subsequent emergences, being the percentage lower in the nests incubated in situ (TABLE I).

Size of hatchlings

Mean body size of hatchlings in the first emergence event was 42.0 mm of straight carapace length (Range=39.0-45.0, N=126). If we compare between different emergence events (from 1st to 5th, due to small sample size from 6th to 8th), there are no significant differences ($F_{4, 258}=2.36$, $p=0.053$, FIGURE 2).

DISCUSSION

Incubation period for sea turtles is influenced by factors such as temperature (Mrosovsky & Yntema, 1980) and O_2 levels (Ackerman, 1980). Therefore, eggs from the same nest may have different incubation periods, resulting in more than one emergence per nest. On the other hand, emerging in groups is better from the energetic point of view to climb to the surface (Carr & Hirth, 1961), although there exist limiting factors in the time they wait for their siblings (energy expenditure or predatory detection, Hays et al., 1992).

In general, our results suggest that the pattern of emergence of hatchlings of *C. caretta* in Boavista is similar to the ones already described, which shows once more that there is not just one emergence event in each nest, and that this occurs in a variable interval of days (Hays et al., 1992; Peters et al., 1994). Comparing the total number of days of emergences with the data on the bibliography, there are no outstanding differences. For example, in Turkey, emergences cover a time of 2.3 days (Peters et al., 1994), while this value is 8.3 days in Greece (Hays et al., 1992), and in Florida it ranges between 1 and 3 days (en Whitherington et al., 1990).

The higher number of emergence events as well as the total duration in the hatchery could be due to the different incubation temperatures inside a single nest unlike those incubated on the beaches. Even though the chambers made by us in the hatchery tried to be similar to those made by the loggerhead females, it is possible that the shape of the chambers was more variable, resulting in the differences mentioned before. Nevertheless, the characteristics of the beach chosen for the hatchery compared with the features of the beaches with the nests in situ may also cause the differences.

On the other hand, the percentage of hatchlings emerging from the nest in the first emergence event is lesser in the nests incubated in the hatchery, possibly because, in these nests, hatchlings emerge in a higher number of days (TABLE I).

However, the emergence success from hatchlings incubated in the hatchery was higher than the same result in the beaches (see results in "Hatching success between natural and relocated nests from loggerhead in the island of Boavista (Cape Verde, Western Africa)" in this Symposium).

If we observe now the size of the hatchlings, there is no significant relationship between subsequent emergences (FIGURE 2), as it is noted in other known populations, e. g., in Greece (Hays et al., 1992). Although we have no data on this subject, the hypothesis relating to the smaller size of hatchlings that remain in the nest after all emergences results feasible, as it occurs in Turkey (Peters et al., 1994).

Acknowledgements:

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Figure 1. Map showing Cape Verde Islands, and the position of Boavista.

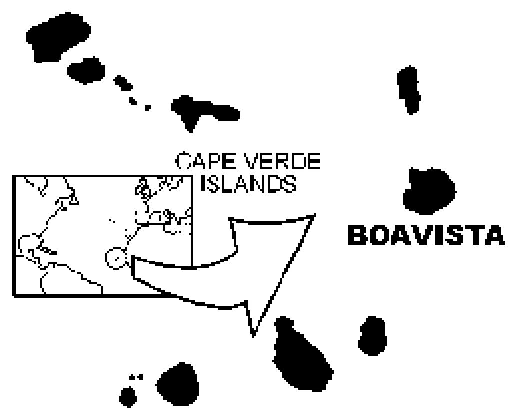

Figure 2. Mean body size (SCL of hatchlings of *caretta caretta* from Boavista (bars show Standard Deviation).

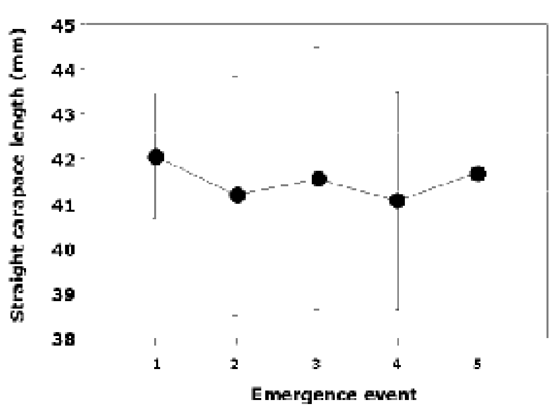

Table 1. Percentage of hatchlings emerged on each emergence event.

Emergence	1	2	3	4	5	6	7	8
Natural	90.76%	8.98%	0.23%	0.02%	-	-	-	-
Hatchery	86.36%	9.78%	1.88%	1.3%	0.5%	0.08%	0.02%	0.05%
General average	88.1%	9.46%	1.23%	0.8%	0.3%	0.05%	0.01%	0.03%

LOW-GRADE FIBROSARCOMAS IN GREEN TURTLES (*CHELONIA MYDAS*) IN THE HAWAIIAN ISLANDS

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ABSTRACT

Fibropapillomatosis in green turtles (*Chelonia mydas*) has been recognized as one of the most important mortality factors in stranded turtles in the Hawaiian Islands. Several viruses including herpesviruses, a retrovirus, and a papilloma-like virus have been associated with the tumors but the causative agent has not been characterized. Histologically, some tumors of the nasopharynx, mouth and temporomandibular tissues appear to have an aggressive, invasive behavior. These masses are well demarcated from adjacent tissues but demonstrate infiltration of surrounding stroma and bone lysis. Although there is no evidence of vascular invasion or high mitotic activity, these tumors have been classified as low-grade fibrosarcomas.

INTRODUCTION

The green turtle (*Chelonia mydas*) is protected under the U.S. Endangered Species Act and the Wildlife Laws of the State of Hawaii. Fibropapillomatosis (FP) is a disease of marine turtles characterized by multiple cutaneous masses ranging from 0.1 to more than 30 cm in diameter that has primarily affected green turtles. The disease has a worldwide distribution and has been observed in all major oceans and in all species of marine turtles that are considered endangered of extinction. Where present, prevalence of the disease varies among locations, ranging from as low as 1% to as high as 90%. Although several viruses have been identified associated with the tumors, including herpesviruses, a retrovirus and a papilloma-like virus, the primary etiological agent remains to be isolated and identified. Concurrent infections of FP and cardiovascular trematodiasis have been recognized as important mortality factors of Hawaiian green turtles considerably reducing the survival of the species.

The neoplastic processes previously observed by Aguirre and Spraker (1995) and more recently during gross and histopathologic examination of 14 turtles collected in the Hawaiian Islands with FP suggested a synergistic effect of cardiovascular trematodes and the primary agent of FP. Tumors in the internal organs of some turtles were characteristic of fibropapillomas, fibromas, myxomas, and fibrosarcomas. This study suggested that, when occurring together, spirorchidiasis and fibropapillomatosis represent a debilitating and fatal syndrome of Hawaiian green turtles.

We describe the gross and histopathology of temporomandibular tumors found in green turtles from the Hawaiian Islands, and present histopathological evidence suggestive of the presence of low-grade fibrosarcomas.

METHODS

Stranded green turtles with FP have been recovered for detailed gross and histopathologic examination. Also, live turtles have been captured unharmed using SCUBA in Kaneohe Bay for sampling since 1991. All of these turtles were strong and appeared to be relatively healthy and not emaciated. All turtles were released safely back into the ocean after tumors were biopsied. All stranded turtles were transported to the NMFS Honolulu Laboratory for clinical evaluation, euthanasia, and necropsy. Predilection was given to the freshest specimens with FP in the oropharynx. Turtles were humanely euthanized with a lethal intraperitoneal injection of Buthanasia-D Special Solution (Schering-Plough Animal Health, Kenilworth, NJ, USA). Detailed necropsies were performed following the protocol described by Wolke and George (1981). After external examination of skin, head, and appendages, the plastron and muscle masses of the pectoral girdle were removed and viscera examined in situ. Special examination of the buccal cavity, nares, tongue, soft and hard palates, pharynx, larynx, glottis and eyes was performed and the tumors were recorded. Standard techniques were followed for the histopathologic evaluation of specimens. Specimens of normal and affected tissues were fixed in 10% neutral buffered formalin, embedded in paraffin, sectioned 6-m thick and stained with hematoxylin and eosin (H&E). Selected tissues were also stained with Masson's Trichrome.

RESULTS

For the purposes of this study, a total of 54 masses 15 mm or less in diameter were surgically removed from 30 turtles. Tumors were small, white to gray, smooth to verruciform, raised masses on the integument and eyelids. Necropsies of 26 turtles were considered in the study based on freshness of the carcasses and location of tumors.

Five of the stranded turtles with large white multilobulated masses of the temporomandibular area were examined histologically. These tumors appeared to have taken their origin from the angle of the mandible/maxilla. Two of these turtles also had tumors of the glottis. These tumors grew both outward and formed multilobulated masses around the angle of the mandible and inward and occupied the orbit, invaded periorbital salt glands and destroyed bone of the orbit and hard palate. These retrobulbar masses caused mild protrusion of the globe. These tumors were composed of sheets and thin to broad interweaving bundles of fibroblastic tissue. Neoplastic cells had plump oval nuclei surrounded by an extensive amount of eosinophilic fibrillar cytoplasm. The degree of cellularity of these tumors was considered to be moderate. Mitotic figures were extremely rare. Sections did show invasion of bone. In most areas epidermis covering the tumor had undergone necrosis, but in other areas there was a layer of loose relatively normal subcutaneous tissue separating the tumor from the acanthotic epidermis. Pseudoepithelomatous hyperplasia was not a feature of the epidermis. These tumors were diagnosed as low grade, well-differentiated fibrosarcomas.

DISCUSSION

The tumors observed in Hawaiian green turtles occurring primarily in juvenile turtles do suggest at least infectious agents may play a role in the etiology. Elucidation of the etiological agent or agents was not the focus of the study, but the histological features are similar to the fibropapillomas described in domestic animals.

A histological study of the external and internal tumors of these turtles do show several differences. The fibropapillomas of the glottis were histologically similar to the cutaneous and ocular tumors. These glottal tumors were usually found in turtles that had cutaneous tumors. These tumors appeared to be benign, however caused great distress to the turtles due to their location. These glottal tumors would cause severe difficulty in eating and breathing. The tumors of the temporomandibular area were of fibroblastic origin as the other tumors, but did show marked differences. First, the degree of cellularity was slightly higher and the neoplastic cellular nuclei were large. Bony invasion is observed. Tumors similar to these have been described in large breeds of dogs that histologically appear to be benign fibromas of the maxilla or mandible, but biologically act as malignant tumors. These tumors invade bone and occasionally metastasize to lung and regional lymph nodes. (P.A. Ciekot, B.E. Powers, S.J. Withrow, R.C. Straw, G.K. Ogilive, S.M. LaRue. 1994. Histologically low-grade, yet biologically high-grade, fibrosarcomas of the mandible and maxilla in dogs: 25 cases, 1982-1991). These temporomandibular tumors were diagnosed as low-grade, well differentiated fibrosarcomas. Cellular features used for this diagnosis included morphology of individual neoplastic cells, degree of cellularity and invasion and destruction of surrounding bone.

Metastasis or malignancy of FP has not been demonstrated; however, some tumors have shown invasion of bone tissue and some internal organs. Adenomatous changes of an ocular tumor of a green turtle suggesting malignancy were described during the late 1930's. Fibromas in lungs, kidneys, heart, liver, and gastrointestinal tract have been reported in green turtles with FP in Florida and Hawaii. These masses are well demarcated from adjacent tissues but some show infiltration of surrounding stroma.

The association of parasites with tumor formation in animals has been documented in other species. *Spirocerca lupi*, a nematode of dogs and wild carnivores in tropical and subtropical areas, has been associated with the induction of tumors in the esophagus and stomach. Pathologic changes include reactive granulomas that develop around the parasite (esophageal nodules); the fibroblasts in the inflammatory lesions may be metaplastic and appear transitional between a granuloma and a sarcoma; and definite neoplastic transformation to fibrosarcoma and osteosarcoma may occur. Other lesions of *S. lupi* include arterial stenosis, fibrosis, and granulomas; and aortic aneurysms. The exact mechanism of tumor induction by the above endoparasites in these animal species in not well understood. It has been suggested that the secretion of a chemical carcinogen by the parasite may induce neoplasia.

Although there is no evidence of vascular invasion or high mitotic activity, further research is necessary to demonstrate whether the visceral lesions are the result of metastasized external papillomas, or indeed are multiple independent processes. In other species, the precancer to cancer sequence in the progression of canine oral papilloma to carcinoma has been documented. Currently our project is trying to establish the biological behavior and molecular characterization of these tumors.

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AN ANALYSIS OF SAND CHARACTERISTICS IN COLLIER COUNTY, FLORIDA

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INTRODUCTION

During the winter of 1999, 14,840 cubic yards of sand from an upland sand source was placed in two locations (2,500 linear feet) on the Naples City Beach in Collier County. This sand is associated with an emergency renourishment project initiated to rebuild the beach habitat that had been eroded by the last hurricane season. In this report we analyzed sand temperature, moisture content, bulk density, composition and compaction during the 2000 sea turtle nesting season as a way to look for adverse nest conditions due to the upland sand. Our objectives were to: (1) determine if there are any differences in the physical properties between the upland sand and the natural sand during the 2000 nesting season and (2) analyze the beach characters and nesting activities pre- and post-renourishment in the area of the upland sand placement.

The study site involved approximately 5 miles of beach that incorporates areas containing sand from three sources: sand trucked in from an upland pit, sand hydraulically pumped onto the beach, and from native/natural sand. The upland sand originated from a sand pit in Lee County and was placed in two locations on Naples Beach during the winter before the 2000 nesting season. The hydraulic sand originated from an offshore borrow site (1996) and from the dredging of Clam Pass (1999) where the beach compatible sand was placed on the beach. The native sand came from locations where beach renourishment projects have not occurred. Great care was taken to ensure all data and sand samples were taken from the intended sand typed.

Bulk Density and Moisture Content

Sand samples were taken using a standard volume core (2.5 cm diameter X 10 cm length) at depths between 35-45 cm on the berm and at the base of the dune. Each sample was weighed and then immediately dried at 40 °C for 24 hours. The weight of the dry sand was measured to determine bulk density (g/cm3). The percentage moisture content was also calculated as the ratio of water loss to dry mass multiplied by 100.

The bulk density measured from sand samples in natural (n=16), renourished (n=16), and upland (n=12) areas showed no significant differences (p=0.91). The mean measured bulk density is 1.44 g/cm3 in natural sand, 1.45 g/cm3 in renourished sand, and 1.45 g/cm3 in the upland sand.

The measured moisture content in the sand samples from the dune in natural, renourished, and upland sand was 5.4%, 6.1%, and 8.1%, respectively. This represents a significant difference of moisture content between the natural and upland sand (p=0.002). The moisture content in the sand samples from the berm in natural, renourished, and upland sand was 15.2%, 6.7%, and 8.4%, respectively. This represents a significant difference of moisture content between the natural sand, renourished sand, and upland sand (p=5.0-7). When comparing the sand samples in natural sand from the berm and dune, the moisture content is significantly different (p=5.9-6). This same difference is not seen in the renourished or upland sand.

Sand Temperature

Eleven Onset Hobo External Temperature Loggers (Onset Computer Corporation, Bourne, MA) were placed at the depth equal to the middle part of an egg chamber (approximately 45 cm depth) on May 15, 2000. Four data loggers were placed in natural sand, four placed in hydraulic sand, and three placed in upland sand. All instruments were placed approximately 10’ from the vegetation line where the majority of sea turtle nests are laid. The temperature was logged every hour from June 1, 2000 to August 29, 2000. Due to hurricane threats in September, the data loggers were retrieved early. The data was downloaded using Boxcar Pro software on an IBM compatible PC. Temperatures measured from the data loggers were tested against an NIST traceable thermometer at an accuracy of 0.1 °C.

The combined daily sand temperature ranged from 25.5 °C to 29.5 °C with an average of 27.7 °C. There was no significant difference in the sand temperature between each data logger and no significant difference between the three sand types (p=0.17). The temperature fluctuation throughout the summer was minimal, with a range of only 4 °C. There is a strong correlation between increased rainfall and decreased sand temperature (Figure 1).

The sand temperatures in each area show clear diurnal cycles throughout the summer. Figure 2 shows these diurnal cycles of maximum and minimum temperatures do not match what is expected for maximum and minimum air temperatures. The maximum temperature for each day was not reached until up to 6 hours after sunset. The minimum temperature wasn’t reached until up to 6 hours after sunrise (Figure 2).

Sand Compaction

Compaction sampling was conducted at 500’ intervals throughout the study area using a cone penetrometer approved by the US Army Corps of Engineers. The measurements were taken at 6”, 12”, and 18” depths before nesting season and after beach tilling. Three measurements were taken at the seaward edge of the dune and midway to mean high water (berm) at each interval. The replicates were averaged together and converted to PSI units. The data for the 6” measurements are presented here.

The sand compaction was significantly higher in the upland sand than in the natural or renourished sand at the berm (p=0.03) and at the dune (p=1.8-6). The upland sand measured to 581 PSI on the berm and 714 PSI at the dune. Compaction of the natural sand was significantly higher than the renourished sand at the berm (p=0.04) but not along the dune (p=0.35). The measured compaction of the natural sand at the berm was 437 PSI and at the dune was 394 PSI.

Sand Composition

Sand samples were taken by Coastal Engineering Consultants Inc. from the upland sand source after the final wash and from native beach sand throughout Collier County. Missimer International Inc. analyzed the grain size and Jupiter Environmental Lab analyzed the carbonate content. Samples were taken from the upland sand source after the final wash and from native beach sand throughout Collier County.

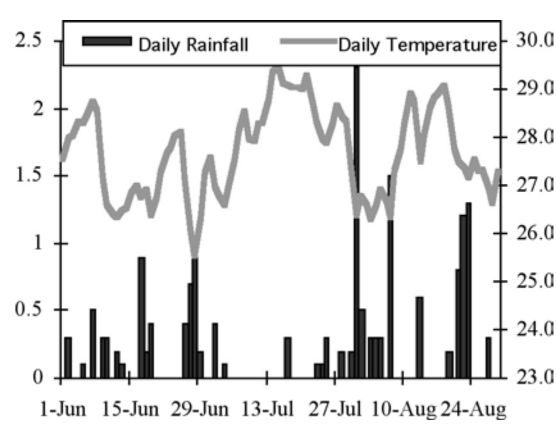
Beach compatible material specifications state the material shall be free of coarse gravel (0.75” and greater in size) and no greater than 5% shall be fine gravel (between 0.75” and 0.19” in size). All samples from the upland sand source and the native beach fell within the specifications for beach compatible material. The native beach sand contained between 7.3-12.6% carbonate content and the upland sand samples contained between 7.3% and 15.8% carbonate. An increased amount of carbonate can cause the sand to be more compact and may also cause the sand to hold more water.

Upland Sand

The small area of beach where the upland sand was placed has historically not been very active for sea turtle emergences. Before the renourishment activity this area received an average of 10 emergences per summer. For the one year of post renourishment data three emergences were recorded.

When comparing the sand compaction one year before renourishment and then after renourishment, there is a significant increase at the dune from 360 PSI (1999) to 714 PSI (2000) (p=0.013). There was no significant difference at the berm for the two years (Figure 3).

Figure 1. Rainfall and daily sand temperature.



CONCLUSIONS

1. The bulk density is not significantly different among the sand types and the measurements are within the 1.25-1.50 g/cm^3 range previously reported for Collier County's natural sand (Liudahl et al, 1998).

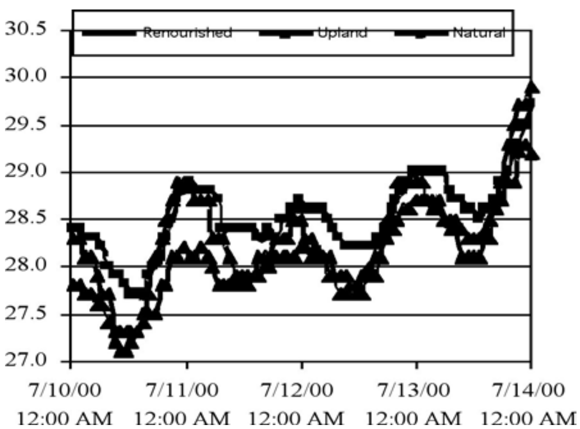
2. The increased moisture content found in the renourished upland sand is consistent with earlier reports that renourished sand contains more moisture. Ackerman et al (1992) showed that renourished sand in Florida contains more moisture than natural sand.

3. The higher moisture content of natural sand from samples taken at the berm may be due to a lower beach profile on natural beaches causing the samples to be taken closer to the water level.

4. Although the sand compaction measurement is much higher in the upland sand, it is difficult to determine if this adversely affects the sea turtle nesting behavior due to the low amount of activity in this area.

5. The renourished sand has a lower compaction measurement than the natural sand and this may be due to the annual pre-season beach tilling that occurs on the renourished sands in Collier County.

Figure 2. Diurnal temperature cycles.

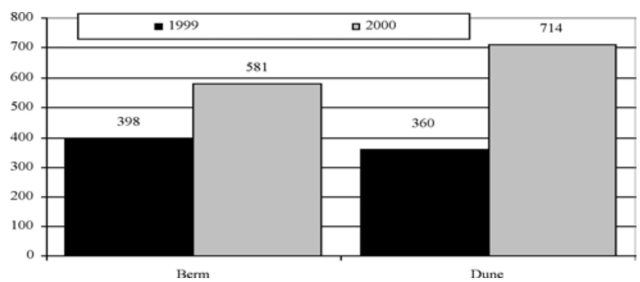


6. The sand temperature wasn't significantly different in the different sand types.

7. The sand temperature throughout the summer averaged 27.7 ^{o}C, and only reached the loggerhead pivotal temperature (29.1 ^{o}C) twice. Each time the temperature was quickly reduced by rain-storms.

8. The diurnal cycles seen with the sand temperature shows the sand not warming until the sun has reached over the dunes and condominiums and the sand temperature continues to rise for several hours after sunset. A similar diurnal cycle has been reported by Milton et al (1997) for sand on the east coast of Florida.

Figure 3. Pre (1999) and Post (2000) renourishment sand compaction.



9. We propose the sand of southwest Florida maintains cooler temperatures and will only warm to temperatures above 29.1 ^{o}C during long periods of no cloud cover. During seasons of increased rain the temperature may stay well below the pivotal temperature.

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EXERCISE-REST CYCLES DURING NESTING IN GREEN TURTLES *CHELONIA MYDAS* AT RAS AL HADD, SULTANATE OF OMAN

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INTRODUCTION

During nesting, sea turtles undergo bursts of cyclical strenuous and exhaustive exercise, followed by a resting period. In vertebrates, which adopt such patterns of short exercise, rest cycles trigger respiratory and cardiovascular changes as well as neuroendocrine activation and metabolic shift associated with stress. These conditions have been reported in fishes (Hughes et al., 1988; Van Raaij et al., 1996), in birds (Yvon le Maho et al., 1992) and in turtles (Coneau & Hicks, 1994; Johnson et al., 1998). Like other marine and freshwater turtles, green turtles ventilates intermittently. Periods of ventilation, which consists of one or more breaths, are separated by longer non-ventilatory periods (Jackson et al., 1979; Butler et al., 1984).

The purpose of this study was to gain some knowledge of the pattern of exercise-rest cycles during different phases of nesting periods, so that it can be related to future physiological and behavioral studies.

METHODS

Exercise - rest intervals were studied for four individual green turtles *Chelonia mydas* at at Ras Al Jinz beach (22^o 25' N, 59^o 50' E), at Ras Al Hadd Turtle Reserve, on the shores of the Arabian Sea, in October 2000. Ras Al Hadd hosts one of the largest nesting populations of the green turtle in the world (Ross and Barwani, 1982). The study was conducted during the peak nesting period in October. The observer sat directly a few feet behind the turtle with a stopwatch, and the duration of each exercise-rest cycle was recorded. The turtles were observed completely during each phase. Occasionally, they did not complete the entire phase because of unfavorable conditions.

The exercise-rest cycles (Exercise interval+Rest interval) of the turtles were also measured during eight behavioral phases during nesting: ascending the beach (phase 1), wandering (phase 2), digging body chamber (phase 3), digging egg chamber (phase 4), laying eggs (phase 5), filling egg chamber (phase 6), filling body chamber and camouflaging nest (phase 7), and return to sea (phase 8). The duration of each nesting phase was compared between individual turtles by ANOVA (Underwood, 1997). The sample size was N=13-27, depending on the nesting phase, as some turtles did not complete the nesting process. Exercise - rest intervals were compared by ANOVA for each one of the nesting phases. Oviposition phase was excluded from this study because of the minimal activities during this phase.

RESULTS

In general, phases 3 and 7 are the longest in the nesting process (Table 1). For the four individual turtles selected to study exercise-rest cycles, the duration of exercise-rest cycles showed significant differences among the nesting phases. There was a significant difference between rest and exercise intervals during phases 1 and 8 only, but there was no significant difference between resting and activity time intervals during phases 2, 3, 4, 6, and 7 (Table 2).

DISCUSSION

The nesting activities in sea turtles are very elaborate and exhaustive. Evolutionary, they may have adapted a short burst of exercise followed by a brief resting pause – a behavioral pattern, which may be of survival value. The exercise-rest cycles, which includes one interval of exercise and one interval of rest, usually last less than one minute for either exercise or rest interval. The duration of either interval depends on the specific phase. For example during the later phases of digging, the exercise intervals shorten while the rest intervals lengthen. This condition is typical of intermittent breathers. In which the animals are subjected to severe hypoxia, acidemia and overall acid-base disturbances during the exhaustive exercise periods (Wasser and Jackson, 1991). In addition to that, turtles demonstrate an increase in rate of respiration in response to hypoxia (West et al., 1992). During exercise, the turtles are shallow breathers, but as soon as they pause for rest, they inhale a large amount of air with force, to overcome the hypoxic condition they develop during the exercise. Apparently, during exercise, green turtles practice anaerobic metabolism, which leads to acidemia and hypoxia (Al Kindi et al., 2000). The high metabolic acidosis associated with exhaustive exercise has also been shown to be related with a sharp rise in epinephrine and norepinephrine plasma levels in turtles (Wasser and Jackson, 1991: Al Kindi et al., 2000). These hormones may facilitate removal of lactate from muscles into the blood stream, and also oxygen uptake during the rest period (Al Kindi et al., 2000). Moreover, the high rise in catecholamine may also combat stress during the nesting process.

Table 1. Duration of each nesting phase (minutes) of undisturbed green turtles at Ras Al Hadd, Oman.

Nesting Phase	1	2	3	4	5	6	7	8
N	25	27	24	13	13	13	14	14
Mean	11	24			38	17	70	11
Median			23	51				
Range	7-20	5-130	5-172	15-60	16-55	10-30	42-98	8-15

Table 2. Comparison of exercise-rest cycles for each nesting phase in 4 undisturbed individual green turtles at Ras As Hadd, Oman.

Nesting	Exercise + Rest Interval (seconds)					
Phase	Mean	SE	SD	95% C. I.	F	P
Phase 1	28.91	2.67	13.12	5.54	22.5	<0.01
Phase 2	45.41	6.4	31.12	13.24	0.85	0.47
Phase 3	34.25	2.33	11.46	4.84	0.85	0.47
Phase 4	28.87	5.36	26.27	11.09	1.3	0.28
Phase 5	not tested					
Phase 6	32.45	1.89	9.28	3.92	2.35	0.08
Phase 7	42.16	3.46	16.97	7.16	1.81	0.15
Phase 8	25.66	2.44	11.97	5.05	5.57	<0.01

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NATURAL PREDATION ON EGGS AND HATCHLINGS OF HAWKSBILL TURTLES *ERETMOCHELYS IMBRICATA* ON AL DIMANIYAT ISLANDS, GULF OF OMAN

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INTRODUCTION

The Dimaniyat Islands in the Gulf of Oman, an archipelago of nine uninhabited islands, surrounded by coral reefs, provide good feeding and nesting grounds for hawksbill turtles *Eretmochelys imbricata*. This is probably the densest population of hawksbill on earth for this species, with at least 250 females per year nesting on 1.5 Km of beaches (Salm, 1991; Salm et al., 1993; Mendonça, 1999). Green turtles *Chelonia mydas* also nest on the islands (Salm, 1991).

During the nesting seasons of 1999 and 2000, research was carried out on the Dimaniyat Islands. Predators of turtle eggs and hatchlings on turtle nesting beaches were identified and their abundance estimated. The qualitative impact of predation on the turtle population is also discussed.

METHODS

Crab abundance was based on counts in 10 quadrats of 3 m * 3 m in April and June 1999, at two beaches chosen randomly on D1 island. Impact of crabs on turtle eggs is discussed based on distance between crab hole and tidal mark and turtle nest chamber and tidal mark, as they were obviously placed on different areas of the beach. Impact of crabs on turtle hatchlings is discussed based on crab hole diameter as an index of their size, therefore of their ability to drag hatchlings to their holes.

Birds were identified and their abundance was based on bird nests on 10 quadrats of 5 m * 5 m in transects, and on bird counts (flying, resting and/or feeding) in transects. Impact of birds on turtle hatchlings was discussed based on bird abundance and size of their beaks and their ability to pick their prey.

Qualitative information on the major aquatic predators was also assessed by snorkelling during daylight hours, and by observations from the top of the cliffs, also during daylight hours.

RESULTS AND DISCUSSION

There were no mammal predators on the islands. Many crab and bird species were identified as potential predators of sea turtle eggs and hatchlings on beaches, especially ghost crabs *Ocypode* sp., seabirds (sooty gulls *Larus hemprichii*), and birds of prey (osprey *Pandion haliaetus* and sooty falcons *Falco concolor*). Seabird species such as gulls and terns had their breeding season coincident with turtle hatchling season.

On the largest beaches on D1, D4 and D9 islands, ghost crab holes were in general placed 2 – 4 m above the high springs tidal mark, not at the level where most turtle nests were placed (9 –17 m). Therefore, ghost crabs on these Islands, during the nesting seasons of hawksbill turtles, did not significantly affected hatch success rate, by predating on eggs in the nests, consequently not significantly affecting hatchling emergence rate.

Some of the ghost crabs observed were large enough to drag hatchlings to their holes, as these holes could reach 9.5 cm in diameter. Nevertheless, most crab holes were around 6 cm in diameter, which is still small for large crabs to pass dragging 4 – 5 cm long turtle hatchlings. Therefore the role of crabs in hatchling mortality is not likely to be significant.

Nevertheless, the effect of bird predation on turtle hatchlings can only be significant if hatching takes place in daylight hours or during full-moon nights. And once hatchlings reach the sea, predation by fish, especially by reef sharks *Carcharhinus melanopterus* might be significant. However, supporting data is lacking worldwide (Stancyk, 1995).

Human presence is minimal, but fishing nets left on the beach to dry and repair are a threat for hatchlings, as they may become entangled and either die by desiccation or become more exposed to bird predation.

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OMAN SEA TURTLES MIGRATION ROUTES - EVIDENCE FROM RETURNED TAGS

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INTRODUCTION

Four sea species nest on Oman beaches. These are the loggerhead *Caretta caretta* population on Masirah Island in the Arabian Sea, the green turtle *Chelonia mydas* at Ras Al Hadd Nature Reserve in the Arabian Sea, and the hawksbill turtle *Eretmochelys imbricata* on Al Dimaniyat Islands Nature Reserve in the Gulf of Oman are of global importance. Few olive Ridley *Lepidochelys olivacea* also nest on Masirah Island. Oman coast also provide major nesting grounds for sea turtles.

METHODS

Tagging of turtles on nesting beaches started in the late 1977-78 at Ras Al Hadd and Masirah Island, and in 1999 on the Dimaniyat Islands. Information stored in the long-term database of sea turtles in Oman, under the Ministry of Regional Municipalities and Environment/Nature Conservation permitted to up-date the previous study on migration routes dated from the 1970s (Ross and Barwani, 1982) and 1980s (Ross, 1987; Salm, 1991). No tagging has been carried out on feeding grounds.

RESULTS AND DISCUSSION

Tag returns for loggerheads (from Masirah) and greens (from Ras Al Hadd and Masirah) shows that turtle nesting populations from Oman migrate to foraging areas in the Arabian Gulf (United Arab Emirates, Qatar, and Iran), Gulf of Oman, Arabian Sea (Pakistan, Oman, Yemen, and further south to Suqutra Island and Somalia, and Red Sea (Yemen, Saudi Arabia, and Eritreia). Recently, a green turtle tagged in Oman, was found in the Maldives. However, for hawksbills and olive Ridleys there is no available information to date on their migration routes.

Nevertheless, there remain other unanswered questions regarding the migration of these turtles. Tagging on feeding grounds and telemetry are recommended to be used in the future management of Oman´s turtle species.

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THE ROLE OF THE HATCHERIES IN CONSERVATION OF SEA TURTLE FAUNA OF SRI LANKA

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INTRODUCTION

Out of a total of seven living species of sea turtles in the world, five are reported to nest along the coastal belt of Sri Lanka namely; Loggerhead (*Caretta caretta*), Green turtle (*Chelonia mydas*), Olive Ridley (*Lepidochelys olivacea*), Leatherback (*Dermochelys coriacea*) and Hawksbill turtle (Eretmochylus *imbricata*) (Daraniyagala, 1952).

The collection of turtle eggs is a traditional practice in all the coastal areas of the island. This practice is extensively carried out in the beach between Bentota to Balapitiya (in Galle district) and Rekawa to Bundala (in Hambantota district) areas, where the nesting visits of turtles are being reported regularly.

The history of the sea turtle hatchery practices in Sri Lanka is extended back to 1970s. Some enthusiastic people and non-government organizations began those to prevent the sea turtle eggs from human consumption. Today the turtle hatcheries are a well-established component of the coastal tourist industry.

The concept of the hatchery is not complicated: Hatchery managers buy eggs from turtle egg collectors, rebury the eggs in protected areas of beach where they incubate, hatch and the resulting hatchlings emerge from the nest. This concept reduces the threat of terrestrial predation, both human and animal, to eggs and emerging hatchlings (Richardson,95).

The main objectives of the study were to estimate the number of eggs buried annually by the hatcheries, to identify the positive and negative impacts of the hatcheries and to identify the possible measures to develop the hatcheries as the tool for ex-situ conservation of sea turtles.

METHODS

Eight sea turtle hatcheries in the Galle district and one in the Hambantota district were visited fortnightly from January 1996 to December 2000. The data were collected on the aspects of number of eggs buried, number of hatchlings emerged, number of eggs rotten, number of hatchlings died, number of hatchlings in tanks and their age, and number of hatchling released.

Observation were made on the hatchery practices, such as the collection of eggs, transportation, burying, handling and rearing of hatchlings and releasing them to sea. The measurements were taken on the surface area of the egg burying places, distance from the high tide level to these places, the depth and the diameter of the pits used to rebury the eggs and the distance between adjacent pits. The length, width and the depth of the tanks were also measured. The flapping rates and other behavior of the hatchlings were documented with special attention to their age and species. The number of turtles with wounds and visible infections on the body surface were counted and lenses were used to obtain proper observations.

In order to evaluate the socio-economic impact of these hatcheries, information such as the number of egg suppliers, hatchery staff and their wages, the direct and indirect dependents on these activities, the price of eggs, the price of a entry ticket and monthly income (when it was possible) were documented.

RESULTS AND DISCUSSION

Richerdson (1995) recorded 16 turtle hatcheries from Chilaw to Koggala. This number has been declined into 7 in 1996 (Amarasooriya, Dayaratne, 1996). Presently a total of 9 hatcheries are operating (8 in the Galle district and 1 in the Hambantota district). During the period Aug. 1996 to Dec. 2000 three hatcheries of Galle district were closed and four new hatcheries were opened.

During the study period a total of 882,700 eggs were reburied by these hatcheries. The annual number of eggs buried was increased from about 100,000 in 1996 to about 300,000 in 2000 (Fig. 1).

These results indicate an increasing trend of eggs burying process. This is due to both the increasing number of hatcheries and the good market available for the turtle eggs at these hatcheries.

To rebury the eggs there are enclosed areas at every hatchery. These enclosures have been used for long periods without replacing the sand inside. About 20% of the eggs were spoilt within the pits and the contents of these contaminate with the sand leading to microbial growth. The result of this bad practice could be the reason for the infections observed on the eye, head and the yolk sac of the juveniles.

The average number of egg- pits in 1m2 was 4 and the number of eggs buried in one pit was varied from 40 to 75. The average depth of a pit was 1.5’. These artificial conditions may have direct influence on the incubation temperature and may lead to an unbalance sex ratio among hatchlings.

The estimated average incubation periods inside the hatchery did not show much variation with the natural time frame. The respective incubation periods for Green turtle,d Olive Ridley, Leatherback, Hawksbill and Loggerhead were 50, 51, 60, 55 and 60.

Figure 2 shows the monthly variation pattern of the number of eggs reburied by all the hatcheries. The maximum numbers were reported during January to April. From May to November the numbers are relatively less. Since the period of less number of eggs reburied coincides with the South-west monsoonal period (May - October), it is safer to conclude that the South - west monsoon may have some effect on the nesting behavior of the turtles nested in these areas.

The mean annual number of eggs reburied by these hatcheries was about 180,000 (this is about 33% of the mean annual egg production in these districts). Out of them 52% and 43% were represented by Green and Olive Ridley turtles respectively. The representations of Leatherback, Hawksbill and Loggerhead were 1.5%, 1% and 0.5% respectively.

98% of them was incubated by the hatcheries in the Galle district and 2% by the hatchery in the Hambantota district.

The average hatching percentage was 75% and the mortality rate among rearing hatchlings was 3%. 60% of the hatchlings aged over three days was with pustulated wounds on the body. The estimated rate of predation on eggs was 0.5% per month.

About 35% of newly hatched juveniles in the tanks were with damaged yolk sac. It was observed that, once few hatchlings come out from a pits, the remaining hatchlings, which are yet to come out, were manually removed and sorted into two groups according to the size of the exposed yolk sac. The hatchlings with large yolk sacs (premature ones) were reburied again and others (with small yolk sac) put into the tanks. During this practice the possibility of damaging the delicate outer cover of the exposed yolk sac is high.

Over 75% of the hatchlings inside the tanks were over three days old, and over 50% of the observed hatchlings were with completely or partly healed naval. A systematic releasing was not observed from any of the hatcheries. The releasing of hatchlings back into the sea was observed on two occasions. One was the releasing of hatchlings by the visitors (when outsiders came to visit the place, the hatchery staff sell hatchlings to them for releasing. The price for a hatchling was varied from Rs.50.00 to 100.00 and from place to place). The other occasion was when the hatchling comes in large numbers.

Figure 3 Shows the declining of flapping rates of the hatchlings within five days after birth. This decline may be a indicator of the change of hatchling behavior or the loosing of energy due to the continuos flapping in the rearing tanks.

Five of the hatcheries kept number of sub-adults (20 Green turtles, 16 Hawksbills, 9 Olive-Ridleys and 6 Loggerheads) and juveniles in captivity for display. Owners of the hatcheries give more attention to feed and secure the larger animals and neglect caring for the juveniles. It was observed that the main objective of maintaining these hatcheries, except for two, was to generate income through tourist attraction.

About 35 egg-collectors are reported to have provided eggs for these hatcheries. The mean annual income of the hatcheries was about Rs.27,244,960 (US$340562). These hatcheries have provided direct employment to approximately 175 persons who support over 650 dependants.

The practices in egg collection, transportation, burring, handling and rearing hatchlings and releasing them to sea have considerable negative impacts on the survival of the wild stocks. In order to minimize these impacts a set of hatcheries guidelines were prepared by this study and it emphasize the introduction of a hatchery monitoring system and a license scheme to improve them as a tool of ex-situ conservation.

Fig. 1. Annual variations of the number of eggs buried by the hatcheries.

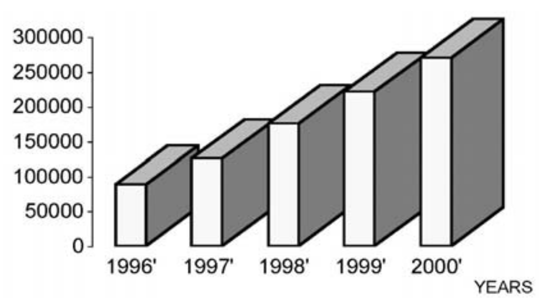

Fig. 2. Monthly variation pattern of the number of eggs reburied by all the hatcheries.

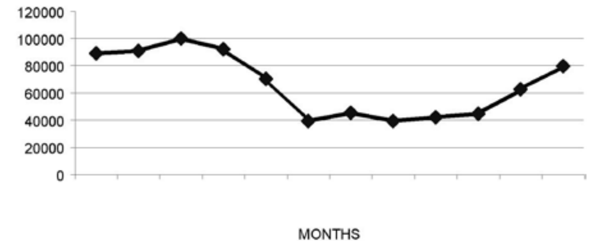

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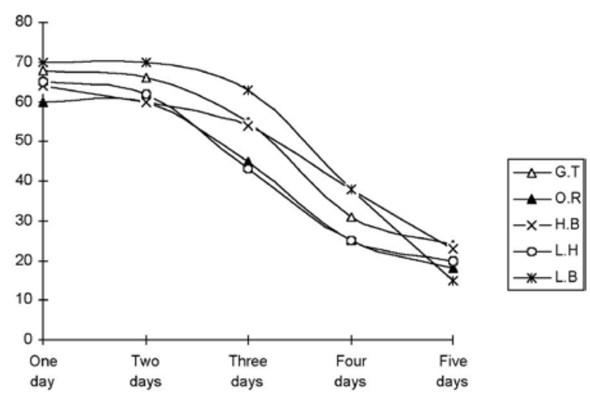
Fig. 3 : Average flapping rate (per minute) fore each species according to age.



FEEDING OF HAWKSBILL TURTLE IN XCARET PARK, QUINTANA ROO, MEXICO

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INTRODUCTION

The hawksbill turtle (*Eretmochelys imbricata*) is a present quelonio in the coral reefs communities of the Mexican Caribean. As particularity of the specie it´s distinguished the nutritious habit based 90% in the consumption of sponges, composed structurally by fibers of collagen and silica spicules, which have protein of animal origin and vegetable due to microfauna and flora that inhabit them, the remaining 10% is based on other ingredients among those algae can be mentioned.

In 1996, arrived at Xcaret Park two broods of hawksbill turtle of which 217 animals were born. They were placed in ponds of 2x3 m. with an open system. For their feeding commercial pellets for marine turtle brand AS with 35% protein were used, in an equivalent quantity to 2% of its weight, distributed in two portions a day. In the first six months 60% of mortality was registered. During the first weeks the main problem was cannibalism and aggressiveness, for what the animals were separated in groups and in some cases the isolation was individual. Later on, serious problems of meteorism were presented ending up in diverse enteritis degrees that were getting complicated with bacterial infections. It was then when we decided to feed the hawksbill turtles with jello for fish elaborated with fish, spirulina algae, beer yeast and cod liver oil, being able this way to diminish the accumulate of gas and the enteritis. From seven to the sixteen months old, the turtles were fed with 100% of jello.

With these results and with the information on the metabolism of reptiles in general, as well as in particularities of the diet of the hawksbill turtle, a jello was designed that was to be but appropriate for these organisms. From the jello used for the feeding of the fish, the quantity of fish was reduced, and the spirulina was eliminated, substituting it for lettuce and spinach. From 16 months old to the date 80% of this jello is provided, with 20% pellets. Distributed in two portions a day in an equivalent quantity to 2% of their weight.

MATERIAL AND METHODS

For the elaboration of the jello a previously established procedure that allows the homogeneous mixture of the different ingredients that conform it, exists already.
The ingredients used to designe the jello were chosen due to their own characteristics. The jello as commonly known is a protein ingredient derived of the collagen of bones and cartilages of different animals. It is used as base to mix with other ingredients that complete the nutritional quality. It is also of high digestibility and with a good percentage of calcium, but it is faulty in vitamins, essential amino acids and fatty acids in general (Noga, 1995; Murai et al , 1987). Basically it is made up of 25% glicina, 8.7% alanina, 18% prolina, 14% hidroxiprolina, 11% of sour glutámico and 23.3% of other amino acids. (Dergal, 1988). One of its most important characteristic is the one of absorbing from 5 to 10 times their own volume in water.

The spinach contains 90.7% of water, 4.3% of total hydrates of carbon, 0.6% of raw fiber, 3.2% of proteins, 1.5% ashy. 0.3% of fat, vitamin A, vitamin C and oxalic acid. (Dergal,1988). The lettuce is rich in vitamins of the complex B, A, C, E and K. The beer yeast is rich in vitamins of the complex B and essential amino acids mainly. The oil of cod liver is rich in vitamin A, D and E but mainly it contributes the essential fatty acids that are lacking in the rest of the ingredients.

RESULTS

As it can be observed in the graphics, there exists two lots of hawksbill turtles that correspond to two different broods. Both lots were fed under the same conditions and at the moment an average size of 66.43 cm and an average weight of 36.635 kg for the lot 5 and an average size of 60.828 cm and an average weight of 26.185 kg for the lot 6 is registered.

When using the jello specially designed for the feeding of the hawksbill turtle, it was possible to solve the problems of the accumulate of gas and the enteritis that was registered during the first six months of life of the turtles.

If the quantity of dry matter of the pellets is compared with the jello, it is that the pellets when presenting a very low humidity contains bigger dry matter. For this reason, it should be taken into account the quantity of water present in the jello when the portions that were used when feeding the turtles are calculated. On the other hand, the jello has turned out to be excellent to mix with medications when it requires to treat the turtles.

DISCUSSION

Still when the results are good, it is necessary to increase the quality of the jello carrying out bromatological studies A.Q.P. (Chemical Analysis Proximal) as much for the jello as for the sponges, of which the hawksbill turtle feeds in free life. It should also be considered to carry out studies of the percentage of digestability of the jello. This way it will be able to carried out a comparison and a balance of the jello that it is used at the moment. All this charges main importance for the fact that the feeding in captivity is one of the main obstacles to carry out the cultivation of the hawksbill turtle.

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THE RELATIONSHIP BETWEEN THE POTENTIAL TUMOR-PROMOTING DINOFLAGELLATES *PROROCENTRUM* SPP. AND GREEN TURTLE FIBROPAPILLOMATOSIS: PRELIMINARY RESULTS OF A COMPARISON BETWEEN HAWAII AND FLORIDA

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The etiology of green turtle (*Chelonia mydas*) fibropapillomatosis (FP) is still unknown, although the cause is circumstantially linked to a virus. Many potential cofactors may play a role in the etiology of this disease. Benthic dinoflagellates, *Prorocentrum* spp., produce the toxin okadaic acid (OA). OA has been demonstrated experimentally to induce papillomas in mice. A preliminary study in the Hawaiian Islands found a positive correlation between the distribution of these potential tumor-promoting dinoflagellates, turtle food substrates (macroalgae and seagrass) with epiphytic *Prorocentrum* spp., presumptive OA in turtle tissues, and FP prevalence.

On a more expansive geographic scale, a study comparing abundance and distribution of *Prorocentrum* spp. at two locales isolated from one another, the Pacific and the Atlantic/Gulf of Mexico region, is ongoing. Eight research sites in the Hawaiian Islands, and four sites around Florida, have been sampled seasonally for the presence and abundance of epiphytic, benthic *Prorocentrum* spp. Previous research has shown that these sites demonstrate a marked FP distribution, with areas having high prevalence of FP, and "control" areas with no FP. Environmental factors that influence *Prorocentrum* abundance are considered, including seasonal variation and substrate preferences.

According to initial results, there is a significant relationship in numbers of *Prorocentrum* cells to FP in Hawaii, but not in Florida. However, *Prorocentrum* spp. are present at all of the Florida research sites. Geographic location and environmental variables are important, as many dinoflagellates are known to vary their toxin production depending upon their distribution. We recognize that there are a number of variables in toxin production, and hence the exposure of green turtles to varying concentrations of OA. But confirmation of the presence of *Prorocentrum* species known to produce OA in areas of FP is important. In this study we clarified that in two major areas in the U.S. where FP is highly prevalent, *Prorocentrum*, a known tumor-promoter, is a common risk factor.

CONSERVATION OF *CARETTA CARETTA* IN SOUTHEAST MADAGASCAR

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Caretta caretta nests on the southeast coast of Madagascar, north and south of the main town Fort Dauphin (Tolagnaro), in the region inhabited by the Antanosy people. Over the past five years, Malagasy researchers have been visiting the area during the nesting season (November – January) to determine the conservation status of the nesting population and investigate the importance of turtles in the local economy.

Gathering turtle eggs and capturing occasional nesting turtles to be shared or sold locally helps the Antanosy through the seasonal closure of their lobster fisheries (December – April). Unlike the Vezo people of southwest Madagascar, the Antanosy do not consider themselves specialist turtle hunters. In recent years, young Vezo men have sailed to the southeast to fish Antanosy waters for turtle and shark. Local people have noticed a decline in nesting frequency over the last 15 years, and the Vezo immigrants confirm that capture rates have declined since they first arrived six years ago.

Future plans for marine turtle conservation in the region include working with local communities to develop alternative economic strategies to direct utilisation of marine turtles; establishing a beach monitoring strategy to follow trends in nesting frequency; and carrying out tagging and genetic sampling to identify migratory routes and thus assess threats to the population away from nesting region. Data collected will be used to provide recommendations to local marine resource management committees wishing to minimise threats to nesting beaches and coastal waters resulting from development of mineral extraction and/or tourism in the area.

We thank the David and Lucile Packard Foundation and the Sea Turtle Symposium for travel support.

DESCRIPTION OF THE EASTERN PACIFIC HIGH-SEAS LONGLINE AND COASTAL GILLNET SWORDFISH FISHERIES OF SOUTH AMERICA, INCLUDING SEA TURTLE INTERACTIONS, AND MANAGEMENT RECOMMENDATIONS

Randall Arauz

Sea Turtle Restoration Project, 1203-1100, Tibás, San José COSTA RICA

Incidental capture and death of sea turtles during industrial fishery operations is now a global concern. A current issue being addressed is the capture and mortality of sea turtles by high-seas driftnet and longline fisheries, which target swordfish in the North Atlantic, the North Pacific and the South Eastern Pacific, but including other billfish, shark, tuna and maji maji in the Central Eastern Pacific. Attention has only recently been drawn upon the coastal gillnet and high seas longline fisheries of the South Eastern Pacific, due to the drastic decline of the Eastern Pacific Leatherback. The effect of these fisheries on the Eastern Pacific leatherback population is unknown. This report describes the pelagic long line and gill net fisheries of the countries that target the South Eastern Pacific swordfish (either as a main or secondary target) and their interactions with sea turtles based on interviews with local fishermen and fishery officials, and offers recommendations on conservation strategies.

TEDS IN CENTRAL AMERICA, AN EVALUATION OF PUBLIC LAW 101-162

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Public Law 101-162 Section 609, provides that The importation of shrimp or products from shrimp which have been harvested with commercial fishing technology which may affect adversely such species of sea turtles shall be prohibited unless the President certifies to the US Congress by 1 May of each year, that any nation which intends to export shrimp to the USA conforms with certain conditions. An evaluation of shrimp/prawn fishing and sea turtle conservation programs in each exporting country is carried out by the US Department of State in conjunction with the National Marine Fisheries Service (US Department of Commerce), and with few exceptions certification requires that shrimpers from other nations use Trawling Efficiency Devices (also known as Turtle Excluder Devices or TEDs). However, does the certification process carried out by the US government really encourage better sea turtle conservation programs in the certified nations? Do those nations certified by the US government routinely have better sea turtle conservation programs than those that do not? A visit was carried out to each Central American nation in late 1999 to answer these questions, and follow up was given into the 2000 certification process. Fishery, environmental and military officers of each country were interviewed, as well as fishery industry representatives and crew members. Personal informal inspections were performed when allowed during dock visits, and information was gathered on turtle strandings. US Embassy officers responsible for the certification process were also interviewed.

MORPHOMETRIC MEASUREMENTS AND SEX OF TRAWL-CAUGHT SEA TURTLES FROM THE SOUTHEAST COAST, USA

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OVERVIEW AND METHODS

Beginning in summer 2000, an in-water survey of sea turtle health and abundance in coastal waters of the South Carolina, Georgia and northern Florida was initiated. Between 25 May 2000 and 17 August 2000, 253 sea turtles were collected. Of these sea turtles, 7 escaped and 246 (218 *Caretta caretta*, 25 *Lepidochelys kempii*, and 3 *Chelonia mydas*) were processed and released. Processing of sea turtles included collecting blood samples, taking a series of morphometric measurements, and tagging. Blood chemistry analysis and an overview of year one sampling are presented elsewhere (See Segars et al. and Stender et al. herein). In this paper, we present morphometric measurements for live, non-stranded *Caretta caretta* and *Lepidochelys kempii*.

Nine different size measurements (Carapace length (notch-notch, notch-tip)), carapace width, head width, tail length (plastron-tip), and body depth) were recorded for each sea turtle in this study. Measurements were selected based on standard use in morphometric studies with sea turtles. Straight and curved measurements were recorded for carapace length (notch-notch and notch-tip) and carapace width. Straight measurements (carapace length, carapace width, head-width and body depth) were made using a 1m stainless-steel caliper device. Curved measurements of carapace length, carapace width and tail length were made using a nylon tape measure. Because straight and curved measurements are used equally, we provide equations for conversion from straight to curved measurements for *Caretta caretta* and *Lepidochelys kempii*.

Body weight was also recorded. Length-weight relationships provide insight into growth rates, but are rarely recorded for sea turtles because of the impracticality of weighing stranded turtles on beaches or small boats. For this study, body weight (kg) was measured with hanging scales using a nylon rope harness. Length-weight equations for *Caretta caretta* and *Lepidochelys kempii* were computed separately using SigmaStat and SPSS.

Precision of measurements was recorded for a sub-set of turtles. Two different sets of measurements were recorded for 18 *Caretta caretta* and 2 *Lepidochelys kempii* to determine the percent error associated with each morphometric measurement. After the first set of measurements was recorded, the entire measurement sequence was repeated by another person who was unaware of the results of the first set of measurements.

A testosterone radioimmunoassay was used to determine testosterone levels in blood plasma samples, which were processed and stored in liquid Nitrogen within 30 minutes of initial collection aboard research vessels. Sex was predicted based on the following testerone levels: 0-20 picograms/ml (female), 20-30 picograms/ml (unknown) and > 30 picograms/ml (male).

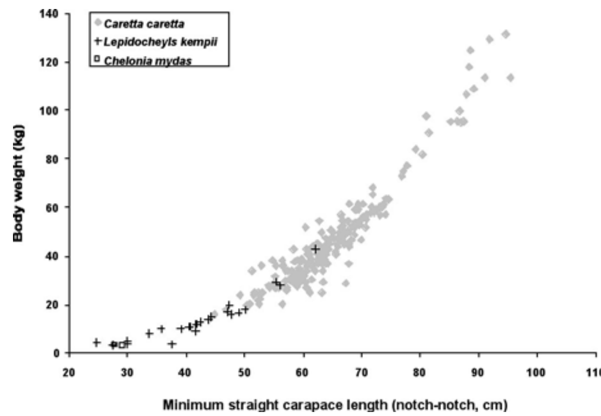
RESULTS

Curved measurements of carapace length and carapace width generally exceeded straight-line measurements (Table1) and both types of measurements were precise (Table 2). For these dimensions, curved measurements exceeded straight-line measurements. Conversions between straight and curved measurements are provided in Table 3. With the exception of Bjorndal and Bolten (1989), who computed conversions between straight and curved carapace length for *Chelonia mydas* sea turtles in the Bahamas, we know of no other studies for which such conversions exist.

Precision of head width, tail length, and body depth measurements was moderately (2-6%) variable (Table 2). Tail length was useful for distinguishing male and female *Caretta caretta* ? 90 cm SCL (notch-notch).

Although size ranges rarely overlapped, length-weight relationships for *Caretta caretta*, Lepidocheyls kempi, and *Chelonia mydas* appeared to be similar (Figure 1). No apparent sex differences in length-weight relationships were detected for *Caretta caretta* or *Lepidochelys kempii*; thus, separate regression equations were not computed for different sexes. Length-weight equations [wt = 0.0307(L)2 - 2.0462(L) + 47.8674 (r^2=0.934, p<0.001)] for *Caretta caretta* and [wt = 0.0290(L)2 -1.5339(L) + 24.8518 (r^2=0.961, p<0.001)] for *Lepidochelys kempii*. Length-weight relationships using exponential equations have been previously documented (Coles 1999).

Female sea turtles were more frequently encountered than male sea turtles. Sex ratios for *Caretta caretta* < 70 cm SCL (nn) and *Lepidochelys kempii* <50 cm SCL (nn) were biased toward females at approximately 2:1 and 3:1 ratios, respectively; however, sex ratios for *Caretta caretta* 70 cm SCL (nn) and *Lepidochelys kempii* 50 cm SCL (nn) were 1:1 (Figure 2). Similar bias towards female sub-adult *Caretta caretta* at the 2:1 ratio is reported from Florida (Wibbles et al. 1991).



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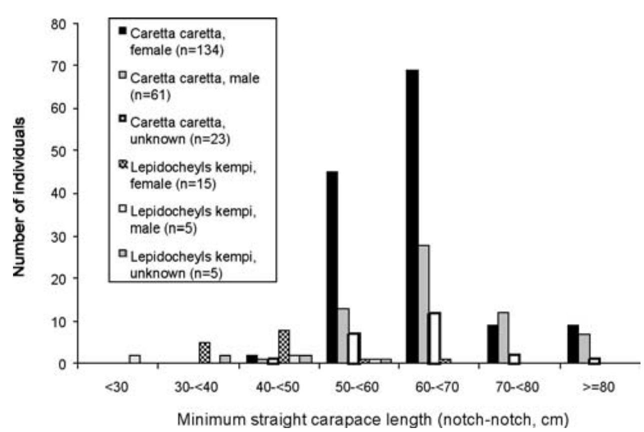

HAEMATOLOGICAL PROFILES OF THE GREEN SEA TURTLE IN QUEENSLAND, AUSTRALIA.

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This study set out to develop a method of monitoring health of turtle populations using haematological profiles and to establish baseline data for two feeding ground populations of green sea turtles, *Chelonia mydas*, in Queensland, Australia. Blood samples were collected from immature, pubescent and adult turtles from Moreton and Shoalwater Bays. The cellular constituents of the peripheral blood were identified, described and the abundance of each cell type quantified. In addition, packed cell volumes and blood biochemical profiles were determined for each turtle. Significant variation in leukocyte abundance, packed cell volume, triglyceride, lactate and glucose plasma concentrations were observed between turtles from the two populations. No significant correlation was observed between haematological parameters and the age class, curved carapace length or sex of the animal. These results suggest that the monitoring of marine turtle populations would be enhanced by the inclusion of haematological assessments. This study provides the first comprehensive haematological analysis for *C. mydas* in the southern Great Barrier Reef and establishes normal reference values for wild populations of *C. mydas* during winter in these feeding areas.

AN UPDATE OF SEA TURTLE NESTING ALONG THE ANDAMAN COAST OF THAILAND, 1996 – 2000

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Five species of marine turtles have been recorded in Thailand : green turtle (*Chelonia mydas*), olive ridley turtle (*Lepidochelys olivacea*), leatherback turtle (*Dermochelys coriacea*), hawksbill turtle (Erethmochelys *imbricata*) and loggerhead turtle (*Caretta caretta*) (Phasuk and Rongmuangsart, 1973).

Three main nesting grounds of olive ridley, leatherback and green turtle are found along the Andaman Sea coast: Phra Thong island, Thaimuang beach in the Phang Nga province and Phuket island in the Phuket province. Data concerning nesting activities was collected by different programmes, which might provide an underestimated result. Minor nesting beaches with low number of nests and not laid every year are also found in the area but they are not included in this review. Nesting season along the coast is from October to February for olive ridley and leatherback, with rare olive ridley nesting activity in September and March, whereas green turtle nest from March to July.

Despite sea turtles have been protected by National law since 1975 (Fisheries Act, B.E. 2490), they have been exploited. Historical data showed a massive sea turtle eggs harvest which is estimated to be about 400,000 eggs per year in Thailand, of which 60,000 from the Phang Nga province (Polunin, 1975). Regulations for egg harvesting have been applied along nesting beaches in order to control egg poaching activities. The sea turtle nesting beaches were in fact declared concession areas by the Thai Government and licences were given to collect turtle eggs to local people who were required to release hatchlings equivalent to 20% of the egg collected (Chantrapornsyl, 1992). As a result of long-term excessive egg harvest stocks of olive ridley and leatherback turtle in the Andaman Sea of Thailand have been decimated to only tens of females nesting annually (Limpus, 1995). Data concerning sea turtle nesting activities showed a drastic decline (90%) of sea turtle nests in the Andaman coast from 1985 (N=360) to 1995 (N=36) (Chantrapornsyl, 1997) Fig.1. Then, from 1997 to 2000 the low number of nests was confirmed with a total of 32, 21 and 21 in the three nesting sites respectively (Table 1).

PHRA THONG ISLAND is one of three relatively large islands located just off the coast of Phang Nga province. Fine sand beaches (total length 15 km) are found on the West Coast . Three fishermen villages are located on the island and a tourist resort.

Data concerning Phra Thong island was collected from 1979 to 1990 from the Phuket Marine Biological Centre (PMBC) and from 1996 to 2000 on a daily basis during nesting season by sea turtle project run by PMBC and CHELON (Italy). A reduction of 82% of olive ridley laid nests was recorded between 1979 (N = 238) and 1990 (N = 42) (Chantrapornsyl, 1992). Considering the number of nests per season recorded in 1990 (N=42) and the nests found (N=3-8) during 1996-2000, a decrease of 83% is estimated.

The yearly decrease of numbers of nests from the decade, 1979-1990 and the low number of olive ridley nests found in the last 4 years at Phra Thong island could be consequence of the excessive egg harvesting began long time ago and documented only in the last 20 years . In addition, to egg harvesting the consumption of turtle meat, the hunting of turtles to use the shells, etc., has also contributed to the actual result. The low number of olive ridley nests at Phra Thong island could indicate the beginning of the species extinction in the area.

The sea turtle conservation programme started in 1996 in Phra Thong island is managing the nesting site. In addition to a complete evaluation of turtle nesting activities, the programme includes an educational section conducted in the local schools of the island which gave an important contribution to the local community making them aware of sea turtle conservation and a collaboration with villagers started non c'e' spazio!. As a result the egg poaching activity on the most attacked species (*Lepidochelys olivacea*) decreased from 50 % in 1996 to 0% in 2000. Even if one of the main threats can be considered eliminated, the intense illegal fishing activities near nesting beaches during breeding season and plan of tourism development are threating the survival of the small nesting population. A long term education programme for fishermen and lobbying activities to limit the tourism development are needed.

PHUKET ISLAND has only one sea turtle nesting area which is located along the west coast of the island. It is called Maikhaw beach and it is 10 km long. The beach was patrolled, protected and managed by a national NGOs and local villagers in collaboration with a National Park. Data, also in this case was not collected on a daily basis and was obtained by NGOs' volunteers. At Phuket island a decrease of 95% was recorded from 1981 to 1999. The island massive tourism development brought about the loss of many nesting beaches. In addition, egg poaching, development of prawn hatcheries and fishing activities are a still a sea turtle threat (Chantrapornsyl, 1997).

THAIMUANG BEACH is located along the coast south from Phra Thong island. The beach is about 20 km long. It is now partly included in a National Park (Department of Forestry) and many people live nearby the nesting beach. Nesting areas were patrolled by the National Park authority and data was obtained by their national office, but was not collected on a daily basis.

The number of nests decreased of 95% from more than 300 nests in 1981 to less than 10 nests in 1999. The part of the beach included in a National Park is now protected but the other part which is close to a village still has egg poaching as the main threat. In addition, fishing activities and prawn hatcheries located near the beach provide light pollution (Chantrapornsyl, 1997).

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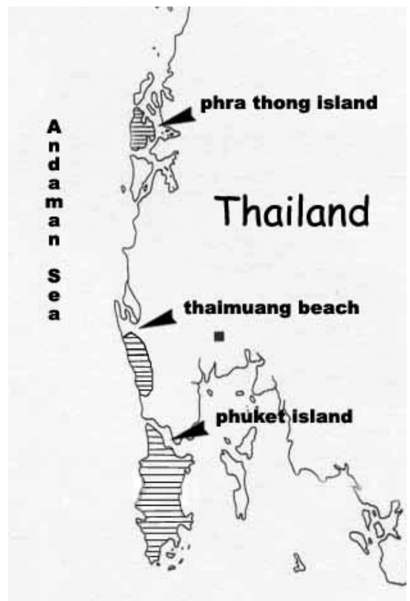

Figure 1. Sea turtle nests found along the Andaman coast of Thailand.

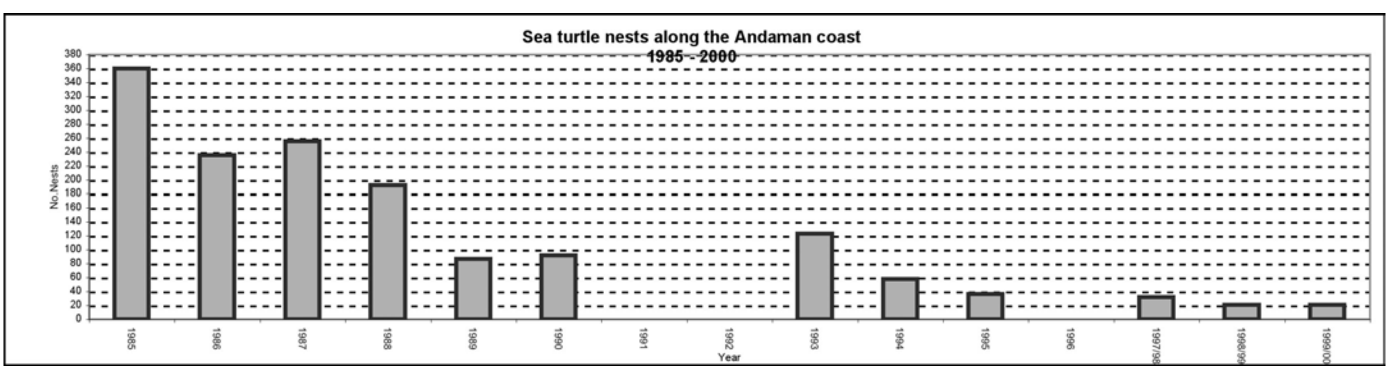

Table 1. Nesting activity and season of sea turtle along the Andaman coast of Thailand.

Season	1997-98	1998-99	1999-00	1997-98	1998-99	1999-00	1997-98	1998-99	1999-00
Location	PT	P	T	PT	P	T	PT	P	T
Lepidochelys olivacea									
No. nests	3	1		8	1	2	7	1	
Egg laying period	D/Ja	M		D/F	F	?	D/Ja	S	
Dermochelys coriacea									
No. nests	9	14	5	5		2		8	2
Egg laying period	D/Ja	O/Ja	D/F	D/F		?		N/Ja	
Chelonia mydas									
No. nests					3		3		
Egg laying period					Ma/Jl		M/A		
Total No. nests	12	15	5	13	4	4	10	9	2
Total No. nests Andaman coas	32			21			21		

Tab. 1. Nesting activity and season of sea turtle along the Andaman coast of Thailand.

PT = Phra Thong island; P = Phuket island; T = Thaimuang beach; Ja = January; F = February; M = March; A = April;
Ma = May; Jl = July; S = September; O = October; N = November; D = December;

SEASONAL CHANGES IN THE ORIENTATION OF JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) FROM CORE SOUND, NC, USA

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After recruiting to feeding grounds in sub-tropical to temperate inshore waters along the east coast of the US, juvenile loggerheads exhibit a seasonal cycle of behavior. Results of mark-recapture studies suggest that the turtles take up residence in localized foraging areas during warmer months, returning to them both within and between years even after being displaced. In the fall, when water temperatures drop, the turtles leave inshore waters. Evidence yielded by satellite telemetry suggests that some juvenile loggerheads migrate to warmer waters to the south, remaining there until it is time to make the return migration.

Recent behavioral research has shown that juvenile loggerheads will manifest this seasonal change in orientation under controlled conditions. From 1998-2000, loggerheads captured in pound nets in the inshore waters of North Carolina between May and November were displaced from their capture locations and allowed to swim in a circular, water-filled orientation arena. Turtles tested from May-September oriented to the northeast, a direction which corresponded closely with the most direct path back to the capture location, supporting the hypothesis that juvenile loggerheads exhibit homing behavior. Conversely, loggerheads tested in the arena during October and November oriented southward, a direction consistent with the orientation of juvenile loggerheads migrating in the wild. The results of this study suggest that the orientation of juvenile loggerheads in captive conditions accurately reflects their natural behavior, setting the stage for further research to investigate the factors guiding their orientation.

YEAR 2000 NESTING OF A CAPTIVE-REARED HAWAIIAN GREEN TURTLE TAGGED AND RELEASED AS A YEARLING

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THE AMAZING STORY OF 5690 - First Known Nesting of a Headstarted Green Turtle: During September of 1980, 235 newly emerged and vigorous hatchling green turtles (*Chelonia mydas*) were collected at French Frigate Shoals in the northwestern segment of the Hawaiian Archipelago (Figure 1). Located at 24°N, 166°W, this remote site hosts the principal breeding colony for the discrete population of green turtles inhabiting the 1500 mile long Hawaiian chain (Balazs, 1976, 1980; Bowen et al., 1992; Niethammer et al., 1997). Within a few days of capture, the hatchlings were flown by chartered aircraft 500 miles to Honolulu for an experiment to evaluate the use of "living tags" as a permanent and safe means of identification. Living tags on hatchlings involve tiny grafts of contrasting pigmented tissues, exchanged between the carapace and plastron, that will hopefully grow with the animal and be visible for life. The originators of this novel idea for sea turtles, Lupe and John Hendrickson, conducted the pioneering living tag research in Hawaii under contract to the Honolulu Laboratory of the National Marine Fisheries Service (Hendrickson and Hendrickson, 1980). The hatchlings were subsequently reared for 12 months in seawater tanks on a diet of squid and fish under contract to a commercial oceanarium, Sea Life Park on Oahu. At the conclusion of the evaluation period there were 175 or 75% surviving yearling turtles. The mortality that occurred in captivity was not statistically related to the graft tests when compared to a control group of non-grafted hatchlings incorporated into the study. Overall, about 80% of the turtles grafted resulted in a living tag that was recognizable at the end of one year.

During August and September 1981 the turtles were weighed, measured, determined to be in good health, and tagged with a single Inconel alloy 681C tag (Balazs, 1999) applied through a proximal scale on the trailing edge of a front flipper. The turtles were released at several coastal locations on the islands of Oahu, Kauai, Maui, and Hawaii. In addition, 10 of the turtles were returned for release at French Frigate Shoals. The 25 turtles taken to the island of Hawaii by U.S. Coast Guard aircraft were released by Balazs on September 11, 1981 at the Richardson Ocean Center, Hilo Bay (Fig. 1). One of these turtles had the flipper tag 5690, but no living tag. This turtle weighed 2.7 kg and measured 22.0 cm in straight carapace length.

Nineteen years later, during the summer of 2000, turtle 5690 was identified by a confirmed tag resighting while nesting on Maui, about 125 miles from the release site of Hilo Bay. Three of the turtle's four known nestings were clustered at a location in West Maui next to the Lahaina Shores Beach Resort (Fig. 2). These nestings took place on August 7, 23 and September 9, 2000. Another nesting, presumably 5690's first for the season, occurred on July 17, 2000 at Kihei, Maui, about 15 miles east of the Lahaina location. The nest at Kihei contained 94 eggs, of which only 14% resulted in hatchlings, possibly due to very dry sand conditions. The three nests at Lahaina contained 76, 76 and 88 eggs, respectively, of which 63%, 57% and 55% resulted in live hatchlings. All nests were left in place and estimates of success were calculated from the excavation of clutch remains after natural incubation, hatching and emergence. Tag 5690 was read on August 23 by co-author Mary Jane Grady and verified by another beach observer. The tag was clean, legible and securely attached to the flipper. The turtle was described as large, maybe 200 lbs., and healthy looking with no tumors. Assuming 5690 had a carapace length of 85-90 cm, she would have grown a robust 3.3 cm/year or more during her 19-year life in the wild. This estimated rate of growth generally exceeds that of naturally occurring green turtles tagged and recaptured throughout the Hawaiian Islands (see Balazs et al., 1998, In press).

A few hawksbills (*Eretmochelys imbricata*) have been recorded nesting on Maui during recent years (Mangel et al. 2000). However, similar documentations of nesting on this island are not known for green turtles. The year 2000 nestings on Maui by 5690 may be the first for this species in modern times. In June 1981, the following statement appeared in a report outlining the anticipated ocean release of the 175 green turtles (Balazs, 1981):

"No turtle from a headstarting project has as yet been recovered as an adult, but this may be due in part to the loss of identification tags placed on the turtles at the time of release. The recovery of such a turtle as a breeding adult will be an encouraging sign. However, in order to be considered a valid and proven conservation technique, headstarting must (in the author's view) be shown to 1) result in the recruitment of adults to an established breeding colony at a significantly higher rate than would occur under natural conditions or in the absence of head starting, or 2) create a new breeding colony without significantly reducing the established colony where hatchlings were originally obtained for headstarting."

Confirmed nesting during coming years of other headstarted green turtles in the Hawaiian Islands, and additional nestings by 5690, will provide further insight into the potential value of headstarting as a means to establish new nesting sites. It should be noted that the amazing part of this story is not that a headstarted green turtle successfully nested in the wild. There's no reason to believe one wouldn't, if it survived to grow to maturity and eventually mated. What is amazing is that a single flipper tag applied to such a small turtle stayed on for so many years making it possible for the success of 5690 to become known.

Acknowledgements:

We appreciate the contributions and assistance of Hannah Bernard, Imme Brueshaber, Claire Cappelle, Peter Dutton, Shandell Eames, Ted Grupenhoff, Cindy Hylkema, Matthew Johnson, Robin LeRoux, Amy Miller, Shawn K. K. Murakawa, Joylynn Oliveira, Denise M. Parker, Steve Williams, the U.S. Coast Guard, the U.S. Fish and Wildlife Service (caretakers of French Frigate Shoals a component of the Hawaiian Islands National Wildlife Refuge), and the numerous individuals that were involved in the release of the yearlings.

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Figure 1. Hawaiian Islands showing, from left to right: the green turtle nesting colony where hatchlings including 5690 were collected in 1980; Maui where 5690 nested in the summer of 2000; and Hilo Bay, Hawaii, where 5690 was released in 1981 as a 22cm yearling.

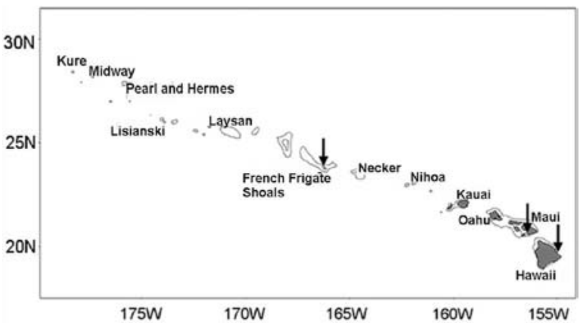

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Figure 2. Location on Maui near the Lahaina Shores Beach Resort where 5690 successfully nested on August 7, 23 and September 9, 2000.

GREEN TURTLE FORAGING AND RESTING HABITATS AT MIDWAY ATOLL: SIGNIFICANT FINDINGS OVER 25 YEARS, 1975-2000

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A PINNACLE IN PELAGIC SEAS - In 1975 a unique research partnership was formed with the Koral Kings Dive Club at the Midway Naval Air Station. The goal of this union was to learn more about the sea turtles commonly seen at this tiny remote Pacific atoll (28°N, 177°W) at the northwestern end of the Hawaiian Archipelago (Apple and Swedberg, 1979; Rauzon, 2001). No nesting or terrestrial basking occurred at Midway in the 1970's, and all turtles encountered were green turtles (*Chelonia mydas*), nearly all of which were juveniles (Balazs, 1982a). During periodic visits by Balazs, Koral Kings' members were shown how to safely hand-capture turtles to measure, flipper tag and release them during recreational snorkeling and scuba diving. Important turtle resting habitats were found within the sheltered man-made Inner Harbor and underneath the large Cargo and Fuel Piers at Sand Island (Fig. 1 & 2). At nearby Eastern Island turtles frequented the shallow southern reef flat, but elsewhere within the atoll sightings were not common.

By 1979, as reported that year at the World Conference on Sea Turtle Conservation (Balazs, 1982b), eight juvenile turtles tagged and recaptured at Midway after 0.5-3.0 years were found to exhibit the astonishingly slow growth rate of 1.1 cm/year in straight carapace length (SCL). The high level of predation on juvenile turtles by tiger sharks at Midway caused one to wonder if year-class survival was sufficient, given such slow growth, for any turtles to reach adulthood. By the early 1980's the Navy's personnel and presence had diminished significantly at the historic World War II battle site of Midway. Clean-up activities were initiated to mitigate decades of military use. In 1988, National Wildlife Refuge status was achieved with the Navy's transfer of the atoll to the U.S. Fish and Wildlife Service. In collaboration with Midway Phoenix Corporation, limited ecotourism presently allows public viewing of the atoll's magnificent nesting seabird colonies and other special resources .

During the 1990's new partnerships were formed to resume sea turtle research at Midway, as shown by the authorship affiliations of this paper. Important and exciting discoveries have resulted from this renewed effort founded upon the pioneering work of the 1970's. The conservation status of the turtles at Midway has markedly improved, as demonstrated by the current size-class composition of 40% subadults/adults, in contrast to only 3% in the 1970's (Fig. 3). Resident adult females have been recorded migrating to, and returning from, the Hawaiian green turtle nesting colony at French

Frigate Shoals (see Balazs, 1980; Bowen et al., 1992). The slow growth rates of juveniles at Midway have now been confirmed by additional data that include a 22-year Inconel flipper tag recovery (0.5 cm/year SCL, Fig. 4). However, in contrast, a large subadult recently recovered after a 21-month interval displayed a growth spurt of 5.3 cm SCL (2.8 cm/year). Also of considerable significance is the finding that the Inner Harbor, piers, iron seawalls and related artificial elements at Midway continue to be preferred foraging and resting habitats for turtles (see Rice and Balazs, 2000). Other significant findings of recent work at Midway are briefly presented as follows:

– Basking ashore by juvenile, subadult and adult turtles is now a common occurrence.
– Juvenile turtles regularly feed on algae such as Spyridia filamentosa and Centroceras clavulatum growing on the iron seawalls. The turtles also feed on wind-driven pelagic invertebrates that accumulate along the seawalls, including gooseneck barnacles attached to synthetic floating debris.
– A small seagrass foraging pasture of *Halophila* hawaiiana occurs inside the atoll adjacent to the Cargo Pier and principal basking beach. Foraging on Codium cuneatum by subadults and adults takes place outside the atoll along the southern side.
– A time-depth recorder and sonic tag placed on an adult male revealed long periods of resting at depths of 20-25 ft., probably under the Fuel and Cargo Piers. Average dives lasted 67 min (range 17-120 min) representing 82% of each day. Seawater temperature during 1998-99 ranged from 19-27°C.
– Fibropapilloma tumors have been observed on several turtles during the 1990's, but none were seen during the 1970's.
– Turtles routinely travel between the Inner Harbor and foraging, basking and underwater resting habitats less than a mile away on the north side of Sand Island (Fig. 1). The turtles swim close to the seawalls and shoreline during this short transit, making them highly visible to tourists and readily available for observational research.

Figure 1. Sand Island showing, from left to right, the locations of: deep-water foraging zone of Codium cuniatum used mainly by adult/subadult turtles; Inner Harbor with seawall foraging and underwater resting habitats; Cargo and Fuel Pier underwater resting habitats, adjacent *Halophila* foraging area and "Turtle Beach" used for basking; and the southern reef flat of Eastern Island.

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We express our sincere appreciation to the numerous individuals and organizations that have contributed to this work since 1975. Special thanks are given to Linda and Gary Means, Jim Bradley, Curt Haney, Mac MacFarland, Anja Schiller, Noriel Tabo, Ron Anglin, Ken Niethammer, Bruce Casler, Suzanne Canja, Cynthia Vanderlip, Wayne Sentman, Dennis Russell, Peter Dutton, Thierry Work, Skip Naftel, Roy Harrington, Arjun Clary, George Watson, and Hawaii Preparatory Academy students John Alexander, Dylan Boyle, Kelly Davis, Kalia Goo, Katie Harrington, Joshua Johansen, Jill Quaintance, Kenneth Shimo, and Candace Sullivan.

Figure 2. North side of Sand Island showing Midway's lagoon and, from left to right: the Fuel and Cargo Piers where turtles sleep underwater; the *Halophila* hawaiiana seagrass pasture; the concrete seawall where drifting pelagic invertebrates collect and are eaten by turtles; and "Turtle Beach" where basking takes place.

Figure 3. Comparison of size-class composition of green turtles at Midway, 1970's and 1990's.

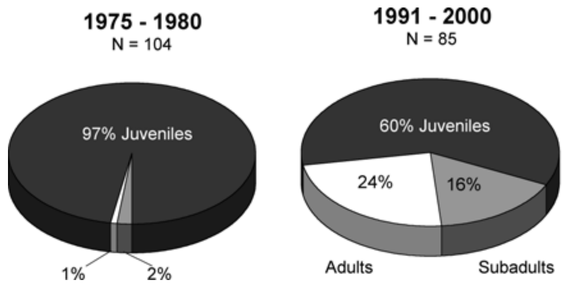
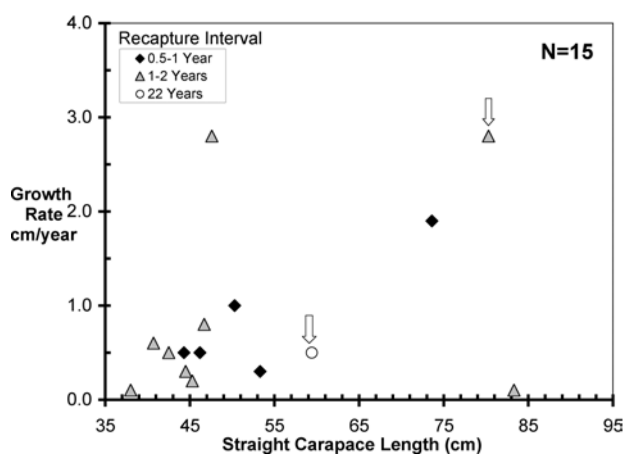


Figure 4. Growth rates of green turtles at Midway determined during the 1990's. Arrows point to the 22-year tag recovery and the large subadult with the growth spurt of 2.8 cm/year.



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THE SIZE OF THE LOGGERHEAD NESTING FEMALES IN THE CAPE VERDE ISLANDS

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INTRODUCTION

The recently discovered nesting colony of *Caretta caretta* at the island of Boavista (Cape Verde Islands, West Africa, FIGURE 1) is being subject of research since 1998. A total number of 1,391 different females have been tagged during the 1998, 1999 and 2000 nesting seasons. Although more data are needed, these islands may represent one of the most important populations for the species in the North Atlantic (Brongersma, 1982; Ross, 1995; López-Jurado & Andreu, 1998).

The present study shows a comparative analysis between the morphometric data collected at Boavista during the last 2000 nesting season and those recorded in the 1998 and 1999 seasons. These data have also been contrasted with those from other loggerhead nesting populations around the world for possible differences.

MATERIAL AND METHODS

During the 2000 nesting season, night surveys were conducted along 17 km of beaches on the southeastern coast of Boavista searching for nesting loggerheads. Once the egg-laying process concluded, the females were tagged and their body measurements were taken before release. The morphometric data (in cm) presented in this study are as follows: curved carapace length (CCL), curved carapace width (CCW), straight carapace length (SCL), straight carapace width (SCW), pileus length (PL), and pileus width (PW). A few turtles were also weighed (W).

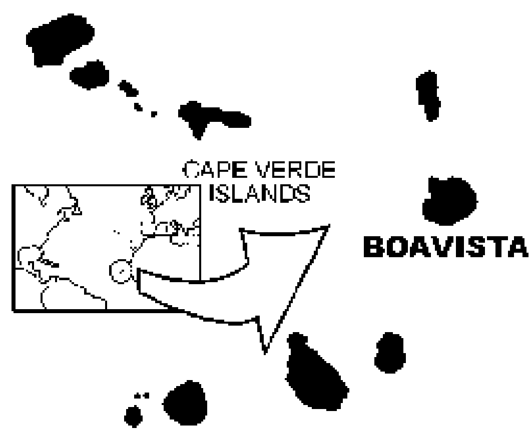
RESULTS

Morphometric and weight data of female loggerheads from Boavista are shown on TABLE I and TABLE II presents body size (curve and straight carapace length) from other nesting loggerhead populations of the world.

The global number of females emerging from the sea recorded in the 2000 season was 1,487. Although the number of emergences in the 1998 and the 1999 seasons was lower (143 and 998 emergences respectively).

The size of the female loggerheads at Boavista does not seem to vary as nesting season progresses and there is not a significant correlation between the curve carapace length and the time of the season either (ANOVA: $F_{1,941}=1.348$, $r^2=0.001$, $p=0.24$, FIGURE 2).

Figure 1. Map showing Cape Verde Islands, and the position of Boavista.



DISCUSSION

As we can see in TABLE I, nesting females at Boavista are relatively small. Only some loggerhead colonies in the eastern Mediterranean, such as in Turkey (Erk'akan, 1993), Cyprus (Broderick & Godley, 1996), and Greece (Margaritoulis, 1982), show a similar or smaller body size (TABLE II). In fact, this population has the smallest mean body size of the Atlantic.

The potential effect of an historical high level of human depredation on the size of nesting loggerheads at Boavista could be one of the possible explanations. Nonetheless, there are not still enough data to support this hypothesis. Otherwise, we may not discard that, the relative small body size in Mediterranean Sea and it's high fisheries incidence in *C. Caretta*, may has a parallelism with the situation in Cape Verde islands, where for at least 500 years human predation of this species (due to its meat) was so high. On the other hand, as mentioned before, female body size does not decrease as nesting season progresses. Some authors reported that larger females nest earlier in the season (Ehrhart & Witherington, 1987), but this fact has not been proved in our study.

Figure 2. Mean body size of loggerhead nesting females along the 2000 season.

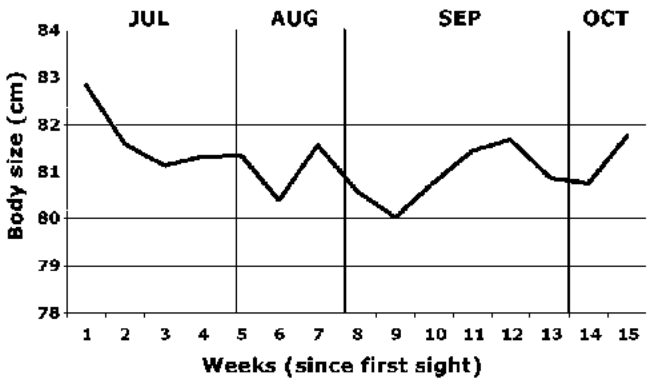


Table 1. Morphometric and weight data of loggerhead nesting females at boavista.

		CCL (cm)	SCL (cm)	Source
Florida (USA)	Mean (cm)	98.9	93.9	Witherington (1986)
	Range	87.9-108.9	82.5-104.4	
	N	119	114	
South Carolina (USA)	Mean (cm)		92.7	Caldwell (1959)
	Range		84.5-102.9	
	N		18	
Masirah Island (Oman)	Mean (cm)		92	Ross (1979)
	Range		79.0-101.0	
	N		–	
Australia (Queensland)	Mean (cm)	95.8		Limpus (1985)
	Range	80.0-113.5		
	N	2,207		
Tongaland (South Africa)	Mean (cm)	93.7	87.6	Hughes (1975)
	Range	82.0-106.5	76.0-98.0	
	N	254	320	
Colombia	Mean (cm)		87.9	Kaufmann (1975)
	Range		70.0-100.0	
	N		78	
Natal (South Africa)	Mean (cm)	84.7	79.2	Hughes (1974)
	Range	71.0-94.0	65.1-87.1	
	N	23	23	
Boavista (Cabo Verde)	Mean (cm)	**81.1**	**75.8**	
	Range	**70.0-104.0**	**60.2-96.5**	
	N	**940**	**933**	
Zakynthos (Greece)	Mean (cm)	80.4		Margaritoulis (1982)
	Range	69.5-95.0		
	N	27		
Dalyan Beach (Turkey)	Mean (cm)		73.1	Erk´akan (1993)
	Range		60.2-83.9	
	N		49	
Northern Cyprus	Mean (cm)	73.4		Broderick (1996)
	Range	65.0-86.5		
	N	78		

Acknowledgements:

We thank the David and Lucile Packard Foundation and Sea Turtle Symposium for travel support.

Table 2. Mean, range, and sample size (N), of CCL and SCL of some populations of the world, including Boavista (in bold.

	CCL (cm)	CCW (cm)	SCL (cm)	SCW (cm)	PL (cm)	PW (cm)
Mean	81.1	76.6	75.8	60.9	17.7	15.4
SD	3.94	4.07	3.80	4.22	1.22	1.22
Range	70.0-104.0	57.0-96.0	60.2-96.5	49.5-91.5	14.0-26.0	13.0-22.0
N	940	938	933	933	943	947

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MARINE TURTLE NESTING MONITORING PROGRAM IN MACHALILLA NATIONAL PARK, ECUADOR SINCE 1996 UNTIL 2000

Maria-Jose Barragán

CDC-Ecuador, Eugenio Santillán N34-248 y Maurián. Pichincha Ecuador 17-16-229

The marine turtle nesting monitoring project has been developed in seven beaches of Machalilla National Park, PNM (Ecuador) and its zone of influence. It has taken place between 1996 and 2000.In spite of the fact that the monitored beaches have physical characteristics which would make it easier nesting activities, the quantitative analysis and results of the study which show that there is a minimal nesting. In general, the marine turtle nesting activities in this area are very low. The analysis of human and introduced animal impacts show that there is definitely a high effect on nesting activities. Otherwise, the greatest impact on marine turtle populations could be the bycatch from artisanal fisheries, but this topic is still unknown. Environmental education activities have also been developed. They are very important in the process of involving local people with the marine turtle protection and conservation program in Machalilla National Park and the zone of influence.

INTRODUCTION

Ecuador has four sea turtle species reported: *Lepidochelys olivacea*, *Chelonia mydas agassizii*, *Eretmochelys imbricata* bissa y *Dermochelys coriacea* schlegelii (Green 1978). Green & Ortiz (1980), mentioned that *C. mydas agassizii*, *E. imbricata* y *D. coriacea* are probably nesting in Machalilla National Park beaches. The conservation status of sea turtles says that three of four species reported for Ecuador are in UICN Red List: Sea turtles in Ecuador are one of the biggest priorities for research. There are very little information about them.

This study began in 1996 with a preliminary evaluation of nesting zones. Eight beaches were selected to make the research: Salaite, Los Frailes, Tortuguita, Salango, La Playita, Piqueros, Playa Dorada y Puerto Rico.

STUDY AREA

Most of the study area is inside of Machalilla National Park. The vegetation of PNM is included in the Dry Tropical Forest ecosystem. This zone is considered to be part of the Tumbesian Region and is one of the last remnants of this type of forest in South America. There are many economic activities being developing within the park. These activities are having substantial impact on environmental maintenance. The PNM zone is one of the most important areas for artisanal fisheries in Ecuador and has potential for future economic development.

METHODOLOGY

· Preliminary evaluation of nesting places.
· Map of Nesting Places and Special Coastal Structures based on the PNM map.
· Design terrestrial routes for conducting the census of selected beaches (Pritchard et.al.,1983).
· Standardize the values for beach length : # prints / day divided for the beach length = # prints / day for every beach kilometer.
· Obtain the average number of prints and nests / day / Km., for every beach, specie and month.
· Sea turtle activity analysis based on: # (prints/day)/Km and # (nests/day)/Km of beach, and these data for every specie, beach and month.
· Record human and introduced animals impact in nesting beaches registers.

RESULTS

There are beaches where sea turtle activities are more intensive than others. Main problems and threats in the area are human activities which are causing most of the disturbance in zones of the protected area. Encouraging the people to be more sensitive to the risks of sea turtles is one of the goals of this project. Young people have become more conscientious about the importance of this project in conserving this resource.

1. Sea turtle nesting activities in four beaches of Machalilla National Park and its influence zone. Activity analysis with (#prints/day)/km and (#nests/day)/km of beach. The program made since 1996 until now, shows results about reproductive information of sea turtles. The information comes from data registered in special periods like Fenómeno de El Niño in 1997. The data shows that the mean of (prints/day)/km and (nests/day)/km is 0.063. We can see that the reproductive activity of sea turtles in this area is low.
2. Sea turtles nesting activity in four beaches of Machalilla National Park and its influence zone. Activity analysis for each species. *Eretmochelys imbricata* is the species with the biggest mean and total number of prints and nests.
3. Sea turtles nesting activity in four beaches of Machalilla National Park and its influence zone. Activity analysis for each beach and each monitoring month. The analysis results show that there are differences between the sea turtle activity in the beaches monitored. La Playita is the beach with the biggest activity of sea turtles, between four beaches analyzed. Data in
Making comparisons between most activity beaches in four study periods, we see that there are similarities between them. La Playita is one of the most active beach in four periods, it is the same for Los Frailes, Playa Dorada. These data are showing to us that there are preferences for some beach or zones by the sea turtles.

The monitoring data analyzes respect the sea turtle activity in different months show some similarities in number of footprints and nests in this times. The only one data recorded of sea turtle activity in 2000 was done on September. The months with more activity in the last periods are not the same month with more activity in 2000.

4. Human impact in nesting zones in Machalilla National Park and its influence zone.

At first we thought that the beaches with more sea turtles activities could have less human impact. Or these beaches would be these that are far from towns. During the study, the data showed that the beaches with most activity are not necessary that ones which are far from towns. In the lasts periods there is one beach which has had the most activity: La Playita. This is one of the beaches with less human presence.

Education activities

People from local zones (students, young people, fishermen) have participated in education activities designed and focused to the marine resources conservation and protection. We made encourage people to focus their attention to the sea turtle species present in that area.

Figure 1. Mean of (prints/day)/km and (nests/day)/km of beach.

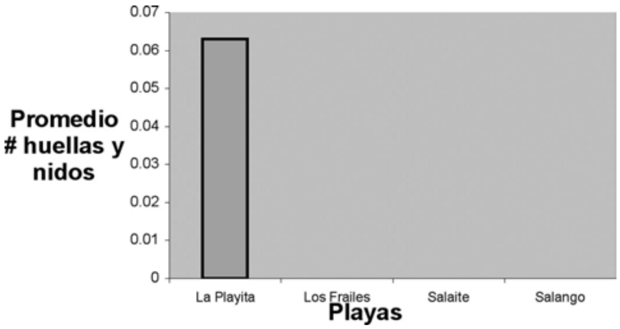

Figure 2. People and domestic animals # / beach.

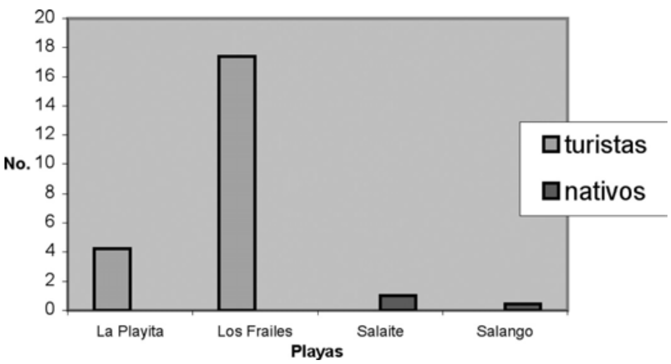

Figure 3. Mean of prints number for species.

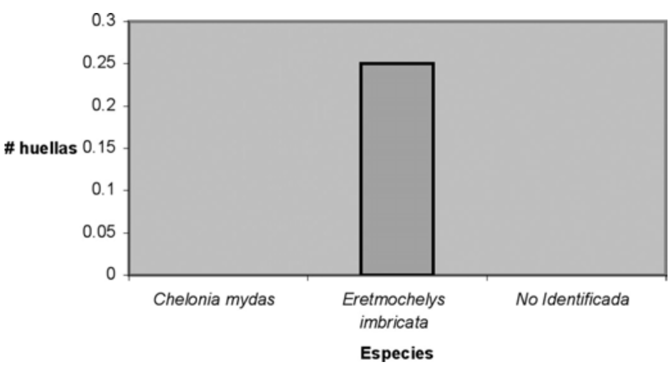

Figure 4. Mean of nests number for species.

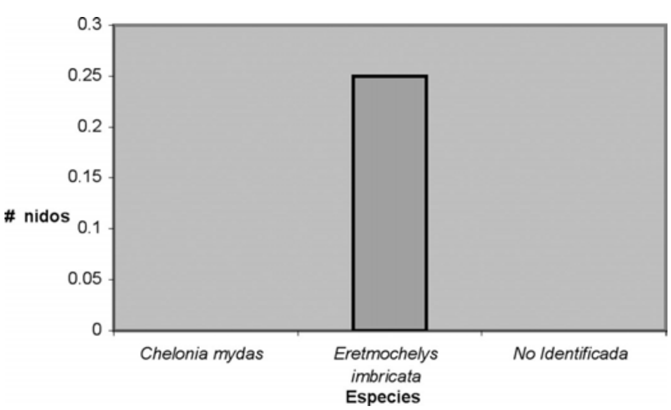

Figure 5. Comparing the most used beaches in four study periods (prints/day)/km.

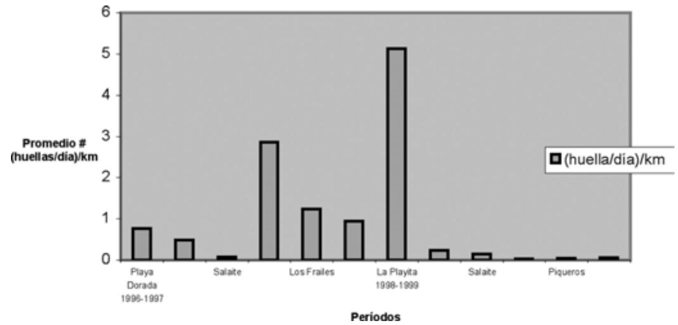

Figure 6. Comparing the most used beaches in fours study periods (nests/day)/km.

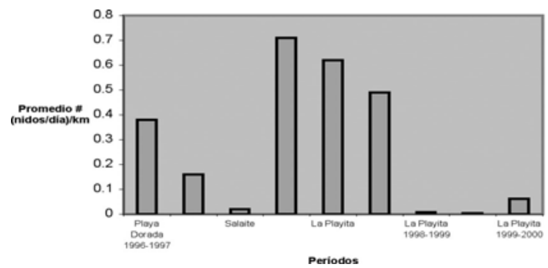

Figure 7. Prints record in four study periods.

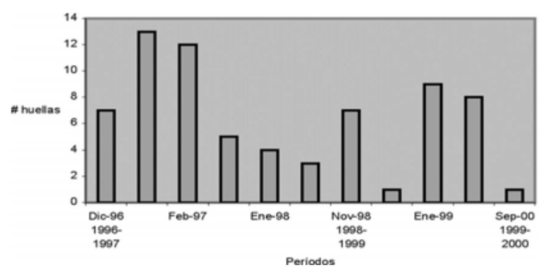

Figure 8. Nests record in four study periods.

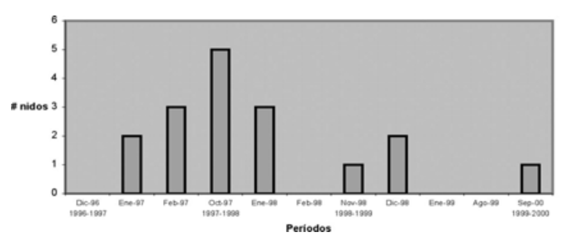

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Table 5. Months with most sea turtles activity in the four study periods: 1996-1997, 1997-1998, 1998-1999 y 1999-2000.

PERÍOD	MONTH	PRINTS #	NESTS #
1996-1997	December	7	
	January	13	2
	February	12	3
1997-1998	October	5	5
	January	4	3
	February	3	0
1998-1999	November	7	1
	December	1	2
	January	9	0
	August	8	0
1999-2000	September	1	1

Table 6. Prints and nests #, for each species.

SPECIE	MEAN PRINTS #	PRINTS #	MEAN NESTS #	NESTS #
Chelonia mydas	0	0	0	0
Eretmochelys imbricata	0.25	1	0.25	1
No Identified	0	0	0	0

Table 1. More used beaches in 96-97 period. In accord with mean of prints and nests number, by day, by Km.

BEACH	(print/day)/ km	prints #	*C.m*	*E.i*	N/I
La Playita	2.86	5	0	0	5
Los Frailes	1.24	4	0	0	4
Playa Dorada	0.95	1	0	0	1

BEACH	(nest/day)/ km	nests #	*C.m*	*E.i*	N/I
Los Frailes	0.71	1	0	0	1
La Playita	0.62	2	0	0	2
Puerto Rico	0.49	7	0	0	7

Table 2. More used beaches in 97-98 period. In accord with mean of prints and nests number, by day, by Km.

BEACH	(print/day)/ km	prints #	*C.m*	*E.i*	N/I
La Playita	5.13	18	0	0.52	0.31
Playa Dorada	0.24	1	0	0.24	0
Salaite	0.15	4	0	0	0.035
Los Frailes	0.029	4	0	0.005	0.016
Piqueros	0.045	2	0	0	0.022

BEACH	(nest/day)/ km	nests #	*C.m*	*E.i*	N/I
La Playita	0.009	1	0	0	0.009
Los Frailes	0.005	1	0	0	0.005

Table 3. More used beaches in 98-99 period. In accord with mean of prints and nests number, by day, by Km.

BEACH	(print/day)/ km	prints #	*C.m*	*E.i*	N/I
Playa Dorada	0.76	4	1	2	1
La Playita	0.48	19	2	11	6
Salaite	0.07	7	4	3	0

BEACH	(nest/day)/ km	nests #	*C.m*	*E.i*	N/I
Playa Dorada	0.381	2	0	1	1
La Playita	0.161	5	2	1	2
Salaite	0.021	2	1	0	1

Table 4. More used beaches in 1999-2000 period. In accord with mean of prints and nests number, by day, by Km.

BEACH	(print/day)/ km	prints #	*C.m*	*E.i*	N/I
La Playita	0.063	1	0	1	0
Los Frailes	0	0	0	0	0
Salaite	0	0	0	0	0
Salango	0	0	0	0	0

C.m :Chelonia mydas ; E.i: :Eretmochelys imbricata ; N/I: No identified

BEACH	(nest/day)/ km	nests #	*C.m*	*E.i*	N/I
La Playita	0.063	1	0	1	0
Los Frailes	0	0	0	0	0
Salaite	0	0	0	0	0
Salango	0	0	0	0	0

STRANDING OF A LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) IN CASTILLETES, PAEZ COUNTY, ZULIA STATE, VENEZUELA

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Laboratorio de Investigaciones Piscícolas

The Leatherback turtle (*Dermochelys coriacea*) is the sea turtle species with the lowest observation frequency the Gulf of Venezuela, after Olive´s Ridley turtle (*Lepidochelys olivacea*). This species is seriously endangered in certain places like the Pacific Ocean, were its extinction has been predicted in the next five years.

It is necessary to have a better knowledge of this species in the places were its exploitation takes place to develop efficient conservation strategies. During the Turtle Camp Guajira 2000, organized by the group Tortugueros del Golfo de Venezuela (TGV) from August 15 to 25, 2000, one turtle of this species, with its carapace and plastron, but very decayed was found in Castilletes locality, Paez County, Zulia state, Venezuela (11° 51´ 06´´ N; 71° 19´ 44´´ W), This turtle stranded in the coast, decapitated and with its extremities cut off. This was possibly due to interaction with fishing activities, developed by the communities in this region. It is common to find dead turtles in the Gulf Coast, since they are not used for human consumption. The total curve length of the carapace was 1090 mm and the
maximum width of the carapace was 605 mm. We were unable to determine the gender of this specimen, since they were not evident secondary sexual characters. The individual was classified as a subadult of this specie, since the minimum adult size for this species is 1300 mm.

Figure 1. Measuring the sea turtle. Personal from TGV and Policia Nacional de Colombia (Photo: H. Barrios-Garrido).

Figure 2. Leatherback turtle carapace (Photo: H. Barrios-Garrido).

JAIYARIYÚ: HOPE FOR THE SEA TURTLES FROM THE VENEZUELAN GULF

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ABSTRACT

Tortugueros del Golfo de Venezuela (TGV) is a group of students and teachers from the University of Zulia, Venezuela, interested in research and education on sea turtles from the Gulf of Venezuela, specifically in the Venezuelan Guajira region. In August of the year 2000, we developed the activity "Turtle Camp Guajira 2000". The main objectives of this activity were to implement field activities with sea turtles in their habitats and to establish contacts with indigenous people from villages around this region. We found one green turtle (*Chelonia mydas*) specimen tied close to the fishermen houses. The fishermen wanted to sell this animal. Finally, we pursue them to give away the animal to the group for its study, free it from parasites, mark it and then proceed to release it in the gulf. We named the animal after the indigenous tribe or "casta" Jaiyariyú that gave us logistic help for the development of the camp activities. We applied two monel marks, one in the right fin another in the left fin, identified with the codes P-2216 y P-2217 respectively. Its measures were: Maximum Carapace Length (LMC) 920mm and Maximum Carapace Width (AMC) 770mm. Jaiyariyu´s the first marked and released turtle in the Gulf of Venezuela. This success is a demonstration that education is a very important tool for conservation of this animal in Guajira. It is necessary to get more financial and research support from national and international institutions to be able to keep working for the conservation of these animals.

INTRODUCTION

The coast of the Venezuela Gulf is considered as a possible habitat for sea turtles. In the Guajira region specifically, commercial trade of green turtle (*Chelonia mydas*) meat has been registered, but recently other species, like the leatherback turtle (*Dermochelys coriacea*) were recorded also (Barrios-Garrido, H. 2001). With this previous information, a group of students and teachers, known as "Tortugueros del Golfo de Venezuela" (TGV), has been developing research and education activities related with this species. An example of these activities is the Turtle Camp 2000 ("Campamento Tortuguero Guajira 2000").

The main objective of this camp was to develop field research on this subject and to have contact with the people that inhabit this region. This was done by visits to the fishermen villages, giving lectures on environmental education and conservation of marine turtles, with the main objective to decrease the negative effect of this communities on these wild populations.

METHODOLOGY

During the development of these activities, while we were recognizing the region, a green turtle specimen (*Chelonia mydas*) was found tied near to a fishermen house. He was going to sell its meat. After a series of conversations, we convinced the fishermen to give away the turtle to the representatives of TGV. The students then proceed to inspect the health status of the animal, take measures, mark it and then release it. To free it from parasites, a manual procedure was used. Measures were then recorded, corresponding to the maximum length and maximum width of the carapace. Two Monel marks were applied to the animal, on the right and left fins, identified with the code numbers P-2216 y P-2217 respectively. Once ready to free the animal, it was taken on a boat to safer waters, since close to the camp, a fishing net was devised. The turtle was named "Jaiyariyú", honoring the indigenous family that helped with the logistic support for the camp activities.

RESULTS

Its measures were: Maximum Carapace Length (LMC) 920 mm and Maximum Carapace Width (AMC) 770 mm. The parasites found in the carapace and the plastron of the specimen were identified as *Balanus balanoides*. The animal was a *Chelonia mydas* sub-adult.

DISCUSSION

The Venezuelan Gulf is one of the main feeding areas for sea turtles in the country (Barrios-Garrido, H. 2000). Its coasts are characterized by the presence of extensive Thallasia testudine prairies, one of the main dietary resource for the green turtle. This might influence the abundance of this species in the region. That makes this region specially important to develop research activities in this species and to check for turtles marked in other Caribbean places that might be coming to this feeding ground. It might also be an important place to study if we want to have a clearer knowledge on the migratory paths of this species. Since the measures of the animal corresponded to the measures of a sub-adult, it is possible that the animal visiting this feeding ground might prefer this place to fed and then travel to other placed to reproduce and lay eggs.

Figure No. 1. Map of Venezuelan Gulf. See Parashiou the place where was captured *Jaiyariyú*.

CONCLUSIONS

Jaiyariyú represents the first marked and freed marine turtle in the Venezuelan Gulf, making a very important point on how conservation and research must go hand in hand with education of the community in the Guajira region. It is also important to keep getting help and assistance from public and private institutions, to develop research activities on the biological aspects, ecology, behavior, genetics and migration of this species. The results of this studies will give us a better approach to develop management practices and laws to protect marine turtles, ensuring its survival for many more decades.

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To Rectorate of University of Zulia, to Mr. Segundo Palmar, Mr. Jose Luis Gonzalez, Mr. Abraham Fernandez, Mrs. Chinca de Gonzalez, Mr. Yordano Palmar, Mrs. Maria de Palmar and all the friends form the Guajira. Thank you very much.

TURTLE CAMP GUAJIRA 2000: AN ACTIVITY TO HELP SEA TURTLES

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The group ' Tortugueros del Golfo de Venezuela (TGV)', has been working on research and education activities related with sea turtles in the Gulf of Venezuela for three years. This region is the most important feeding ground for different species along the Venezuelan coast. Also the species are subject to and increased exploitation process. TGV organized a turtle camp from August 15 to 25, 2000 in Porshoure, Parashiou and Castilletes villages in La Guajira,north of Maracaibo and close to the colombian border. This camp was named 'Turtle Camp Guajira 2000'. This camp was directed to Biology students from University of Zulia and Graphic

Communication Students at Instituto Tecnológico Talavera. The main objective of this activity was to develop daily activities with the animals, educational activities with the fisherman and people from the villages as well as environmental education conferences for the children and the military authorities in the area, the Guardia Nacional Venezolana and Policía Nacional de Colombia. During these ten days, we measured 34 turtle shells or carapaces, 25 from the species *Chelonia mydas*, 5 of *Eretmochelys imbricata*, 3 of *Caretta caretta* and one (1) from the species *Dermochelys coriacea*. We also marked and reintroduced a female green turtle (*C. mydas*) that was going to be sacrificed to sell its flesh. This camp helped to build friendships relations with the indigenous people, the authorities and researchers from the group, that will help to establish and define future activities for the conservation of all sea turtles species of this area.

Figure 1. Porshoure´s Turtle Camp. Near the beach the personal from TGV was working. (Photo: H. Barrios-Garrido)

Figure 2. Venezuelan Gulf Map. Castilletes, Parashiou and Porshoure.

Figure 3. Conference with the personal of TGV, about "Jaiyariyu" a female *Chelonia mydas* found on Parashiou. (Photo: T. Leon)

PREVALENCE OF SEA TURTLE FIBROPAPILLOMATOSIS IN BRAZIL

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Fibropapillomatosis (FP) is a debilitating and potentially fatal pathology to sea turtles. In Brazil, the first FP case was observed in 1986 in the State of Espírito Santo, on the Brazilian eastern coast, and since then occurrences of this pathology have systematically been recorded in the database of Projeto TAMAR-IBAMA, the Brazilian Sea Turtle Conservation Program. In this study, we present the prevalence of FP on the Brazilian coast by species, region and year, for nesting and feeding areas, using data gathered from 1986/1987 to 1999/2000. Data will be presented only from 1986 on, as this is the year when the first FP case was recorded in Brazil.

METHODS

Projeto TAMAR maintains 20 stations, monitoring over 1000 km of the Brazilian coast and three oceanic islands: Fernando de Noronha, Atol das Rocas and Trindade (Marcovaldi and Marcovaldi, 1999). Most of the stations are located in nesting areas, but usually juvenile or adult turtles can be found year round in those areas in the sea (mostly captured in fishing gear) or stranded. Only two TAMAR stations (Ubatuba, State of São Paulo, southeastern Brazil, and Almofala, State of Ceará, northeastern Brazil) are located in exclusively feeding areas, where no nestings occur. Whenever found, turtles are examined for FP. This exam, however, is performed under field conditions and sometimes the turtles cannot be completely searched for FP, as it is generally not possible to lift them or turn them upside down to examine their ventral surfaces when they are too heavy, as it happens to adult turtles. Juvenile turtles can usually be completely searched for FP.

Fibropapillomas are identified morphologically, and whenever possible samples of fibropapillomas are collected and sent to the University of São Paulo for histopathological analysis (Matushima et al., 2000); all those samples had a histopathological confirmation of fibropapillomatosis. Turtles are examined for FP only when the occasion arises, during regular fieldwork; no dedicated surveys for FP are carried out at TAMAR stations. It should be noted that different TAMAR stations were created and started fieldwork in different years, following a regular expansion of TAMAR activities. So, the temporal coverage of the data is uneven among regions.

Projeto TAMAR's database has two different main files. In one of them, data related to the nesting process are stored (completed nestings, aborted nesting attempts, etc.). The other file has to do with turtles found in feeding areas or found on or around nesting beaches but in situations not directly related to the nesting process (turtles captured in fishing gear, captured through diving, found stranded, floating or in any other way). Data analysis, accordingly, will be presented separately for those two situations, labeled below "nesting beaches" and "feeding areas".

In this work, the data unit is the observation of a turtle, so turtles found more than once are accordingly included more than once in the analyses. However, in the Fernando de Noronha Archipelago, a research on growth and residency of turtles is carried out. There, turtles are captured through diving, and some turtles have been captured systematically again and again, often many times in a year. Results related to observations pertaining to that research (n = 537 observations) will be stated separately. In Brazil, the nesting season goes generally from September to May, and so each season is denoted by a two-year code, e.g. 1999/2000. In the data analysis, TAMAR stations were grouped into regions: region N1 (States of Ceará and Rio Grande do Norte), FA (Atol das Rocas and Fernando de Noronha), N2 (States of Pernambuco, Alagoas and Sergipe), BA (State of Bahia), ES (State of Espírito Santo), TD (Trindade Island), RJ (State of Rio de Janeiro) and SP (State of São Paulo). The TAMAR station in Mucuri, in the southernmost part of the State of Bahia, is included in region ES. Two areas where turtle observations were available (Recife, State of Pernambuco, and Natal, State of Rio Grande do Norte) were included in the analyses, although there are no TAMAR stations there. The prevalence rate (PR) is computed as (FP cases/observations) x 100.

Sampling: nesting beaches

Between 1986/1987 and 1999/2000, TAMAR's reproductive database recorded 67097 observations related to the nesting process (range over the years: 845-10727 observations). 20290 observations (30.2%) were made on the islands (range 50-5994), and 46807 (69.8%) on the mainland (range 771-5564). In 13453 observations (20.1% of total observations), the turtle was found on the beach and tagged, and so she could then be examined for FP. However, this percentage (20%) is not uniform neither over the years nor over the several areas where TAMAR works. On the islands, 57.8% of the observations (n = 11731) included the finding of the turtle on the beach (range over the years 10.8-75.5%); on the mainland, this figure is 3.7% (n = 1722, range 1.0-10.1%). Turtles could be measured in 48.2% of the observations where the turtles were tagged, then allowing the determination of their size class (juvenile or adult). On the mainland, this figure is 96.5%, and on the islands, 41.1%. The green turtle (*Chelonia mydas*) is the only species nesting on the islands. On the mainland, the loggerhead turtle (*Caretta caretta*) is the most common species among the nesting turtles examined for FP (n = 1409, or 81.8% of the total examined for FP). The other species found on mainland beaches are the hawksbill turtle (*Eretmochelys imbricata*, n = 99 turtles examined for FP, or 5.7% of the total examined), the olive ridley (*Lepidochelys olivacea*, n = 167, or 9.7%), the leatherback turtle (*Dermochelys coriacea*, n = 35, or 2.0%), and the green turtle (n = 9, or 0.5% of the total examined for FP). Three turtles examined for FP (0.2% of the total examined) had their species not recorded.

Sampling: feeding areas

Between 1986 and 1999, there were 5473 observations in feeding areas. Green turtles amount to 78.9% of those observations. Among the observations in which the species was known (n = 5147, or 94.0% of total observations), green turtles amount to 83.9% (n = 4316). 64.1% of the green turtle records were from region SP, where the turtles, nearly always juveniles, are mainly incidentally captured in fishing gear and generally liberated alive back to the sea - in the the State of São Paulo, TAMAR directs its activities mostly to this kind of captures. Other species found in feeding areas are the loggerhead (4.2% of the observations with known species), the hawksbill (6.0%), the olive ridley (5.5%) and the leatherback (0.4%). Among the 5473 observations, 76.5% were juvenile turtles, 10.3% were adults and 13.2% did not have their size class recorded. Among the green turtles, 89.3% were juveniles, 4.8% were adults and 5.9% did not have their size class recorded. In 71.5% of the green turtle observations the turtles were found alive, and in 28.4% they were found dead; in 3 observations (0.1%) the condition of the turtle was not recorded.

RESULTS AND DISCUSSION

Nesting beaches

16 FP cases were recorded: 14 in green turtles, 1 in a loggerhead and 1 in an olive ridley. All 14 tumored green turtles were found on Trindade Island (region TD): one case in 1989/1990 (87 observations in the year, PR = 1.1%), 2 cases in 1994/1995 (2132 observations in the year, PR = 0.09%) and 11 cases in 1995/1996 (3226 observations in the year, PR = 0.34%). The tumored loggerhead was found in region ES in 1994/1995 (1 case in 75 loggerhead observations in the year, PR = 1.3%), and the olive ridley in region N2 in 1996/1997 (1 case in 8 olive ridley observations in the year, PR = 12.5%).

Feeding areas

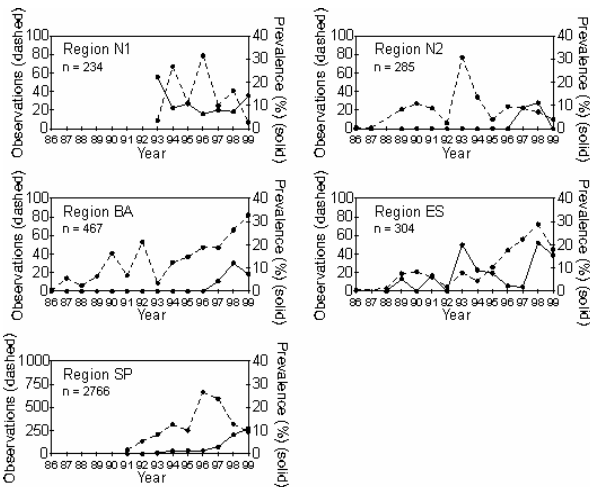
In all, 171 FP cases were recorded since 1986: 167 in green turtles, 1 in an olive ridley and 3 cases had the species not recorded. The olive ridley case occurred in region N2 in 1999 (1 case in 24 olive ridley observations in the year, PR = 4.2%). Those cases with species not recorded occurred in region ES, 2 cases in 1992 and one in 1996. No FP cases were observed in the diving study in Fernando de Noronha, but one juvenile green turtle with FP was filmed on video there around 1995. Fig. 1 shows the number of turtle observations and FP prevalence rates for green turtles by year, by region, for those regions with a significant number of observations.

Except for one case in a loggerhead turtle, two cases in olive ridleys and three cases where the turtle species was not recorded, FP has only been observed in Brazil in green turtles. Overall, the prevalence of green turtle FP in Brazil in feeding areas seems to be increasing (Fig. 1). However, several points should be made concerning this assertion:

1 - As stated in the section on Methods, no dedicated surveys for FP are performed at TAMAR stations - observations are made during regular fieldwork. So, all results presented here should be looked at cautiously, as they could be somehow biased by the available sample. A dedicated research on FP is being carried out for the first

time since 2000 in Vitória, State of Espírito Santo, where juvenile green turtles are found in significant numbers.
2 - An observation bias might possibly be happening: maybe FP cases are more readily recognized today, as compared to the situation some years ago, when TAMAR personnel were probably less acquainted with that disease than they are today.
3 - Overall results for Brazil are heavily influenced by those from region SP (State of São Paulo): most (64.1%) of the green turtle observations in feeding areas were from that region, where an increase in green turtle FP prevalence is observed (Fig. 1). For the other regions, results are not so clear-cut, due in part to the relatively small number of FP cases.

Figure 1. Green turtles in feeding areas: number of turtle observations (dashed lines) and FP prevalence rate (solid lines) by year, by region (see text for region codes). Note that the left vertical scales are different among the graphs. Sample sizes show the number of observations, not FP cases.



FP prevalence in Brazil seems to be in the low to medium range, as compared to that found in other places around the world. Worldwide, FP prevalence, where the disease is present, can range from 1.4% to as high as 90% (Aguirre, 1998). On the Brazilian coast, green turtles, generally juveniles, are the most common species among stranded turtles. FP is not the main cause of death among those turtles - they are generally found showing signs of interactions with fishing gear. In the State of Espírito Santo (region ES), many necropsies have been performed in stranded green turtles, and they have generally been found to be in good health condition, most of them without signs of FP, having just drowned due to their interaction with fishing gear. No regular data are available in Brazil with regard to the severity or the location of tumors on the bodies of sea turtles. Matushima et al. (2000) describe some characteristics of cutaneous papillomas of green turtles found in regions SP, ES and BA.

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THE STATE OF SEA TURTLES NESTING ON THE OSA PENINSULA, COSTA RICA

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INTRODUCTION

The Osa Peninsula is one of the most biodiverse areas of Costa Rica, with Corcovado National Park, another third in forest reserve, and four of Costa Rica's six species of nesting sea turtles (Chacon, 99; Govan, et al 2000). The four species of turtles that have been reported to nest here are the Olive Ridley (*Lepidochelys olivacea*), Hawksbill (*Eretmochelys imbricata*), Pacific Black (*Chelonia agassizzii*), and, Leatherback (*Dermochelys coriacea*), all of which are categorized by the International Union for the Conservation of Nature (IUCN) as either critical or endangered.

Within the studies done in this area, two have been done on the Leatherback population of the peninsula (Drake, 94 & Govan, et al, 2000) and one on the former Rio Oro project (Govan, 98). For many years, the exploitation of eggs, meat, and shells has threatened nesting turtles. Now, they are faced with habitat disruption from coastal development, incidental capture in fishing boats, and water pollution (Lutcavage et al, 97). Despite the presence of several groups working on turtles in the area, there have not been any studies which bring together all of the information about which types of turtles nest on the Osa, on which beaches, and the present conditions of those beaches. This study will unite this information and help existing projects integrate protection measures. It will also aid in starting projects at beaches where no protection currently exists and focus attention on the importance of the Osa turtle populations.

For this study, the objectives were to: 1) observe the various beach conditions, such as the presence of development, vegetation, inclination, and presence of animals, 2) register nests where possible, to estimate the number of nesting females, and 3) collect information from previous and ongoing studies about the threats and history of the various beaches.

METHODOLOGY

This investigation began September 1st and ended November 30th of 2000. The data were obtained by way of interviews, visits to the beaches, registration of nesting females and tracks where possible, and data published in previous studies. The study area was the Osa Peninsula (8.51N, 83.52W), where three beaches currently have some form of conservation project; Platanares, Sombrero, and Carate, while two others, Rio Oro, and Tamales have none.

The interviews were done with community members and people working with various projects. In all, 10 people were interviewed, focusing on the types of nesting turtles and the history of the area and its turtle populations. Each beach was visited on several occasions to gain relative perspectives on tides and changing conditions. The data was recorded during night and early morning patrols, depending on the tide schedule. This data was recorded regularly at Sombrero and Carate. We also used data published by ADECORO (Asociacion de Desarollo y Conservacion de Rio Oro), ASTO (Asociacion Salvemos las Tortugas de Osa), and TUVA, three local groups working on turtles, as well as studies obtained from MINAE, the Costa Rican Ministry of the Environment.

RESULTS

A total of approximately 300 females were registered in the study period. Of these, over 90% were *Lepidochelys olivacea*. According to the figure 1, the month with the most females was October, with an estimate of 5 turtles per night; Carate being the beach with the highest numbers of females, though historically Rio Oro has had much higher totals than any of the others. For each of the beaches, we described the most principal characteristics, including the presence of a conservation project, the types of turtles arriving, the principal threats, and a general description of the beach.

Carate

Starting in the west with Carate, local landowners have hired a local citizen to patrol at night and collect eggs for placement in a hatchery. This work will soon be augmented by volunteer students from the Osa Rainforest Institute, an ecotourism company starting in the area. Within the study period, Olive Ridleys (90%), Leatherbacks (5%), and Hawksbills (5%) were recorded, though according to interviews Pacific Black turtle have also nested here. The biggest threats here are poachers, with an average of 2/night, increasing beachfront development. The beach stretches for 3 km and borders the beach of Rio Oro. Conditions are optimal for turtles, with a large inclination and width. Approximately 15 families live in the area, as well as several hotels, though light pollution doesn't appear to be a problem. Neither driftwood nor erosion are problems. During the rainy season, residents often use quads for transportation, as the rivers can be impassable inland.

Rio Oro

From 1994 to 1999, the Development and Conservation Association of Rio Oro (ADECORO) administered a turtle project protecting the beach's nesting population. The majority of this data was obtained from Hugh Govan (personal communication, 2000) and Dana Drake (93). The species registered in this zone were Olive Ridley, Leatherback, and Pacific Greens, though, Hawksbills are believed to nest here, too, though none have been positively identified. In 1994, 83% of nesting females were Olive Ridleys, 1.6% were Pacific Greens, 0.2% were Leatherbacks, and 15.2% were unidentified. Currently, the project has been abandoned and the majority of the families have left the area. The beach is about 6 km long and its conditions for turtles are very favorable as there is little driftwood and the area was declared a wildlife refuge in 1999. Also, there is a favorable inclination for larger turtles such as the Leatherback and Pacific Green. The beach has major problems with poachers and it is one of the peninsula's most vulnerable beaches. Past records indicate that many more turtles arrive here than any other beach on the Osa, averaging 2,348 between '94 and '96-'98.

Sombrero

Residents of this area are forming an official association to protect the turtles, Asociacion Pro Tortuga de Playa Sombrero. Currently, nests are being collected and put into a hatchery. We only observed Olive Ridleys nesting here, though two nests appeared to be hawksbills. The main turtle threats here are poachers, (19%) and animals, including dogs (3%) and Pizotes, and other factors, such as severe erosion, that have affected the morphology of the beach. The length is about 2 km, the first km having a slight inclination and is bordered in part by a large pasture. We found dead coral, and after heavy rainfalls, part is covered by driftwood coming from the river. Hermit crabs are very common, as well as pelicans, raptors, and frigate birds. We observed trucks and quad tracks on the beach on various occasions. Several dogs live in the area and their tracks were often observed during night patrols. Groundwater filtration through the sand adds to erosion. There is one house near the beach without electricity and several others farther back whose light cannot be observed from the beach.

Tamales

There are no conservation measures taken here. The only turtles definitively observed nesting here have been Olive Ridleys. According to interviews, poaching is near 100%, though few people live here, many travel from town. Pigs are believed to be responsible for much depredation, as well as dog and horse tracks. Erosion is noticeable here, but does not appear to be severe. Land use in the area is dominated by agriculture and pasture, along with a few houses that don't seem to cast much light. Two important rivers bisect the beach and during rainy periods deposit much sediment and driftwood. Scarlet macaws and pelicans are common, as are howler and squirrel monkeys.

Platanares/Preciosa

In 1999, a nonprofit association called Asociacion Salvemos las Tortugas de Osa (ASTO) began a program of daily night patrols to collect almost all nests from the beach for relocation into a hatchery. Members of ASTO are mainly local who work, live in, or own hotels located on the beach. Platanares is a 6km/4 mi long beach with a rocky reef offshore and is located within the Golfo Dulce. Some areas are protected as a national wildlife refuge (Preciosa-Platanares), which consists of mangroves, secondary forest, and pasture. The hotels rely on generators and candles and though some light reaches the beach, it does not seem to affect the turtles. In 2000, 97 nests were relocated to the hatchery. The majority of turtles are Olive Ridleys, with at least 1% being Hawksbill. The biggest problem is the location 3kms from Puerto Jimenez, the peninsula's largest town, and thus is easily accessible by poachers and feral dogs.

RECOMMENDATIONS

For the diversity of species nesting here and the numbers of females arriving on each beach, the Osa Peninsula is an important nesting area of Costa Rica. The most important things that need to be done here are to 1) initiate a new project at Rio Oro, and 2) integrate the various projects so that the methods can be standardized to allow for comparison among the beaches. Many of the people currently involved have sufficient desire to help, but lack the concrete knowledge of how to correctly identify species, how to handle eggs, and how to build well-designed hatcheries. However, past attempts from people outside of the peninsula to facilitate project improvement have been met with distrust and apathy. Thus, we feel that the most effective way to organize the various projects would be to form an official council of members from each group, with a biologist advisor from outside. This group could standardize the methods, search for ways to work together and improve the knowledge levels of all, and develop together a plan for ecotourism, which to date has been lacking, though there is great potential. This group would have more power to effect change, increasing their ability to improve the situation for the Osa sea turtles.

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THE USE OF SUBJECTIVE PATTERNS IN GREEN TURTLE PROFILES TO FIND MATCHES IN AN IMAGE DATABASE

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Each summer since 1989, we have photographed and videotaped an ohana* of turtles at Honokowai, West Maui, Hawaii. To identify individual turtles, we capture facial profiles and catalog them in a database, as we described in our presentation at the 19th Sea Turtle Symposium in South Padre[1].

Green turtle profiles feature a relatively small number of facial plates in a limited number of arrangements, yet the variety is rich enough that every animal is unique, at least within our ohana. While some profiles are similar enough to cause confusion when seen or captured at a distance or with low resolution equipment, close examination has thus far always revealed differences. Further, when turtles exhibit similar profiles on one side, the other profile has always revealed differences sufficient to identify the animal conclusively.

THE PROBLEM

Until recently, it was feasible (but tedious) to compare each potentially new profile with those already cataloged, one by one. During summer 2000, however, our database quickly grew to exceed 400 left profiles and 400 right profiles. (Because left and rights are not always matched, we have arbitrarily chosen to avoid counting a turtle twice by counting only left profiles, so these numbers represent 407 "counted" turtles and 78 "right profile orphans.")

Upon encountering a profile (called the Unknown Turtle), the task of comparing it with each one of the 400+ profiles became overwhelming. Clearly we needed a methodology to find quickly whether a matching profile existed in the database.

Pattern recognition and matching is a well-explored field with considerable technology in place[2,3,4]. For our purposes, however, existing methods had a significant flaw: implementation would require considerable resources and time. Any adopted technology would have to be integrated into the database structure we already have, or would require re-engineering the database software.

THE SOLUTION

We realized that most existing technologies were designed to find a single solution: the best possible match. We reasoned that we did not need such a precise result. We therefore looked for a solution that would simply reduce the list of possible matches for the Unknown Turtle to a manageable size--a short list. We could then quickly examine the short list and determine whether the Unknown Turtle was already cataloged.

We based our solution on simple keyword-search techniques. We decided that if profiles in our catalog were described by keywords--plate pattern and shape descriptors--we could produce manageable short lists by searching for combinations. In practice, we found that as few as two keywords could produce useable short lists, and that three or four keywords often returned a single candidate--usually the correct match.

Of course, if the Unknown Turtle was not in our database, it would not appear on any list no matter how short. Although experience has shown repeatedly that an Unknown Turtle that does not turn up on a short list really is not in the database, we nevertheless perform a one-by-one comparison with every cataloged profile. This eliminates the possibility that the Unknown Turtle is in the database but the profile did not include the proper keywords.

THE IMPLEMENTATION

To implement our solution we needed a list of keywords--the descriptive terms for patterns and shapes that appear in green turtle profiles. We realized that while there is value in a standardized list (everyone can grasp what is meant by 'inverted Y' or 'big triangle') the list did not have to be limited to universally understood descriptions. The reason for this is that there is no harm (minor performance issues notwithstanding) in including a subjective keyword, i.e. one understood only by one person. Anyone who does not understand the keyword can simply ignore it. This accommodates the tendency of each individual to see different patterns and shapes in a particular profile.

Alternatively, anyone can produce a short list of turtles for a keyword that is not understood. By studying the results, you can often grasp the commonality in the profiles and thereby expand your 'descriptive vocabulary'!

We developed a list of 64 keywords for our use, many of them subjective. For example, terms such as 'big triangle' vs. 'small triangle' leave room for individual interpretation. Indeed, what appears to be 'big' in one image could be interpreted differently in another image, even by the same person. Is this a fatal flaw? The answer is no. The purpose of a keyword is to make sure a profile is included in a short list. While people intuitively think of 'big' and 'small' as mutually exclusive, in this context they need not be. If there is the slightest doubt which of the two descriptions should apply, our implementation works better if both descriptions are included. Having big triangles show up in a short list that requested small triangles is only a detriment if it expands the list beyond a manageable size. In a database the size of ours, there are simply not enough triangles to turn this into a problem.

THE CONCLUSIONS

We believe that we have established that facial profiles are a reliable method of identifying green turtles. We have used this identification procedure to monitor turtles over several years, tracking the effects of fibropapillomatosis on individuals. Fortunately, the Hawaiian green turtle, at least at Honokowai, tolerates human presence enough to let us apply these methods and build our database.

As our database grew, however, a pattern matching system became essential. Taking pictures or video is just one small part of the process. The images must be of sufficient quality to resolve potential confusion in identification. They must be cataloged with the history of the turtle, including a description of the effects of the disease. There is little value if they cannot be quickly retrieved, or if it is not possible to determine whether a 'new' profile already exists in the database.

Our keyword-based technique solves these problems. Further, it is:

- simple, requiring easily understood and available keyword search technology.

- robust, accommodating excessive description and even description that would normally be considered conflicting.

- subjective, meaning that it is not limited to someone else's idea of what keywords can be used to describe a profile.

- expandable, allowing users to add keywords meaningful to them, since such keywords do not interfere with searches by other users.

- self-documenting, since you can search for a keyword that you do not understand and learn what the keyword means from the results.

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* ohana, n. Hawaiian for a group with shared experience. Suggested by George H. Balazs as the best description for the group of turtles we have been observing, as opposed to 'community' or 'population.'

THE EVOLUTION OF COMMUNITY-BASED CONSERVATION ACTION: FORMATION OF THE COMITE PARA LA PROTECION DE LAS TORTUGAS MARINAS, BAHíA MAGDALENA, BAJA CALIFORNIA SUR, MEXICO

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A major goal of community-based efforts in sea turtle conservation is to develop practices, which will protect sea turtle populations and habitats that are also compatible with the socioeconomic system and cultural ecology of local resource-dependent communities. This goal holds true not only in the coastal communities of Bahía Magdalena, Baja California Sur, Mexico, but other coastal communities regionally and internationally. Local education, informal conversations, and community meetings are a fundamental part of the sea turtle conservation project in Bahía Magdalena. Research objectives have been twofold: including both conservation research and community involvement. Within a conservation mosaic, the incorporation of both biological and social research methods and communication are critical. Due to the intimate nature of community-based work and the length of time needed to develop strong partnerships, communication and trust between different interest groups, community-based conservation is not always appropriate for finding quick resolutions to immediate issues of importance. However, an examination of the evolution of sea turtle recovery efforts within Bahía Magdalena indicates that engaging in community-based research has provided the knowledge and information necessary to create successful long-term conservation plans, including the recent partnerships to create the first in-water protected area for sea turtles in Baja California.

THE COMMUNITY-BASED APPROACH

Community-based conservation has been described as more of a philosophy than a technique (Frazier, 1999; Merchant, 1997): community-based efforts are still in their infancy and no clearly defined methodologies or standard techniques are being implemented. While there are success stories in other areas of resource conservation (for examples see: Dedina, 1999; Freeman, 1989; Hackel, 1999; Hamilton & Walter, 1999; Western & Wright, 1994), such efforts have only begun to emerge within sea turtle recovery efforts within the last decade. Because the field of community-based research has not yet won strong support as a valid conservation tool, it is important to evaluate the effectiveness of such research techniques, assessing the potential benefits and associated risks of community-based efforts.

Community-based efforts are necessary for long-term conservation success and require inputs from a variety of disciplines. This necessitates more than simply assembling experts from representative disciplines. Success can be found through teamwork built in partnerships of mutual respect and understanding with the local population. Through social integration and cultural sensitivity, it may be possible to gain an understanding of the capacity, limitations, needs, and desires of local inhabitants (Frazier, 1999).

When empowerment and autonomy occur within the local community, the need for outside facilitation and implementation will be greatly reduced. Ultimately, that should be the goal -- that local communities are self-sufficient and are in control of their livelihoods and their resources. However, there are also risks involved in such an outlook. The primary risk is that complete autonomy and empowerment can lead to 1) a narrow viewpoint that loses the big picture of the overall ecosystem, or 2) a feeling of ownership of the resource that leads to over-exploitation. However, this feeling of "ownership" can also contribute to conservation efforts, as locals may feel more of an attachment or responsibility to the resources.

STUDY SITE

Primary research was conducted within the fishing communities of Puerto San Carlos, Puerto Magdalena, and Lopez Mateos located on the shores of Bahía Magdalena, a large mangrove estuarine complex on the Pacific coast of the Baja peninsula in Baja California Sur, Mexico. Additional work was carried out in the community of Punta Abreojos located at the mouth of Laguna San Ignacio.

METHODOLOGY

Research objectives have been twofold: including both conservation research and community involvement. Within this conservation mosaic, the incorporation of both biological and social research methods and communication have been critical. Our research consists of socioeconomic studies of current and historic sea turtle utilization within the Bahía Magdalena region as well as ongoing biological monitoring and ecological studies (Brooks, et al., this symposium). A variety of data have been collected, including mortality information, diet analyses (Hilbert et al., this symposium), and tissue samples for genetic analysis. Local members from the community of Puerto San Carlos have been involved in all aspects of data collection. Several meetings have been held within the community of Puerto San Carlos in order to identify community issues and generate conservation strategies. Cross-regional communication has also been important in the implementation of the conservation initiatives.

MEASURES OF SUCCESS

Community-based approaches in the Bahía Magdalena region have resulted in community action and conservation planning with promising results. Representatives of eight different fishing cooperatives have recently joined together to form the Comité Para la Protección de las Tortugas Marinas (COMITE); officers were elected from among these cooperatives, and a mission statement developed. The first official meeting of the COMITE was held on 13 August, 2000. The COMITE invited officials/ titled men, members of the fishing cooperatives, students, and community members to this meeting-- over 100 people were in attendance. The COMITE officials were sworn in, taking an oath to uphold the mission and remain dedicated to sea turtle recovery efforts within their community. Individual representatives from the Mexican marines, SEMARNAP and PROFEPA (Mexican Secretary of the Environment and Environmental Enforcement agencies) were present to recognize and support this action. This represents a positive step in the needed unification process, which may lead to greater community support and involvement.

Additionally, the number of people attending the annual meeting of the Baja California Sea Turtle Conservation Network/ Grupo Tortuguero in Loreto has been increasing rapidly. Attendees of these meetings include representatives from local fishing communities, governmental institutions, academia, NGOs, and students. Meetings such as these are indicative of interdisciplinary efforts to bridge gaps between different interest groups, allowing for collaboration between various stakeholders. More and more concerned fishermen are coming to share their knowledge and voice their opinions. Among those in attendance at the 2001 Loreto meeting were representatives from the Bahía Magdalena region advocating the designation of a sea turtle sanctuary within the Banderitas area of Bahía Magdalena.

RECOMMENDATIONS

The major causes of sea turtle decline stem from anthropogenic factors, and with an awareness that there are cultural motivations involved in sea turtle exploitation, it seems appropriate to shift our conservation efforts in the direction of the people at local levels. While the science of conservation is continually creating new tools, the human dimension may be the area of research where most conservation gains can be made. By combining the knowledge gained through scientific investigations with the insights of the social sciences we stand a much better chance of succeeding in our recovery efforts (Agrawal, 1995; Grenier, 1998; Nichols, 2000; Nichols et al., 2000).

Recognition of the strong connection between the people and turtles -- and the richness of their cultural traditions and use -- as a conservation tool, may produce successful results. While many mainstream conservationists and environmentalists may not support less conventional approaches to conservation, particularly ones rooted in human dimensions, it is an area which needs to be given further credit and evaluation. It is important to realize that the local people and the outside researchers and environmental NGOs have the same underlying concern -- to see the turtle persist. Although the reasons behind this concern may be different, it is helpful to look beyond the differences and see that there is common ground on which to stand and work from. By fostering trust and communication between locals and outsiders, conservation efforts can only be strengthened.

By compiling information related to the evolution of specific community-based efforts within the Bahía Magdalena area, insights may be provided for other communities interested in designing and implementing similar conservation education and outreach programs. It is our hope that the information generated within these specific locations may also be used in implementing community-based sea turtle conservation initiatives or assessments of other community-based projects elsewhere.

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HIGH SUB-LETHAL TEMPERATURE EFFECTS ON THE MOVEMENT OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) HATCHLINGS

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INTRODUCTION

Thermal inhibition of movement could hinder the hatchlings ability to effectively climb out of their shells and/or the nests. Thermal inhibition of movement in hatchlings has been documented by Mrosovsky (1968) and Mrosovsky and Shettleworth (1968) for the green sea turtle (*Chelonia mydas*), and by O'Hara (1980) and Christens (1992) for *Caretta caretta*. A review of nest success data collected from the Miami Beach hatchery, Florida, from recent years has shown varying incidences of high numbers of pipped dead in the nests. As monitored nest temperatures from past years have indicated temperatures above 33 ^{o}C are not uncommon and have been as high as 37.2 ^{o}C, an evaluation of the possible effects of high nest temperature on hatchling activity was indicated. The present study evaluates the effects of high nest temperatures on the coordination of movement of loggerhead sea turtle hatchlings (*Caretta caretta*) from nests on a Miami-Dade County beach. This study will be used to evaluate if high nest temperature effects the movement of hatchlings and thereby increase the potential for a greater number of pipped dead at high temperatures.

Collection and Treatments

Three hatchlings from each of 17 nests were evaluated individually (N = 17, with 3 replicates). Temperatures evaluated were 29, 31, 33 and 35 ^oC. The hatchlings were tested as soon as possible following emergence. After hatchlings were collected for the individual experiment, the remaining hatchlings from all of the nests that had emerged were mixed together for the group trials. The hatchlings were placed on temperature-controlled sand to become acclimated to the test temperature for 30-36 minutes. Five turtles comprised a "group" for tests on the activity of a group. 19 sets of 5 turtles were conducted per treatment. (N = 19 per treatment, without replication).

Testing

The methods used in the present study were similar to those used by Mrosovsky & Shettleworth (1968). The hatchlings (individual or group) were placed in a 1-meter long alley inside a dimly lit room with beach sand lining the bottom (controlled to within 1 ^oC of the treatment temperature). One end of the alley was closed off and a light was positioned at the other end. All hatchlings were allowed 2 minutes to reach the end of the alley. If it took longer than 2 minutes, the distance traveled was recorded. For the group, the time/distance for each hatchling was recorded. All times/distances were used to calculate rate (cm/s). The "group" rate was the average of the individual rates of the group.

Data Analysis

Nonparametric One-Way ANOVA test (alpha = 0.05) was used to determine significant differences in the movement of the hatchlings at the different temperatures for both the individual and group experiments. Tukey's Pairwise Multiple Comparisons Test (Systat 1999) was performed to distinguish significant differences between treatments. Linear and nonlinear regression analyses were used to assist in identifying possible relationships between the level of activity and increasing temperatures.

Analysis and Comparison of Past Nest Data

Nest success and rainfall data of past seasons were used (1995-2000 excepting 1996). Temperature data for 1996 was not available. Methods for temperature measurements in the nest are described in Blair et al. (1998). Temperature data for the 3 days prior to emergence were summarized for analysis of historic data. Regional rainfall data was obtained from a National Weather Service rain station approximately 5 miles south of the hatchery. Total rainfall for 1 week, 2 weeks, and 4 weeks prior to emergence were evaluated. Regression analysis was used to identify relationships between either maximum temperature or rainfall and the number of pipped dead in the nest. Five temperature classes, based on those used for movement inhibition evaluation (i.e., 29, 31, 33, and 35 ^oC), were used. The mean number of pipped dead hatchlings per nest was tallied for each class, for each year.

RESULTS

A distinct decrease in the hatchlings' speed was noted with increasing temperature. Hatchling activity for both the individual and group activity showed a negative exponential relationship between movement and increasing temperature (R^2=0.9809 for the individual test; R^2=0.9945 for the group test) (Fig. 1). The One-Way ANOVA indicated highly significant differences between the treatments in both the group and individual experiments (df=3, P<0.001 for both individual and group tests). Tukey's Pairwise Multiple Comparisons Test found that the individual treatments separated by only 2 ^oC were not significantly different from each other, except in the 29 ^oC treatment, which was significantly different from the 31 ^oC (P<0.006). However, treatments separated by 4 ^oC or more were significantly different (Table 1). In the group tests, the 29 ^oC treatment was significantly different from all of the other treatments, but none of the other treatments were significantly different from each other (Table 1). Thermal inhibition seems to occur at 33 ^oC. The Mann-Whitney Rank Sum Test was used to determine whether the response of the individuals was different from that of the group. The t-test indicated that no significant difference between the individual and group results (P<0.130). In fact the results were very similar (Fig. 1).

Analysis of past nest data indicated that there is a strong negative exponential relationship between the maximum temperature within the 3-day period prior to emergence and the number of pipped dead (Fig. 2; R2=0.9496) for each year excepting 1997 (R^2 = 0.0283). 1997 however was an unusually cool year, with only two nests with maximum temperatures at or above 34 ^oC (Table 2), and very few pipped dead (2.141%). No significant relationship was found between rainfall and the number of pipped dead for any of the time durations (1 week, 2 weeks, and 4 weeks) for any year (R^2 = 0.07 for all comparisons).

DISCUSSION

Significant thermal inhibition of movement of the hatchlings with increasing temperature was documented in this experiment. The occurrence of thermal inhibition is consistent with previous research by Mrosovsky (1968), Mrosovsky & Shettleworth (1968), O'Hara (1980), and Christens (1992). Also, the temperature at which inhibition occurred (33 ^oC) is the same as the temperature found by O'Hara (1980). Past research documented a simple linear relationship between hatchling activity and increasing temperature (Christens 1992). The present study documents an exponential relationship. This may impart be due to higher temperatures evaluated in the present study than any of the previous studies. Additionally the hatchlings tested at 29 ^oC and at 31 ^oC were found to have much higher activity levels in the present experiment than in past experiments (3.25 cm/s and 2.1 cm/s versus 1.7 cm/s and 0.1 cm/s respectively). This discrepancy may impart be due to the difference in methods, since Christens (1992) only allowed movement for 1 minute.

Analysis of past nest data also showed a significant trend for the increasing number of pipped dead with increasing temperature over the last three days of incubation. There is a significant increase in the number of pipped dead that occurs in nests that experience maximum temperatures between 32 ^oC and 34 ^oC. This is consistent with the results found in the experimental portion of this study (thermal inhibition at 33 ^oC). These temperatures are also consistent with the upper thermal tolerance of sea turtle embryos, estimated at 33 ^oC to 35 ^oC (Ackerman 1997).

The presence of thermal inhibition is only one of many possible factors contributing to the high number of pipped dead occurring in some of the relocated nests on Miami Beach. It has also been shown, in both subadult Green sea turtles (*Chelonia mydas*) and Loggerhead sea turtles, that rate of ventilation, as well as oxygen consumption, increases with increasing temperature (Jackson et al. 1979; Lutz et al. 1989). This would indicate a possible oxygen stress in the nest.

Ackerman (1977) showed that the partial pressure of CO^2 rises and is coupled with a decrease in the partial pressure of O^2 as the nest incubates. PCO^2 reaches a peak at the time of hatching, coincident with a minimum in PO^2. Thus, oxygen stress can occur within the nest, and can be further exacerbated by the presence of high temperatures. The combination of the low oxygen level, high carbon dioxide level, and thermal inhibition of movement can easily result in the death of the hatchlings. Further research into the combination of oxygen and thermal stress needs to be conducted to determine the exact relationship of the two factors on the survivorship of the hatchlings.

Figure 1. The average velocity of hatchlings at each temperature (Mean ± SE). An average velocity for the treatment was calculated by averaging the velocities of the groups within the treatment, and these are the data plotted.

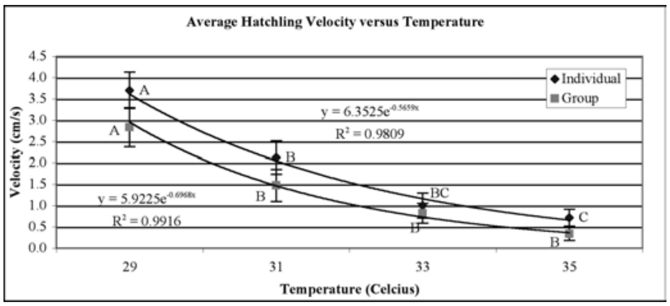

Figure 2. The effect of temperature on the number of pipped.

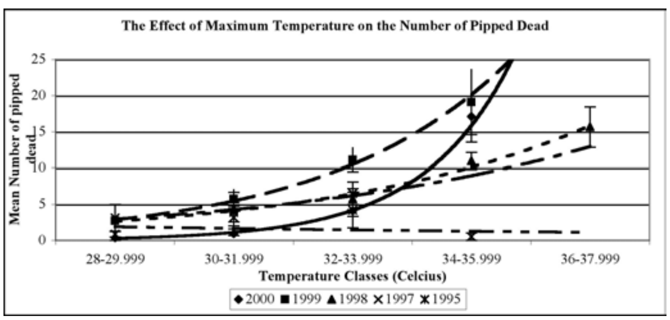

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Table 1. Results of a Tukey's Pairwise Multiple Comparisons Test for the individual tests and group tests.

Comparison	P individuals	P groups
29C vs. 31C	0.006	0.025
29C vs. 33C	<0.001	0.001
29C vs. 35C	<0.001	<0.001
31C vs. 33C	0.091	0.745
31C vs. 35C	0.018	0.305
33C vs. 35C	0.935	0.879

Table 2. The distribution of the number of nests that experienced maximum temperatures in the 5 temperature classes

Temp. Classes	2000	1999	1998	1997	1995
28-29.999	3	7		14	9
30-31.999	25	53	3	13	17
32-33.999	50	67	30	5	4
34-35.999	16	14	71	2	
36-37.999			21		

CHALLENGES AND PROSPECTS FOR SEA TURTLE CONSERVATION IN BENIN WEST AFRICA

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SUMMARY

Benin is a relatively small country in West Africa. Situated at the Gulf of Guinea, the country possesses a coastline of approximately 125 km. The conservation of natural resources has become a high political priority in Benin resulting , among others, in the protection of sea turtles frequenting the coast. The Beninese government signed the Convention on Biological Diversity (CBD) and the

Convention on Migratory Species (CMS) and actively implements its obligations. One of these obligations is the protection of all three endangered sea-turtle species that can be found in Benin.

Although the initiative has been taken by the NGO' Musée Nature Tropicale' the government fully supports their work. The results obtained over the last two years are very encouraging and the initiative is being followed with great interest by other countries in the sub-region. Local participation has been acknowledged as key to the success of the project. Participation is being realised through the creation of 'sea turtle conservation committees' and environmental youth-clubs in schools along the beach. With the support of local eco-guards, the Musée Nature Tropicale developed a monitoring programme for the various species as well as for their nesting sites. Although it is still too early to cry victory, it already can be stated that sea turtles are much safer on the beaches of Benin.

INTRODUCTION

One of the challenges of a sustainable development is the protection of biological diversity and its rational management. Nowadays, many animal and vegetal species are in danger of extinction. All species of sea turtles (olive ridleys: *lepidochelys olivacea* ; green : *chelonia mydas*, leatherbacks : *Dermochelys coriacea* and the hawksbill: *Eretmochelys imbricata*) known in Benin are classified on the danger list of the International Union for the Conservation of Nature (IUCN). The IUCN has therefore concluded that these species are in danger and measures should be taken to protect them. Thus, in accordance with the recommendations of various international treaties on the protection of wild fauna, such as the Bonn convention on the protection of migrating Species (CMS), the convention on Biological Diversity (CBD) and the convention on International Trade (CITES), projects have been undertaken throughout the world in under to ensure the survival of these species. The promoters of these projects face many problems, among which are hunting of turtles on the coastal shelf, accidental fishing by local and international fishers, poaching of turtles eggs, destruction of nests, destruction of the habitats and marine pollution.

In the coastal countries of West Africa in general and Benin in particular, the peoples poverty, inadequate scientific data and specialised competencies on migratory species, lack of partnership between these various countries increase the threats hanging on these migratory species. The political will now being displayed by the Government of Benin and other countries of the sub-region will eventually, lead to a sustainable management of our biological resources.

Global objective

Conservation and protection of sea turtles as well as the ecosystems upon which they depend in Benin, through a programme that a part of a regional strategy.

Specific objectives

- Reinforcement of the national assets towards a better acquaintance with, and conservation of sea turtle;
- Promotion of regional and international cooperation for the protection of sea turtle;
- Stimulation of preservation initiatives for sea turtle, supported by the development of alternative revenue-generating activities for the local people whose livelihoods depend on these resources;
- Inducing the participation of the public at large and the responsibilization of the local communities (Survival Committees) towards the preservation of migratory species;
- Setting-up a system for the valorisation and sustainable management of sea turtle through eco-tourism;
- Setting-up of protected areas along the coast and in the high sea;
- Drawing up IEC (Information, Education and Communication) Programmes at national level;
- Developing permanent monitoring studies on the migratory species.

METHODOLOGY

During the last semester of 2000, four (04) teams of two or three persons continued the campaign on the awareness, installation of survival committees, setting-up hatching areas, training of eco-guards and data collection an Benin beaches, based on the following zoning of the areas covered :

. Seme zone : Krake beach, by km 10, 24 km long;
. Cotonou zone : From Ambassadors zone to Togbin, 22,8 km long;
. Ouidah zone : From Agbehonou zone to Agonsodji beach, 28,2 km long;
. Grand-Popo zone : From Adjakaho zone, to Hilla-Condji beach, 46 km long.

The participative approach method had been backed by billposting, posters, image signboards illustrating the different species of turtles living in the Atlantic Ocean. The awareness session had been held in favour of fishers, local authorities, school pupils and members of environment clubs. Data collections were carried out on the various sites.

RESULTS

. Fifteen (15) survival committees on sea turtles have been set up and made partly operational.
. The training of Eco-guards (members of the Monitoring Committees) has been effected.
. Two existing hatching grounds at Hilla-Condji and Togbin have been made operational and put into use by the eco-guards.
. There is now a provisional hatching grounds, set up by the eco-volunteers, who showed a keen interest in the conservation of sea turtles.
. About 150 shells of slaughtered olive ridleys have been identified.
. There are protected nests on the beaches or transferred and protected up to hatching.
. Many hatchlings have been released on the beaches or into the sea with the local communities.

CONCLUSIONS

Action plan for the implementation of the programme of sea turtle conservation in Benin.

- Reinforcement of information sessions with the coast line people.
- Reinforcing the setting-up the monitoring and protection committees in respect of sea turtles in all the coastal villages.
- Creation of the monitoring funds on the sea turtles.
- Support for the revenue-generating activities that are beneficial for the programme.
- Training in techniques for the preservation and identification of turtles.
- Back-up scientific research.
- Provision of data banks and information and education materials.
- Setting-up partnership for the exchange of experiences on sea turtles preservation, within the framework of a regional programme for the survival of turtles along the coast of the Gulf of Guinea. This programme will enable the coordination of actions migratory species aiming at preserving and managing migratory species.

On the Atlantic coast of Benin, three species of sea turtles periodically come and lay eggs along the beaches. Lack of information on the status of these animal species result in their irrational management. Besides the captures of sea turtles along the beaches, they are also subject to net-fishing by fishers of Benin coastline, and especially the fishing trawlers in the high sea. The sea turtles and their eggs are very much sought for, for consumption, by the inhabitants of Benin coastline areas, despite the fact that these animals are subject to hunting or fishing prohibition as well as to local taboes on the part of some ethnic groups (Awlan, Guin…). The leatherback is very much sought for because of its rich fat.

The reponsibilization of the local communities, through a co-management system in which the later and the department of marine fishery will have to play complementary roles, will enable a sustainable management of these resources.

Regional cooperation for a full-scale protection of sea turtles dwelling within the Atlantic and along the Africa coasts, constitutes a major objective of any national plan, owing to the migratory status of the species concerned.

Acknowledgements:

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NEW MORPHOMETRIC DATA ON CAPTURED SEA TURTLES AT SAN ANDRES INLET, PISCO, PERU

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ABSTRACT

At the Inlet of San Andrés, Pisco, Perú, two species of sea turtles: *Chelonia mydas agassizi* (green turtle) and *Lepidochelys olivacea* (olive ridley) were registered. Peruvian seas are adult feeding areas and breeding subadult areas. From April to August 2000, the following measurements: maximum and minimum curved length (CCLmax, CCLmin), curved width (CCW), and straight length and width (SCLn-t, SCW) were made in thirty-six turtle carapaces. The carapaces obtained from furtive fishing activities, were captured two or three months before they were measured. Regarding the green turtle, those measuring less than 80 cm belong to immature individuals and those larger than 80 cm belong to adult individuals (Hays Brown & Brown, 1979). Thirty-two shells were measured, of which, following the above mentioned criteria, only four were adults (CCLmax 82.1 - 84.1 > 80 cm), the other twenty-eight belonged to immature individuals (CCLmax 51.5 - 76.9 < 80 cm). From the four measured olive ridley turtles, two were adults (CCLmax 67.6 and 68 cm), following Aranda & Chandler, (1989) who state that adult length ranges from 55 to 75 cm. Consequently, the other two were sub adults. These results confirm the presence of adults and subadults of *Chelonia mydas agassizi* and *Lepidochelys olivacea*, in Peruvian sea waters (Lat. 13°45' S, 76°15' W) as well as the continuance of their indiscriminate capture.

INTRODUCTION

Due to the strong occurrence of sea turtles at the inlet of San Andrés, this study was conducted. The main objectives were to assess the current status of individual captures made by local fishermen, differentiate males from females, and to specify the minimum size for sexual maturity.

Although there have been several morphometric studies performed along the Peruvian shore, they were conducted approximately 20 years ago. Due to this, the current assessment of morphometric data from sea turtles in Perú becomes an imperative issue. Furthermore, the knowledge of their individual status could amount to the fact that one of the reasons for the decline in the number of marine sea turtles would be a rise in the capture of sub adult individuals.

On the other hand, the research permitted us to get in touch with local fishermen who incidentally capture sea turtles. Having "cracked the ice", we can now organize environmental education programs which will, in turn, allow us to reduce the capture and commerce of marine sea turtles in the area.

Sea turtles are captured along almost the entire Peruvian shore (Frazier 1979), due to the fact that they are cold waters and contain a great food supply. Studies conducted in the area of Pisco, from January to April, 1969 document 20 green turtle measurements (Frazier 1979, data from Paredes 1969). It was not specified if these were straight or curve lengths but it is assumed that they were straight measurements. Of these 20 individuals only 4 were above 80 cm, the other 16 measured less than 80 cm. The straight length of 2 olive ridley carapaces at the San Andrés Inlet were also reported: 64.5 y 73.5 cm respectively. The author also reports measurements from 19 green turtle carapaces from Laguna Grande, San Andrés and Paracas. The majority of the measurements belonged to individuals from San Andrés, and in all cases, the green turtle measurements were less than 80 cm (Frazier 1979).

In another study, conducted along the 1,750 km of the Peruvian shore, the straight carapace length (SCL) of 416 green turtle carapaces was measured (Hays Brown y Brown 1979). Eighty nine percent of these were immature individuals (80 cm and less) and only eleven percent were mature individuals (above 80 cm). The southern Peruvian coast may be considered as a developing habitat, since immature individuals comprise the majority of the population. Regarding hawksbill carapaces, measurements were taken from 4 individuals, ranging from 30.5 to 41 cm. Additionally, six olive ridley carapaces were measured and they ranged from 47.5 cm to 72 cm. At Pucusana, Lima, 115 leatherbacks were measured, and they ranged from 112 cm to 168 cm (Hays Brown y Brown 1979). Considering that 130 cm is the size at which Pacific leatherbacks reach sexual maturity (Hays Brown y Brown 1979), seventy one percent of these individuals were mature while twenty nine percent were immature individuals. After 1979, no sea turtle carapace measurements have been made in Perú.

MATERIALS AND METHODS

Fieldwork was conducted at the Inlet of San Andrés (Lat. 13°45' S, 76°15' W). The carapace measurements were made using a flexible tape. The tail length was taken from individuals that were found alive.

We only could work with two individuals found alive, the other carapaces which we worked with were provided by a family of fishermen. The turtles had been sacrificed some months ago and had been stored in an abandoned hut (Photo # 1). The carapaces were waiting to be cleaned and varnished in order to sell them locally to houses and restaurants as decorative wall objects.

Carapace measurements were differentiated in the following way: Minimum curve carapace length (CCLmin), curve carapace length notch to tip (CCLn-t), and straight carapace length notch to tip (SCLn-t). Curve and straight carapace width were measured at the widest point.

The tail had two measurements: Total tail length (TTL) which is the distance from the midline of the posterior margin of the plastron to the end of the tail following its curvature, and post cloacal tail length (PTL) which is the distance from the midcloacal opening to the end of the tail following its curvature.

RESULTS

The study was realized with the only two species found: Green turtle (*C. mydas agassizi*)(Photo # 2) and olive ridley (*L. olivacea*). Resulting measurements are shown in Table 1.

Regarding the green turtle (*C. mydas agassizi*), 32 carapaces were found, the major CCLmax was 84.1 cm and the minor CCLmax was 51.5. The mean for this n = 32 is 66.94 cm. The TTL and PTL from the single specimen found alive of this species, were 21 cm and 5.1 cm respectively (Photo #3).

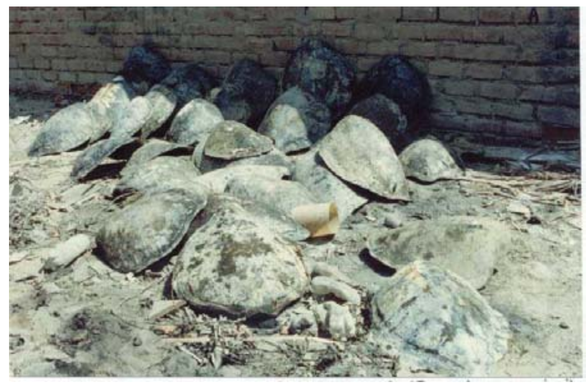
Regarding the olive ridley (*L. olivacea*), 4 carapaces were found, the largest CCLmax was 67.6 cm and the smallest was 48.8 cm. The mean for this n = 4 is 58.8 cm. In the same way as the green turtle it was only possible to obtain one alive individual of this species. The TTL and PTL were 10.2 and 2.9 respectively.

DISCUSSION

Based on the current literature (Pritchard, 1999), the maximum length for the green turtle is 90 cm. Due to this we could affirm that only four individuals, which measured above 80 cm, were mature individuals. The rest of the carapaces measured less than 70 cm, so they belonged to immature individuals. It was impossible to compare the size of females and males because we only found two alive females and the rest of the data were taken from carapaces belonging to dead individuals.

With respect to the olive ridley, the maximum length registered is 72 cm (Pritchard, 1999). According to this, we could suggest that only two of the measured carapaces belonged to mature individuals (68 cm and 67.6 cm), the rest belonged to immature individuals. In this case we could not differentiate females from males.

Tail length can help us make a sexual differentiation in the two species because males present a much longer tail than females , but due to the fact that we could only work with two alive individuals that were females, we did not have the opportunity to see a male tail.



CONCLUSIONS

Results show a high capture of immature individuals.

It was impossible to make a sexual differentiation because of the fact that we worked principally with carapaces and only with two alive individuals.

The most captured species in this zone is *Chelonia mydas*, followed by *Lepidochelys olivacea*. Carapaces from *Dermochelys coriacea*, *Eretmochelys imbricata* and *Caretta caretta* were not found.

However local fishermen mention that *Dermochelys coriacea* is seen in this zone.

The continuation of this research is suggested as it will permit us to document the possible decrease of sea turtle populations in the Southeastern Pacific shores due to an increase in the capture of sub adult individuals.

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Table N° 1 Measurements on *Chelonia mydas* and *Lepidochelys olivacea*.

						Scutes					
Caparazón	CCLn-t	CCLmin	CCW	SCLn-t	SCW	C	P	M	Locality	Species	Observations
C1	65	63	57.8	56.4	51.3	5	4	11	San Andrés	*C. mydas*	
C2	62.5	62.2	61.9	60.1	52.7	5+1	4	11	San Andrés	*C. mydas*	
C3	73.5	72.5	75.5	69.7	60.8	5	4	12	San Andrés	*C. mydas*	
C4	74.1	73.7	77.6	71.2	61.3	5	4	12	San Andrés	*C. mydas*	
C5	68	67.6	66.4	63	55.8	5	4	11	San Andrés	*C. mydas*	
C6	58.1	57.6	58.3	54.3	50	5+1	4	11	San Andrés	*C. mydas*	
C7	55.6	52.2	58.1	54.3	38.1	5	4	11	San Andrés	*C. mydas*	
C8	69.2	68.9	70	65.8	56.9	5	4	12	San Andrés	*C. mydas*	
C9	59.9	59.4	60.2	56.6	54.9	5	4	11	San Andrés	*C. mydas*	
C10	82.1	81.7	80.8	76.6	67.4	5	4	12	San Andrés	*C. mydas*	
C11	65.9	65.6	63.3	63.1	54.2	5+1	4	11	San Andrés	*C. mydas*	
C12	57.1	56.8	55.4	53.9	48.3	5	4	12	San Andrés	*C. mydas*	
C13	76.2	75.2	77.4	74.4	58.9	5	4	12	San Andrés	*C. mydas*	
C14	82.8	82.3	80.4	78.5	62	5	4	13	San Andrés	*C. mydas*	
C15	65.5	64.7	63	62.9	49	5	4	12	San Andrés	*C. mydas*	
C16	62.3	61.9	61.9	58.2	50.3	5	4	12	San Andrés	*C. mydas*	
C17	66	65.5	69.7	62	49.2	5	4	12	San Andrés	*C. mydas*	
C18	51.5	51.2	52.4	48.2	47.1	5	4	12	San Andrés	*C. mydas*	
C19	68.7	68.5	67.1	65.3	57.7	5	4	12	San Andrés	*C. mydas*	
C20	66.2	66	66.5	61.5	56.7	5	4	12	San Andrés	*C. mydas*	
C21	56.7	56.6	57.6	53.2	47.4	5	4	12	San Andrés	*C. mydas*	
C22	63.2	62.9	63.3	59.7	51.5	5	4	12	San Andrés	*C. mydas*	
C23	70.4	69.9	66.5	65.6	54.5	5	4	12	San Andrés	*C. mydas*	
C24	73.1	72.6	71.7	68.7	57.8	5	4	12	San Andrés	*C. mydas*	
C25	84.1	83	84.5	80	68	5	4	12	San Andrés	*C. mydas*	
C26	68.1	67.6	66.7	65.5	58.9	5	4	12	San Andrés	*C. mydas*	
C27	56.9	56.4	58.2	53.6	49.7	5	4	12	San Andrés	*C. mydas*	
C28	68	67.1	70	65.7	51.3	5	4	12	San Andrés	*C. mydas*	
C29	55.2	54.6		51.2	49.4	5	4	11	San Andrés	*C. mydas*	
C30	83.2	82.9	81.8			5	4	12	San Andrés	*C. mydas*	captured 28/04/2000
C31	56		56.5			5	4	12	Chimbote	*C. mydas*	captured 20/11/1999
C32	76.9	74.2	75.3	71	59.9	5	4	12	San Andrés	*C. mydas*	captured 01/07/2000
Average	66.94	66.59	66.96	63.01	54.37						
C33	67.6	66.8	71	65	57.3	5	6	11	San Andrés	*L. Olivacea*	
C34	68	67.3	71	65.7	59.4	5	6	13	San Andrés	*L. Olivacea*	
C35	50.3	49.7	54.4	46.6	46.1	5+1	6	11	San Andrés	*L. Olivacea*	
C36	48.8	48.2	52.6	46.5	43.1	5	6	11	San Andrés	*L. Olivacea*	captured 13/05/2000
Average	58.68	58	62.25	55.95	51.48						

COMPARISON OF FIBROPAPILLOMA RATES OF GREEN TURTLES (*CHELONIA MYDAS*) FROM TWO DIFFERENT SITES IN ST. LUCIE COUNTY, FLORIDA.

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INTRODUCTION

Fibropapillomatosis (FP) is a debilitating and sometimes fatal disease found in marine turtle populations worldwide (George,1997). Although it has been reported in other cheloniids, FP was first described and is most common in green turtles (*Chelonia mydas*; Smith and Coates, 1938). This disease is manifested externally by benign tumors found on the soft tissue, seams and scutes. Severe cases can result in hindered locomotion, loss of vision and mortality (Herbst, 1994).

While the etiology of this disease has yet to be discovered, geographic hotspots have been identified. Many of these areas, where FP is at epizootic proportions, correspond to bays, lagoons and waterways that have been degraded by pollution (Landsberg et al., 1999). In this study we compared green turtle FP rates found at two sites in St. Lucie County, Florida. While these sites are within the same geographic region, they represent different habitat types; estuarine lagoon and Atlantic wormrock reef.

METHODS

Turtles were captured at two different study sites at Hutchinson Island in St. Lucie County, Florida. Hutchinson Island is a 36 km long barrier island on the east central coast of Florida and is bounded on it's east coast by the Atlantic ocean and on it's west by the Indian River Lagoon (IRL).

The first site is located at the St. Lucie Nuclear Power Plant's intake canal, approximately 15 km south of the islands north end. Ocean water enters into a one km long intake canal through three large diameter pipes (see Bresette, 1998). The submerged intake structures are 365 meters offshore and in seven meters of water in proximity of wormrock reefs to the south and west. Turtles entering these structures are quickly entrained into the intake canal.

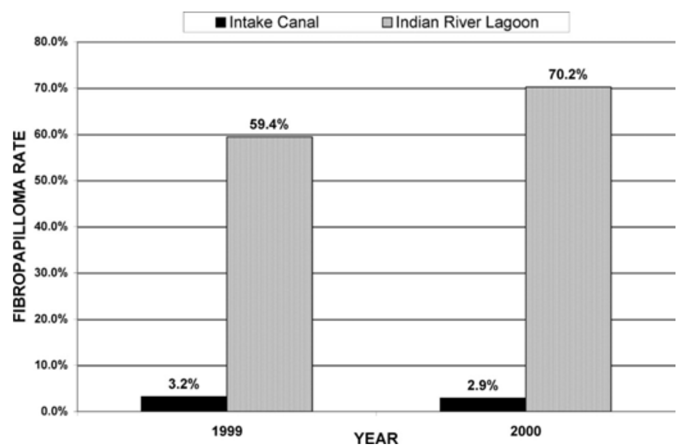
The second study site is in the IRL at Jenning's Cove, 2 km south of the Ft. Pierce inlet. This cove is located 100 meters off the west bank of Hutchinson Island where water depth is between 4-7 meters. This depth is atypical of the lagoon which has an average depth of 1–3 meters. This is due to a large dredge hole which is approximately 200 meters wide by 300 meters long. Our research efforts were concentrated in this area.

Green turtles were captured at both sites in 1999 and 2000. In the IRL, a 100 meter long tangle net was deployed by boat. The top of the net has fixed buoys every three meters and a lead core line is used at the bottom. The net is seven meters deep and has a 40 cm stretch mesh. At the intake canal, two tangle nets were set by boat and attached to fixed structures or buoys at each end. These tangle nets are approximately 30 to 60 meters in length with a 40 cm stretch mesh and six meters deep. The top of these nets have fixed buoys every two meters, but unlike the lagoon net there is no fixed lead line. Turtles were also captured at the intake canal by dipnet and SCUBA. Sampling was conducted seven days a week at the intake canal and 1-2 days a month at Jenning's Cove.

Regardless of study site, turtles that became entangled in these nets were quickly removed and inconel # 681 metal tags were applied to the trailing edge of both front flippers. At the lagoon site a PIT tag was also applied to the right front flipper. A series of morphometric measurements were made using calipers and a flexible tailor's tape. Photographs were taken both dorsally and ventrally and any abnormality or injury was recorded. A thorough check for fibropapillomas was performed on each turtle. When tumors were identified they were measured by small calipers and recorded. Turtles were categorized by tumor severity using the methods found in Work and Balazs (1999). With the exception of turtles needing rehabilitation, all turtles were released near their capture sites shortly after processing.

A Mann-Whitney test was performed to determine differences in fibropapilloma rates between study sites and between years at each study site. Additionally, a students t-test was used to assess differences in straight carapace lengths (SCL) of green turtles at these sites. All statistical tests were performed using Prism version 3.0 for Windows (Graphpad software, San Diego California).

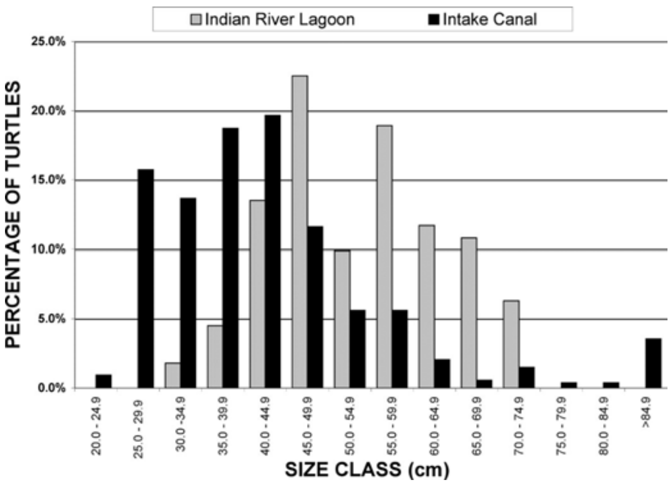
Figure 1. Fibropapilloma rates of green turtles at two sites in St. Lucie County Florida, 1999 and 2000.



RESULTS AND DISCUSSION

In this study, remarkable differences in FP rates between sites were found. Green turtles at our Jenning's Cove site had a significantly higher rate of FP than those found at the intake canal (Figure 1, Mann-Whitney, U = 51.0, P = .0001). We also found similar results when analyzing FP rates for each year of the study. The FP rate at Jenning's Cove was significantly greater than the rate found at the intake canal in 1999 (Mann-Whitney, U = 8.0, P = .0007) and 2000 (Mann-Whitney, U = 18.0, P =.0061) These results were not entirely unexpected given that we were aware of a similar situation at study sites in Indian River County (Ehrhart et al., 1996).

Figure 2. Size frequencies of green turtles found at two sites in St. Lucie County,Florida, 1999 and 2000.



What we did find notable was the difference in size distribution of green turtles found at these two study sites (Figure 2). The mean SCL for green turtles at the intake canal of the power plant was 40.9 cm + 0.47 (n = 515) and was found to be significantly different than the mean SCL of 53.9 cm + 0.94 (n = 111) found for green turtles at Jenning's Cove (t -test, t = 11.75, P < .0001). This size discrepancy in SLC was unexpected given the close geographical location of the sites. Green turtles at the Jenning's Cove site appear to be larger than any aggregation of immature green turtles reported for the IRL (Ehrhart et al., 1996; Provancha, 1998). This may be a function of our relatively brief sampling period. More data is needed to determine if this represents a true size class difference among green turtles in the IRL.

Tumor score (number and size of tumors) can vary widely among turtles with FP and is a good indicator of severity. While there is a significant difference in the disease rate between our two sites there doesn't appear to be any difference in the range of severity.

The results of our study suggest that green turtles inhabiting the Indian River Lagoon are at a far greater risk of contracting FP than those found on the nearshore reefs just a few kilometers away. Clearly, something in the lagoon is promoting the prevalence of FP among green turtles. The degraded condition of the lagoon, caused by anthropogenic activity, could be a contributing factor. Future studies are needed to elucidate any possible link between environmental conditions and FP in these turtles.

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We would like to thank Florida Power and Light Co. for their continued support of the Sea Turtle Research Program at the the St. Lucie Power Plant. Special thanks to Barbara Schroeder of NMFS, Bruce Peery, Jonathan Gorham, Chris Koeppel, Blair Witherington, Carrie Crady and Dr. Ehrhart and his students at the University of Central Florida, specifically Karen Holloway-Adkins and Dean Bagley, for their help and support of our netting project at Jenning's Cove in the Indian River Lagoon.

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STATUS OF GREEN TURTLES NESTING ON ASCENSION: LOOKING TO THE FUTURE.

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Since its discovery in 1501 Ascension has been famous for the green turtles (*Chelonia mydas*) which nest upon its beaches. These turtles provided the fresh meat for passing ships. Turtles were also taken back to the UK for the King and some for the Lords of the Admiralty who found turtle soup a great delicacy. The turtles were kept alive onboard the ship for the journey home, given no food and only had the occasional bucket of water thrown over them. Sometimes few survived the journey but it seems that the majority did. In 1822 over 1500 turtles were harvested but by the 1860's the population had been affected and less than a few hundred were harvested each year. By the 1920's the trade in turtles had virtually stopped, although a few were still caught for Island residents.

Recent research (Godley et al 2001: Biological Conservation 97:151-158) has shown that the number of green turtle clutches laid on Ascension Island each year is in the region of 10-15,000, making this one of the most important nesting colonies on the Atlantic Ocean.

There are very few threats to turtles nesting on Ascension Island and with a population of less than 1000, human disturbance is low. Some nests are lost to high seas and through the digging activities of other females. Feral cats, seabirds, land crabs and fish will take many hatchlings.

At present Ascension Island is not open to large scale tourism, permission is required to visit the island and most visitors are associated with the companies that operate on the island. However, currently the status of the island is under review and there are plans to encourage small scale tourism. We are currently setting in place logistics to protect the nesting beaches, females and nests and in particular to prevent any impact on the turtles from tourism. The following goals have been achieved or are underway:

1) The Ascension Island Turtle Group has been established.
2) Wardens now provide information and guide tours to see nesting turtles.
3) Information boards have been produced.
4) A leaflet has been produced which visitors to the island receive on arrival.
5) The major nesting beach is now closed to vehicles at night.
6) A visitors centre is being established with educational exhibits
7) An increase in both national and international awareness of the turtles at Ascension.
8) A turtle stranding network has been established.
9) A programme has been established to clear invasive plants from beaches.

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This work was supported by grants from the Department of the Environment, Transport and Regions (DETR) Darwin Initiative Programme for the Survival of the Species, the Foreign and Commonwealth Office Environment Fund for the Overseas Territories, Natural Environment Research Council of the UK (NERC). We are grateful for the additional logistical support of Ascension Island Services, Cable and Wireless, Computer Services Raytheon, Merlin Communications Ltd., Royal Air Force, United States Air Force. The authors thank the Symposium Overseas Travel Fund for assistance in attending the symposium.

PRELIMINARY RESULTS ON THE DISTRIBUTION AND MOVEMENT OF GREEN TURTLES (*CHELONIA MYDAS*) IN ESTERO BANDERITAS, BAJA CALIFORNIA SUR, MEXICO

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Eastern Pacific green turtle (*Chelonia mydas*) stocks continue to decline despite national and international protection. Pacific coastal lagoons in Baja California, Mexico, provide important feeding and developmental habitats for these turtles. However, mortality due to direct and indirect take on feeding grounds has impeded population recovery. Fishing cooperatives in Bahía Magdalena have recently taken strides to create a sea turtle conservation area on their fishing grounds. We studied the distribution and movement of juvenile sea turtles in Estero Banderitas, Baja California Sur, Mexico, over a nine-month period to obtain preliminary results with regard to abundance, homerange and potential reserve boundaries. The small average size of turtles caught in Estero Banderitas (SCL=51 cm., n=32) suggests that this area is an important feeding habitat for juvenile turtles. Turtles may show site fidelity throughout the year, and initial growth data indicate higher summer growth rates. Our results suggest that Estero Banderitas is an ideal site for monitored protection and research.

INTRODUCTION

Eastern Pacific green turtles, also known commonly as black turtles or tortuga prieta (*Chelonia mydas*), have been protected on their Mexican nesting beaches for the past twenty years by national and international law and intensive conservation programs (Cliffton et al. 1982). Assessment of these efforts indicates that they are largely effective, yet numbers of nesting females have declined during this same period (Alvarado and Delgado, this symposium). Green turtles on their feeding and developmental grounds are subject to poaching and incidental catch. Mortality is estimated at between 8,000 and 30,000 turtles per year in waters off the Baja California peninsula – perhaps the most important region for developing and feeding East Pacific green turtles (Nichols 2000, Gardner and Nichols, in press).

Bahia Magdalena is regarded as a critical feeding area on the penisula for juvenile and adult turtles. It is believed that turtles enter this area at the beginning of their benthic, developmental phase (approximately 40 cm), growing and feeding primarily on sea grass and algae in the bay until they reach maturity (Nichols, pers. obs., Hilbert et al., this symposium). Reproductive adult green turtles also occur in the region (Figure 1).

Preliminary studies were conducted in Estero Banderitas, one of the largest channels of the Bahía Magdalena-Almejas complex , to assess the demographics of the green turtle aggregation. Studies conducted from June 2000 through February 2001 focused on mark-recapture, habitat mapping, home range analysis, and morphometric studies. In addition, work was begun with eight fishing cooperatives towards establishing a sea turtle conservation area with a nuclear protected area at Estero Banderitas (Bird and Nichols, this symposium).

METHODS

Two 100-m entanglement nets were deployed to catch turtles within Estero Banderitas at three locations. The nets were drifted with the current or anchored across channels, depending on tidal conditions, and were constantly monitored by kayak. Standard morphometric data were recorded for each turtle captured, including straight carapace length (SCL-measured notch to tip), curved carapace length (CCL), and weight. Inconel tags (National Band and Tag Company, Newport, KY, USA) were attached to the rear flippers of each turtle. Turtles were released at the site of capture.

Turtle sightings were recorded during regular kayak surveys. Benthic habitat, tidal cycle and water temperature were recorded at each capture and sighting location.

RESULTS

A total of 37 green turtles were captured during the nine-month study period. Of these, 5 were recaptures. Average SCL was 51.0 cm (n = 32, range = 42.8 – 65.0 cm). CCL averaged 54.3 cm (n=32) and average weight was 40.9 lbs (n = 29, range = 20.0 – 87.0 lbs). Turtles were captured in both summer and winter months and water temperature varied from 16 C to 29 C.

Of the five turtles recaptured, four were at large for two months or more. Two of the turtles (BMA-6JUL2000-1 and BMA-7AUG2000-2) were initially captured in summer. These showed higher average growth rates upon winter recapture than the two other turtles (BMA-10OCT2000-1 and BMA-30NOV2000-2), which were only captured during winter months and showed almost negligible monthly growth (Table 1).

Catch per unit effort was calculated by dividing the total number of turtles captured by the total effort. Each unit of effort represents deployment of one 100 m net for up to 12 hours. A total of 37 units of effort resulted in 37 individual captures, an average of 1 turtle/unit of effort (CPUE = 1).

Sightings from kayak, most often of turtles surfacing to breathe, were recorded throughout the estero during summer and winter months, with summer sightings being markedly higher in number.

DISCUSSION

The size distribution of green turtles in Estero Banderitas indicates that this is an important area for developing juvenile turtles. Adult turtles are frequently encountered in deeper waters both within and outside the bay. However, there is a marked absence of mature, adult-size turtles within the estero. Also, size data show that turtles in the estero tend to be relatively small in comparison to the overall size range for the Baja California region (Figure 1). This suggests that green turtles may be spending several years growing and developing in the relatively shallow waters of Estero Banderitas before entering the deeper bay as they reach larger sizes.

Turtles were captured in the estero in both summer and winter, indicating that they are utilizing this area year round. Recapture data provide evidence for individual year-round residence, as two turtles were captured both in summer and winter months.

Our initial data suggest that turtles in Estero Banderitas experience optimal conditions for growth during the summer and early fall months (Table 1). Assuming negligible growth during winter months, a rough estimate of growth during summer months is 0.39 – 1.2 cm/m (~3.4 cm/y). In the winter and spring, when water temperatures reach 16º C, activity and feeding levels may decrease.

Preliminary observations of daily movements indicate that turtles are traveling north and south within the estero, primarily following the channels. Tidal magnitude appears to play a significant role in direction and speed of this movement, and we hypothesize that turtles are using the tides in their travel throughout the channels.

Catch per unit effort (CPUE) data suggest that Estero Banderitas still harbors a high number of turtles relative to other study sites in Baja California. CPUE data at other sites have consistently been below 0.5 in the last 8 years (Nichols 2000). A CPUE of 1 in this area emphasizes the importance of timely protection.

Future research will include continuing demographic studies with the goal of directly informing management decisions regarding the establishment of a sea turtle sanctuary in Bahía Magdalena. Daily migration patterns within the estero will be further researched using radio and sonic telemetry. Use of tidal currents in daily movement will be specifically studied, with future work relating to energetic implications of passive, semi-diurnal tidal movement. Analysis of diet, feeding area, benthic habitat, and added mark-recapture data will help determine effective reserve boundaries and management.

Recent work within the Puerto San Carlos community has led to the formation of the Comité para la Protección de la Tortuga Marina, a committee comprised of members of eight fishing cooperatives (Bird and Nichols, this symposium). These cooperatives are variously in possession of or applying for the concessions to Estero Banderitas for current low impact fisheries that will allow for continued productive use of the region’s resources while protecting sea turtles. They are working directly with the project to establish a sea turtle sanctuary within their concession areas. Our preliminary studies indicate that it is an ideal reserve site. Estero Banderitas is one of the few areas within the Bahía Magdalena complex to harbor a relatively high abundance of green turtles. It provides important habitat not only for sea turtles but also for numerous other resident and migratory species, including bottlenose dolphins and gray whales. The cooperatives are also working together to promote wildlife eco-tourism in the region.

Estero Banderitas will act as one of four long-term monitoring sites for the Baja California region and will be used to assess the impact of combined conservation efforts on nesting beaches and feeding grounds. It currently stands as one of the last known habitats for relatively high numbers of East Pacific green turtles in Baja California. It has the potential to become one of the first in-water sanctuaries and to lead recovery of this population.

CONCLUSIONS

1. Estero Banderitas is an important feeding and developmental area for juvenile East pacific green turtles due to its relatively high numbers of turtles, potential for protection, low fisheries pressures, and ideal - near pristine - habitat characteristics.
2. Current threats, including poaching and incidental catch, to sea turtles in Baja California underline the need for community-initiated protected areas for these endangered animals.
3. Further research is needed on habitat range and use, feeding ecology, demographics, and the establishment of protected areas in harmony with economically sustainable activities.

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SAND GRAIN SIZE CHARACTERISTICS AND INCUBATION TEMPERATURE AT THE GREEN TURTLE NESTING BEACH IN AVES ISLAND, VENEZUELA

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Aves, a small island of 4 hectares that rises just a few feet above sea level, is located 600 kilometers north of the Venezuelan mainland, and although its green turtle population has been estimated in only between 350 and 1500 reproductive females, is the main nesting site for *Chelonia mydas* in the eastern Caribbean. Aves (Bird Island), is also an important breeding ground for various tern species and in 1972 was declared a wildlife refuge, and some years later a navy post was built. In 1979 FUDENA (Venezuela Nature Conservation Foundation), began to study the green turtle nesting population with a tagging program that lasted for nearly two decades. For those years, the location of each nest was classified according to 12 north to south and west to east, zones of the island. Through the years, nesting frequency showed a clear preference for certain sites, being specially high in the northwestern tip of the island.

In July 1995, a sand sample was taken at each of the twelve zones, and the grain size parameters analyzed in relation with nesting intensity using a multivariate approach. Sand around the island was found to be quite homogeneous, medium to coarse sand with grain size around 0.5 mm and moderately well sorted. However, a Principal Components Analysis (PCA) whose two first components accounted for 74% of the variability, placed the samples from the four zones that historically concentrate more than half of the nests, in the negative side of component two, that is positively and heavily weighted by the dominance of 0.5 mm grains. The PCA indicates positive relation of nesting intensity with the less sorted sand areas. Sorting also splits the sands from the east coast, from those less well sorted of the west coast, where 62% of the nesting takes place. The more frequently used nesting areas have mean sand grain size of 0.5 mm, but with the presence of 0.25 to 2 mm grains.

The temperature of three nests was measured every four hours, during the first 21 days of incubation in July 1995. The nests were located in the northeastern part of the island, an area that historically only accounts for 5 % of the nests. Inter-nest mean temperature ranged from 29.0 to 30.3 °C for the 21 day period. Daily variation ranged from 0.5 to 3 °C. The lowest recorded temperature was 27.5 °C at 2.00 a.m. and the maximum was 32 °C at 6.00 p.m. Although Aves is in the hurricane path of the Caribbean and July is a peak month in the season, no heavy rain fell during the study time and only tropical storm "Chantal" formed 500 km to the north. The three nests showed a sharp increase of 2 °C (from 28-29 °C to 30-31°C) during the last 4 days of measurements, probably due to a change in weather conditions. So, if this trend continued, during the middle third or thermosensitive period of incubation, nests will probably be above pivotal temperature and produce mainly females.

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VOLUNTEERING FOR NATURE: EVALUATING EXPERIENCES OF VOLUNTEERS WITH THE CARIBBEAN CONSERVATION CORPORATION IN TORTUGUERO, COSTA RICA.

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Volunteers play a critical role in conservation, and marine turtle conservation benefits from the willingness of concerned and committed individuals to donate time and/or money to the cause. In an age of government downsizing, the importance of volunteers to conservation programs will continue. Since 1996, the Caribbean Conservation Corporation (CCC) has been surveying research assistants and participant researchers volunteering at the John Phipps Biological Research Station in Tortuguero, Costa Rica. The purpose of the survey is to monitor satisfaction with, and make any necessary changes to, the program, and to provide volunteers with an opportunity to comment on their experiences. In 1998, the CCC agreed to share this data with researchers at the University of Western Ontario, in London, Ontario, Canada, who are interested in volunteer characteristics and motives, as well as their experiences in the program. Survey results from 1996-1998 (n=138) have been analyzed. While some results are quite specific to the CCC's work in Tortuguero, most are more general and may be useful to other organizations operating volunteer programs.

Results presented detail volunteer evaluations of their overall experience, the best and worst components of their experience, and their motivation for participating. Chi Square tests (0.05 significance) were used to determine if volunteer evaluations varied by year in program, gender, or their role as a participant researcher (short term stay that volunteers pay for) or a research assistant (long term stay with room and board provided). Overall, volunteers rank all aspects of their experiences positively. Gender had no significant influence on responses. Year in program was related to evaluation of overall, best and worst things about the program, but not to motivation for participating. Whether or not the volunteer was a participant researcher or a research assistant was related to responses to all questions. In general, research assistants were more critical of all components of their stay. Given that participant researchers pay for their experience, it was anticipated that they would have higher expectations, but this does not appear to be the case. Participant researchers and research assistants appear to be distinct groups, and this poses a management challenge for the CCC.

COMPARISON OF THE HATCHING SUCCESS BETWEEN TRANSLOCATED NESTS AND "IN SITU" NESTS ACCORDING TO THE TYPE OF SUBSTRATE AND THE FLOODS DUE TO THE TIDE

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INTRODUCTION

A new nesting colony of *Caretta caretta* has recently been discovered and described in Boavista (Cabo Verde, Western Africa, FIGURE 1). Although more data are needed, it represents one of the most important populations in the North Atlantic (Brongersma, 1982; ; Ross, 1995; López-Jurado & Andreu, 1998). A tagging and management campaign has been established in Boavista to study this nesting population since 1998.

Several clutches of *C. caretta* in Boavista are laid by the females in improper places, in sand with roots of vegetation, in very compressed sand, or in places usually flooded by tides or rain. During the 1999 season we observed that hatching success was very low (less than 50%, unpub. data), in the beaches of Ponta Cosme and Ervatão, in the southeastern coast of the island, where the density of nesting females is very high. An experiment of artificially incubation of nests was designed in a closer beach to safeguard the survival of hatchlings of *C. caretta* with little probabilities of success in their natural places. We present next data on hatching and emergence success (see Miller, 1999, and Mortimer, 1999).

MATERIAL AND METHODS

In the beach of Benguinho, closer to Ponta Cosme and Ervatão, a hatchery of 225 m^2 was built as recommended by Mortimer (1999), with parcels of 1 m^2 each. All clutches relocated were reburied in the two following hours after they were laid by the female (Miller, 1999), inside 45-cm-deep chambers, which was approximately the same depth as the ones observed in natural nests.

Between 7th July and 27th August 2000, a total of 100 nests were relocated to the hatchery from Ponta Cosme and Ervatão, originally laid in improper places. Another 110 nests were monitored in their original places to compare the results.

After 45 days of incubation, a plastic net was placed around the nest to retain the emerging hatchlings for counting and measuring. When the total number of hatchlings emerged was closer to the number of eggs deposited by the female, or after 70 days of incubation without any noticed emergence, it was excavated with caution, categorizing the content shown below (Miller, 1999; TABLE I).

The analysis of hatching success (percentage of hatchlings that hatch out of their shells) and emergence success (percentage of hatchlings that reach the beach surface) was made as defined in Miller (1999), and the incubation period was calculated since the day of oviposition by the female, until the day of first emergence (Alvarado

& Murphy, 1999), because of the difficulty of controlling hatching moment.

RESULTS

A total of 234 nests were monitored, and 165 of them were included in the analysis (88 from hatchery and 77 natural), excluding nests with doubtful results and those in which the marks were lost due to tides and rain.

The incubation period for *C. caretta* in Boavista is 59.0 days (SD=4.21, Range=50-73, N=87), without any significant differences between nests incubated in the hatchery (Mean=58.9 days, SD=3.12, Range=51-66, N=91) and those on the beaches (t=-0.636, p=0.52).

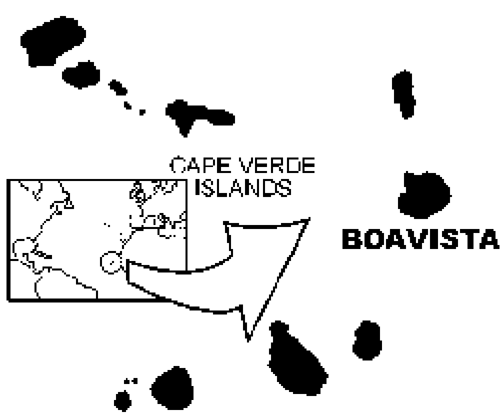
Hatching success for loggerheads in Ponta Cosme and Ervatão averages 46.9% (SD=38.45, Range=0-100, N=77), whereas it averages 63.5% in the hatchery (SD=22.54, Range=0-100, N=88). In the hatchery, the hatching success is significantly higher than on the beaches (Mann-Whitney: U'=4036.50, p=0.034, FIGURE 2).

Furthermore, emergence success in Ponta Cosme and Ervatão averages 43.4% (SD=38.83, Range=0-100, N=77), and in the hatchery the mean is 62.6% (SD=22.79, Range=0-100, N=88). As we saw before, there are significant differences in emergence success between the hatchery and the beaches (Mann-Whitney: U'=4204.50, p=0.007), the percentage being higher in the former one (FIGURE 2).

DISCUSSION

Incubation period for *C. caretta* in Boavista ranges between the values reported in the literature, more closely related to thermal regimes of more temperate regions, e. g., North Carolina and Turkey (see revision in Dodd Jr, 1988).

Figure 1. Map showing Cape Verde Islands, and the position of Boavista.



Hatching success for *C. caretta* in Boavista seems to be low (TABLE I). The beaches of Ponta Cosme and Ervatão have a very high density of nesting females, but they also have features which are improper for nesting, due to the very short range of useful sand and because they are very frequently flooded by tides and rains. It is possible that in other beaches of Boavista with more proper characteristics the hatching success is higher, as in Calheta (70%, unpub. data). As the hatching success increases significantly in the hatchery, the goal of the project of safeguarding survival of hatchlings is achieved. Moreover, further research must be planned with caution, so as not to affect other parameters of population, such as sex ratio (Mortimer, 1999).

Emergence success seems to vary little with respect to hatching success, so it is low compared to other populations (TABLE I). But it is interesting to notice how emergence success in the hatchery is closer to hatching success than in the natural beaches.

Figure 2. Percentage of hatching succes and emergence success in natural (black) and relocated nests (white) of *Caretta caretta* from Boavista.

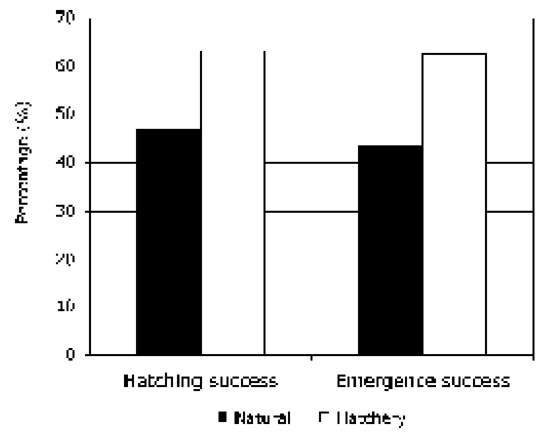


Table 1. Hatchling succes and emergence succes of *Caretta caretta* in some populations of the world.

		Hatching success (%)	Emergence success (%)	Source
G'oksu delta (Turkey)	Mean		63	
	Range		2-98	Peters et al. (1994)
	N		33	
Cephalonia (Greece)	Mean	71.6		
	Range	43.7-89.9		Hays & Speakman (1993)
	N	8		
Northern Cyprus	Mean	79.1		
	Range			Broderick & Godley (1996)
	N	321		
Florida (USA)	Mean		55.7	
	Range		0.0-99.1	Ehrhart & Witherington (1987)
	N		97	
Tongaland (South Africa)	Mean	66.1*		
	Range	31.3-83.1		Hughes (1971)
	N	859		
	Mean	77.8		
Tongaland	Range	0.0-98.7		Hughes (1974)
	N	72		
Oman	Mean	57.3		
	Range	-		Ross (1979)
	N	18		
Queensland (Australia)	Mean	81.9		
	Range	-		Limpus (1985)
	N	422		
Boavista (Cabo Verde)	Mean	**46.9**	**43.4**	
	Range	**0-100**	**0-100**	
	N	**77**	**77**	
Boavista (Cabo Verde)	Mean	**63.5***	**62.6***	
	Range	**0-100**	**0-100**	
	N	**88**	**88**	

* Data on clutches incubated in hatcheries

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DEATH EVIDENCE OF SEA TURTLES BY ANALYSIS OF OSSEOUS REMAINS FOUNDED AT THE TALPICHICHI COVE, CABO CORRIENTES, JALISCO, MEXICO

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Talpichichi Cove is located on the coastal zone of the Pacific Ocean, in the Cabo Corrientes Municipality in Jalisco´s northwest, México (20° 14´ N, 105° 54´ W). Has a length of 800 m. In the nearby region, it is known the intense predative activity on the sea turtle.

We have known that an important number of organisms are captured with nets to be sacrificed for obtain the eggs from the womb, the skin and some of the meat for self-consumption. This is a place where the remainings of sacrificed animals are dropped and some of them after being drifting get to the zone where the waves are breaking. Trying to prove the existence of this illegal activity by the means of direct methods has been difficult.

The purpose of this project is to obtain a first estimation of the number of sacrificed organisms. In order to do this, we recollected all the sea turtle's bones we found all over the cove Talpichichi during the second week of April, 2000. We carried them to the camping site 5 km away. They were grouped and were counted by the kinds of bones. We did this to find which of them would be the indicator of the minimum estimated number of sacrificed individuals.

The most common bone that we found was the left humerus with a net total of 27. Also 11 skulls remaining were found, four of which present injury traces caused by human action to kill them.

LOCAL SEA TURTLE CONSERVATION ON PLAYA PLATANARES

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INTRODUCTION

Platanares Beach or "Playa Platanares," on the Osa Peninsula of Pacific southwest Costa Rica, Central America, is the location of a local sea turtle conservation intiative organised by "Asocación Salvemos las Tortugas de Osa" or ASTO. Platanares is a 6 km-4 mile long dynamic black-sand beach with a rocky reef just offshore. This beach is believed to be at the most interior limit within the Dulce Gulf or "Golfo Dulce" to still play host to nesting sea turtles.

Platanares is the closest beach to Puerto Jimenez the largest town on the peninsula with a growing population of about 7000. Just 3 km-2miles away it is easily accessible to poachers, yet so far there is no public transport link. In general the beach was declared as a tourism area by the "Costa Rican Institute for Tourism" or ICT, and is made up of 3 main areas. From North to South lie areas along the beach designated as:

a)National Wildlife Refuge
b)Regulation Plan Area - medium scale tourism development is allowed
c)Private properties - used for cattle pastures

The properties and two-storey hotels along the beach are powered by electricity generators, use candles and are partially concealed by vegetation. Some tourists stay here during the dry season, which is not the same time as the turtle nesting season.

WHO IS ASTO?

ASTO is a small non-profit-making charity formed specifically to protect the sea turtle population that nests on Platanares. The residents, managers and owners from the hotels, and their friends, make up an international committee of voluntary members who are local Costa Ricans, North Americans, Canadians and Germans. They observed on their beach turtle nests being destroyed by feral dogs; illegal poaching of eggs for sale and own consumption by other local people and a severe decline in the number of nesting turtles. Quotes from different ASTO members were that 20 years ago a maximum of 10-15 or 30-40 turtles nested in one night, in recent years rarely 3-6.

SUPPORTING ORGANISATIONS

"Fundación Cecropia" is another local non-profit making environmental organisation. They were instrumental to the establishment of ASTO and helped to organize a useful workshop on the beach in 1999 brought by "Asocación ANAI" to provide more up-to-date information.

The Swift River High School, or "Rio Rapido," from the USA, organised monthly visits for small groups of students to the Osa Peninsula who volunteered considerable help with beach cleaning and construction of the hatchery.

In 2000 ASTO managed to enlist help from two long-term volunteers to help full-time on the project. Mabel Cheung an independent zoologist helped with patrols, hatchery work and organised classes at the local schools. Tim Packeiser, from the "Center for Tropical Marine Ecology" (ZMT), University of Bremen, has just elaborated on a general management plan for this conservation project.

THE TURTLE CONSERVATION PROJECT

ASTO focuses primarily on practical work on the beach aimed to protect turtle nests by maintaining people presence, via patrols, to deter poachers. Nests found on patrols were relocated to a hatchery where they are relatively more protected from poachers, feral dogs, wave inundation and natural predators than if they were left naturally on the beach.

The workers, notably Efrain Mesen manager of one hotel and ASTO president, began relocating nests from the beach to a 'protected area' in 1995. By 1999 and 2000 ASTO had organized a programme of daily night patrols and managed a hatchery try to maximise the "hatchling success," or the percentage of live hatchlings that emerge from eggs in the nest.

NIGHT PATROLS

Patrols cover the whole beach length 2 times, and last 4 hours, or 1.5 hours between two patrollers. Patrols coincide with the time when turtles are expected to nest, depending on the tide and lunar cycle, and take longer if there are nests to be relocated in the hatchery. Patrollers use plastic buckets for carrying eggs and in 2000 began to use red flashlights and disposable gloves for handling eggs.

HATCHERY MANAGEMENT

The hatchery is located at the top of the beach where grassy vegetation was cleared for a sandy substrate. New nests are placed 50-70 cm apart along parallel rows 100 cm apart. Hatchery nests are dug to the same dimensions as the original nest with a sheet of plastic mosquito net placed at the base to prevent crabs tunnelling in from below. The net does not surround the vertical walls of the nest to avoid trapping hatchlings (Figure 1). A labelled wooden stake is placed next to each nest for identification.

The nests in the hatchery are checked daily approximately every 3 hours until between 10 pm-1 am, and through the night by patrollers. 5 days before hatchlings are expected to emerge a metal cylinder is pushed into the sand around the nest as a temporary enclosure. Hatchlings are then handled with gloves and counted before being released onto the beach allowing them to walk a short distance to the sea. Undeveloped eggs and hatchlings are moved to a newly dug nest to allow final development without the risk of infection from pathogens and parasites accumulated in the original nest. All other nest contents are placed in a rubbish heap outside the hatchery.

RESULTS

Notes were made that only 6 nests were ‘missed’ and left naturally on the beach in 1999, only one was left untouched, 2 nests were poached illegally and 3 nests were destroyed by dogs. Approximately 3 were left on the beach in 2000. These figures are estimations.

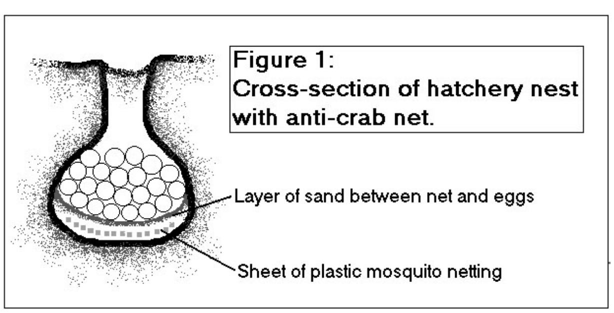
Data was only collected from nests relocated to the hatchery. For each nest data was collected on the date and time the nest was found, species if known, number of eggs, subsequent number of hatchlings and name of the worker. Recorded less consistently was the date of hatching and the original nesting location on the beach, or beach sector. The whole beach length was divided into 6 beach sectors. In 2000 the beach sector was only recorded for 74 of the total 97 nests. Sectors 2 and 3 received the most turtle nests, 25 and 21 respectively, which are incidentally the areas where the hotels are located in the Regulation Plan or tourism area.

The most complete data sets of general hatchery results are shown in Table 1. There has been a significant drop in the number of turtles nesting from 1999 and 2000 (Table 1). However ASTO realises that these are not the same individual turtles returning each year and that there are natural fluctuation reasons. The results of this project will not be seen until, approximately 20 years, when or if female hatchlings survive to reach sexual maturity, reproduce and return. The encouraging 14% increase in the hatchling success is believed to be the result of improved work techniques. Annual patterns of turtle nesting on the beach are displayed in Table 1 and Graph1. August is the month with the highest frequency of nesting in both years.

Species identification has not been recorded consistently or with absolute confidence. However, ASTO believes the Olive Ridley turtle, *Lepidochelys olivacea*, accounts for at least 95% of the turtles nesting on Platanares, with few Hawksbill, *Eretmochelys imbricata*, and just one nesting record for the Pacific Green or Black turtle, *Chelonia agassizii*, in 1999.

The data book shows huge amounts of data has been collected. However, work methods and data collection has not always been consistent and there are some omissions.

Figure 1. Cross-section of hatchery nest with anti-crab net.



FUTURE

ASTO has invested considerable voluntary labour into sea turtle protection on their beach. This enthusiasm could be channelled and refined to maximise the effectiveness of their work with guidance from the new management plan.

FUNDAMENTAL NEEDS

Legal permission

ASTO is awaiting permission to be granted after making an application before the turtle nesting season commenced in 2000.

Volunteers for practical work

Extra manpower is needed to continue and improve the project. The more time volunteers are able to devote, the better the consistency of turtle work and quality of data collection.

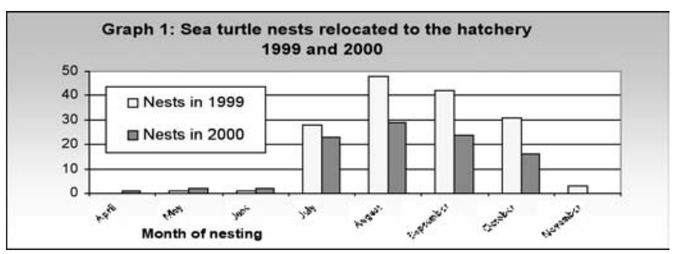
Funding for basic resources and equipment

Funds are vital to assure continuation of the project. ASTO plans to publicise the turtle project by distributing brochures to the hotels on the peninsula to raise funds and awareness. This should not only inform tourists but also the local people as the majority of the local population are employed in the tourism industry.

Table 1. Results from nests relocated to the hatchery, 1999 and 2000.

TABLE 1: RESULTS FROM NESTS RELOCATED TO THE HATCHERY		
	1999	2000
Main period of turtle nesting	29/ 5 - 30/10	15/04 - 31/10
Month with highest frequency of nesting	Aug (48 nests)	Aug (29 nests)
Total number of nests	154	97
Total number of eggs collected	15595	10078
Total number of live hatchlings released	10624	8279
Hatchling success (% of total number of live hatchlings from eggs)	68	82

Figure 2. Sea turtle nest relocated to the hatchery, 1999 and 2000.



OTHER OBJECTIVES

Collaboration with official institutions

eg., (MINAE – the environment ministry) is hoped to provide extra resources and general support.

Investigation programmes

Members of ASTO have expressed an interest to invite researchers to investigate, for example, patterns of nesting and how nest temperature influences hatchling gender.
Educational activities. To spark enthusiasm for turtle conservation ASTO invited local school children to a successful hatchling release

day in 1999 and gave turtle classes at the local schools in 2000. There are plans to build a turtle information platform as part of one hotel, and hopes to organise another hatchling release day.

AND FINALLY

Due to its pristine condition and closeness to Puerto Jimenez, Platanares was recently proposed as a "Primary Tourism Destination." In light of this news ASTO will have to be especially prepared for the expected and announced tourism development at this beach in the near future.

UPDATE ON THE STATUS OF MARINE TURTLES IN THE GUADELOUPEAN ARCHIPELAGO (FRENCH WEST INDIES)

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INTRODUCTION

In the 1980s, marine turtles were « exploited to a greater extent at Guadeloupe than anywhere in the Lesser Antilles, with the possible exception of Martinique » (1). At that time, nesting levels were described as « low » and the marine turtle population levels were showing a « definite decline » in the Guadeloupean Archipelago (1). Despite major changes, such as the complete protection of all marine turtles species since 1991 in Guadeloupe, no review of their status had been conducted. Therefore the most-often cited reference for the status of sea turtles in the region (2) has been and remains Meylan's study of 1983, which was based on an inquest conducted during one month outside the nesting season (December) in 1978 (1).

In 1998, a new marine turtle conservation program, lead by AEVA (a non profit NGO), was founded in the Guadelopean Archipelago (3). The data gathered since 1998 provide an update on the status of the marine turtles found here.

STATUS OF NESTING POPULATIONS

Three species of marine turtles nest in the Guadeloupean Archipelago :

Hawksbill turtles (*Eretmochelys imbricata*) are by far the most common. Nesting seems to be sparse but present on most of the beaches of the Archipelago, and valuable nesting sites have also been identified. In Trois Ilets beach in Marie-Galante 17 different nesting females and 121 nesting activities have been recorded from the middle June to the end of August 2000. Given that on this beach almost all the nesting attempts result in a clutch and that the survey was only partial during the season, the total number of nests on this beach certainly reached 150 in the year 2000. From this partial following, this nesting beach appears to host a population of the same level of magnitude as the well known populations of the Lesser Antilles (Jumby Bay in Antigua or Buck Island in USVI). Other valuable nesting beaches have been identified such as Four à Chaux beach in Fajou island (8 different females observed and 81 nesting activities recorded during the 2000 survey), Petite Terre (14 nests and 5 false crawls recorded between 19/07/99 and 10/08/99 (4)), Anse à Sable and Anse Galets Rouges in Bouillante (17 nests recorded in 1999 (5)) or in Grande Anse and Pompierre beach in Les Saintes.

Green turtle (*Chelonia mydas*) nesting is less common and is more localized on certain beaches such as Gallet beach in Marie-Galante (4 nesting activities recorded in September and October 2000 ; almost no survey had been performed previously on this beach), Grande Anse in Terre de Haut des Saintes (more than 10 nests in 1998 (6) and 5 different nesting females observed in 2000), or Petite Terre (8 nests recorded in 12 surveys in 1998 (4) and 20 nesting activities observed during 16 surveys in 2000).

Leatherback turtles (*Dermochelys coriacea*) also nest in small numbers on the larger beaches of the Archipelago like Cluny beach in St Rose (10 nesting activities recorded in 2000), Souffleur beach in Port Louis (6) or Grande Anse in Trois Rivières (6).

The review presented above is far from exhaustive : none of the nesting beaches have been followed thoroughly during a full nesting season and many beaches have not been surveyed for nesting activities (especially the north of Grande Terre). We suspect that numerous interesting nesting sites still yet are to be discovered in the coming years.

STATUS OF FEEDING POPULATIONS

Hawksbill and green turtles, mainly juveniles, are commonly seen in the shallow water habitat (rocky areas, coral reefs and seagrass beds) of the Archipelago. They seem to be very common in Côte sous le Vent; for example during 47 surveys of about 1 hour each performed in Val de l'Orge, the mean number of juveniles seen per survey was 0.72 turtles for greens and 0.60 for hawksbills. Greens and hawksbills are also common in les Saintes, particularly around Anse Pajot (12 hawksbills, including adults, were observed during 2 surveys), and also in Marie-Galante and Petite Terre. From interviews with fishermen and divers (snorkel and scuba), the general opinion is that marine turtles are much more common now as compared to 10 years ago.

Loggerhead turtles (*Caretta caretta*) and leatherbacks are sometimes seen by fishermen further away from the coast. In late July 1999, a whale watching crew observed a juvenile leatherback interacting with pantropical spotted dolphins (*Stenella attenuata*) off Bouillante (5).

While no previous certified data exist for any *Lepidochelys* species in the Guadeloupean Archipelago, 3 adult olive ridley turtles (*Lepidochelys olivacea*) were observed in 1998 and 1999 (7).

THREATS AND CONSERVATION ACTIONS

Since the protection law of 1991, the number of turtles killed in the Guadeloupean Archipelago has greatly decreased. Today, accidental captures due to fishing and poaching on the beaches and at sea appears to be the two major threats. The destruction of nesting and feeding habitat represent a third serious threat for the long term survival of the marine turtles in the Guadeloupean Archipelago. Others threats are also present on particular locations and can have an important effect on the populations, like eggs predation by mongoose in Fajou (6)or beach destruction in Côte sous le Vent (6).

During the last three years several marines turtles (greens, hawksbills, loggerheads and olive ridleys) found ill or injured have been treated at the Aquarium de la Guadeloupe and released after complete recovery. The program now aims to develop an awareness program targeting schoolchildren and the general public via media reports, school trips, and information posters/billboards, etc. We also will start to work with the fishermen on the bycatch problem.

CONCLUSIONS

The marine turtle conservation project of the Guadeloupean Archipelago is still very young and is now working to produce a Recovery Action Plan from the French Ministry for Environment. The results already gathered permit an interesting review of the status of marine turtle in this part of the Lesser Antilles, showing that the present situation seems less critical than situation as reported in the early 1980s. This encouraging trend can in part be explained by the total protection afforded to marine turtles in Guadeloupe since 1991 and in Martinique since 1993 (where previously hundreds of turtles were killed every year) or perhaps even the decrease in the Cuban hawksbill harvest (8). As these changes affected most of the Lesser Antilles, the improvement seen in the Guadeloupean Archipelago could reflect a larger regional trend. In this case, the data gathered in the Lesser Antilles during the 1980s may be out of date and cast serious doubt on the validity of regional status estimates of species based on old information, such the 1999 review of the hawksbill status in the Caribbean (2).

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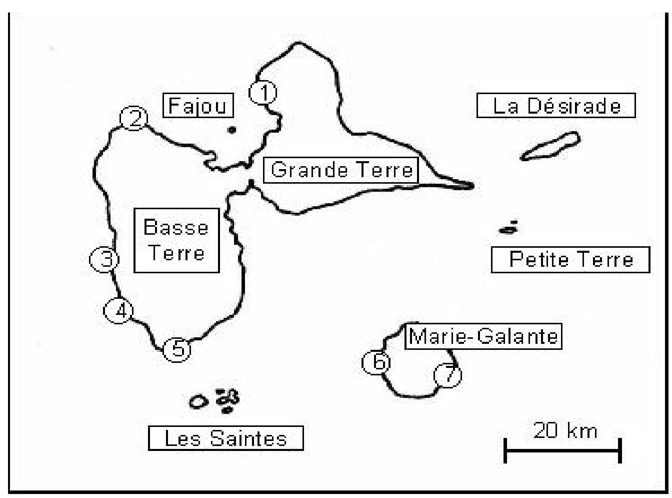
Figure 1 : Map of the Guadeloupean Archipelago with location of the main nesting and feeding sites



Legend
1 – Souffleur beach in Port-Louis
2 – Cluny beach in St Rose
3 – Anse à Sable and Anse Galets Rouges in Bouillante
4 – Val de l'Orge in Vieux-Habitants
5 – Grande Anse in Trois-Rivières
6 – Trois Ilets beach
7 – Gallet beach

INTRAOCULAR PRESSURE OF JUVENILE LOGGERHEADS (*CARETTA CARETTA*) IN MULTIPLE POSITIONS

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Tonometry measures intraocular pressure and aids in the diagnosis of ocular hypertension and glaucoma. The intraocular pressure (IOP) of twelve apparently healthy juvenile loggerhead sea turtles (*Caretta caretta*) was determined by applanation tonometry in dorsoventral, ventrodorsal, and head-down suspended body positions in conjunction with a health survey involving laparoscopic sexing conducted by the National Marine Fisheries Service along the North Carolina coast in the summer of 2000. Loggerheads' eyes were topically anesthetized with proparacaine before application of a Tono-Pen tonometer. Median IOP was 5 mmHg (range 4-9 mmHg) in the dorsoventral position, 7 mmHg (range 5-12 mmHg) in the ventrodorsal position, and 23 mmHg (range 17-33 mmHg) in the suspended position. Significantly higher IOP was found in the suspended position as compared to the ventrodorsal or dorsoventral positions. This study provides baseline IOP reference values for healthy juvenile loggerhead sea turtles. Sustained elevations in IOP are indicative of physiological changes potentially detrimental to ocular health and consideration is warranted during restraint, medical, or surgical procedures involving sea turtles.

A NATIONAL PROJECT ON SEA TURTLE CONSERVATION IN INDIA – A COLLABORATION BETWEEN THE UNDP AND THE GOVERNMENT OF INDIA

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INTRODUCTION

A national project on sea turtle conservation was launched by the UNDP in collaboration with the Ministry of Environment of Forests, Government of India, in January, 2000. The Wildlife Institute of India serves as the implementing agency, whose primary role is to coordinate the activities within the project. The project is governed by a national steering committee headed by the National Project Director (S.C. Sharma, Additional Inspector General of Forests, Ministry of Environment and Forests).

ASSESSMENT OF SEA TURTLES, THEIR HABITATS AND THREATS ON THE INDIAN COAST

One of the objectives of this program was to extensively survey the entire coast for sea turtle nesting and mortality with intensive sampling of key areas. Another objective of the survey is to build a coastal network of organisations and individuals involved or interested in marine conservation and fisheries issues who can serve to disseminate and collect information on sea turtles and related coastal issues.

East Coast of India

West Bengal - This state, with a coastline of 200 km, has a few sporadic nesting beaches of olive ridley sea turtles. It has the largest mangroves left in the country (Sundarbans). Most of the threat is trawler related. There is also some adult mortality due to predation by tigers. Current survey: Nature, Environment and Wildlife Society, Calcutta.

Orissa - Coastline of 480 km. Mass nesting sites of olive ridleys at Gahirmatha, Rushikulya and Devi mouth. Sporadic nesting along the rest of the coast. Heavy trawling related mortality, with over 70,000 turtles recorded dead over the past five years. Current survey: Forest Department, Government of Orissa, Bhubaneshwar. In 1999, the Wildlife Institute of India, Dehradun conducted a Rapid Assessment survey of the impact of the supercyclone (October, 1999) in Orissa with special reference to sea turtle nesting habitats.

Andhra Pradesh - One of the most important maritime states, with a coastline of over 1000 km. Olive ridley sporadic nesting, with high density nesting (~ 50 / km) at a few sites. Threats mostly trawling related, though meat consumption and poaching of eggs is still prevalent in a few areas. Current survey: Wildlife Institute of India, Dehradun.

Tamil Nadu - Coastline of about 950 km. Olive ridley sporadic nesting along the coast. Feeding grounds of green turtles in reef areas in Gulf of Mannar, in southern Tamilnadu. Current survey: Salim Ali Centre for Ornithology and Natural History, Coimbatore.

West coast of India

Kerala - Coastline of 600 km. Olive ridley sporadic nesting. Principally known for being the state with the highest literacy. Fishworkers movement against trawl and mechanised fishing. Sea turtle conservation by a fishing community at one site. Current survey: THANAL Conservation Action & Information Network, Thiruvananthapuram.

Karnataka - mostly rocky beaches along a coast of 300 km. Few sporadic olive ridley nesting beaches. Current survey: University of Mysore, Hassan.

Maharashtra and Goa - Coastlines of 700 km and 160 km, respectively. A few sporadic olive ridley nesting beaches. Green turtles and Hawksbill turtles in offshore waters. Goa has a sea turtle conservation program supported by the local Forest Department with the involvement of local fisherfolk. Current survey: Bombay Natural History Society, Bombay.

Gujarat - Longest coastline in the country; over1600 km. Green turtle nesting in Kachh in northern Gujarat. Sporadic olive ridley nesting along the entire coast. Current survey: Gujarat Institute of Desert Ecology, Bhuj (Baroda).

Islands

Andaman and Nicobar islands - Group of islands in the Bay of Bengal; 94 islands designated as sanctuaries of which 30 are known sea turtle nesting beaches; feeding grounds for greens and hawksbills; nesting of green turtles, olive ridleys, hawksbill turtles and leatherbacks. Nicobar has about 20 known nesting beaches and is estimated to have a population of about 200 leatherbacks. Subsistence hunting, poaching of eggs by humans and dogs and loss of habitat due to tourism and development are one of the principal threats to these turtles. Current survey: Andaman and Nicobar Environmental Team, Port Blair.

Lakshadweep Islands - Group of about 25 islands in the Arabian sea off the west coast of India. Known nesting of Green turtles, olive ridleys and hawksbill turtles. Threats include hunting of hawksbills for shell and leatherbacks. Green turtles and olive ridleys for fat. Current survey: Wildlife Institute of India, Dehradun.

CAPACITY BUILDING

An important component of any conservation program is to empower the people involved directly with the natural resource.

Community based Conservation (Kalpavriksh, Pune)

This project is attempting to document two community based conservation programs in India in Kerala and Goa. In both instances, local fisherfolk from coastal communities have taken the initiative to protect nesting turtles and their eggs with the support of the Forest Department. One objective would be to examine sites in Orissa to evaluate whether similar programs could be initiated there.

Education and Awareness Workshop (Centre for Environmental Education, Ahmedabad)

This workshop is aimed at creating a model for education with reference to sea turtle conservation along the Indian coast. Participants from various states will help design education and awareness packages in the local language (each state has its own language) which are relevant to their regions.

Study Tour

Wildlife managers (Forest Department), Fisheries managers and conservationists will visit international sea turtle conservation programs which have succesfully dealt with management of fisheries and tourism.

TURTLE EXCLUDER DEVICE DESIGN AND DEMONSTRATION WORKSHOPS

This component involves the design of indigenous TEDs (appropriate for Indian conditions) in collaboration with fisheries research institutions. This is to be followed by the more onerous task of persuading trawl fishermen to use the TEDs.

REVIEW OF LEGISLATION (Enviro-Law, New Delhi)

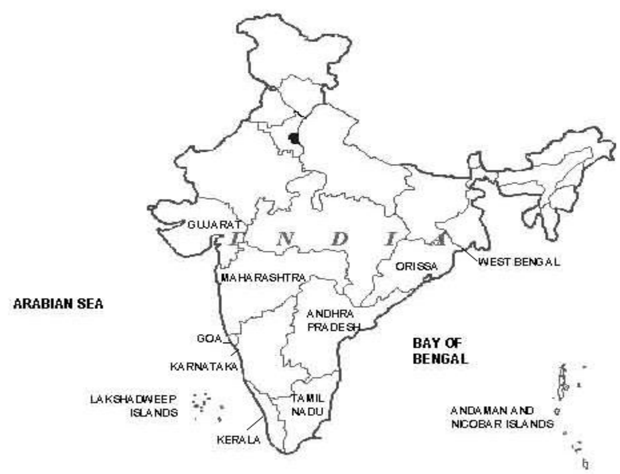
Several laws and acts pertain to the coast, the offshore waters, fisheries and to endangered species in India. All sea turtles are, in fact, listed under Schedule of the Indian Wildlife (Protection) Act (1972). Other relevant acts include the Coastal Regulation notifications which regulates development along the coast and the Indian Maritime Act. Each of the states also has fisheries regulations. This component of the project aims to provide a review of legislation pertaining to marine turtles and their habitats with an evaluation of the implications for conservation.

SATELLITE TELEMETRY (WII, Dehradun & Orissa Forest Department)

There is little information about the non breeding area of the olive ridley population that migrates every winter to nest in Orissa, much less the routes used by the turtles to travel from the nesting beaches to the feeding grounds and back. In this study, four females will be tagged with satellite transmitters in April, 2001 in Orissa.

GIS AND SATELLITE IMAGERY FOR THE CHARACTERIZATION OF SEA TURTLE NESTING HABITATS IN ORISSA

The nesting beaches at two sites - Gahirmatha and Rushikulya - are narrow sand bars at river mouths, which vary substantially from year to year. The Orissa Remote Sensing Agency is carrying out a study on the characteristics and dynamics of the nesting beaches on the Orissa coast.



NATIONAL WORKSHOP

The WII, Dehradun and the Orissa Forest Department plan to conduct a national workshop to compile available information on sea turtles and their habitats, adding information from studies currently in progress, to design management plans for sea turtles in various parts of the country. This will be done in collaboration with various stake-holders including the Forest and Fisheries Departments, Coast Guard, Indian Navy, Trawler Operators, local fishing communities and conservationists.

Acknowledgements:

The Wildlife Institute of India would like to thank the UNDP and the Ministry of Environment and Forests for funding and support in conducting this national project. We would also like to thank all the participating organisations for their cooperation. Kartik Shanker would like to thank the Packard Foundation for a travel grant to attend the symposium.

TURTLE CONSERVATION IN KENYA

Julie Church

WWF - Kiunga Project, Kenya

Kenya is located on the East African coast, bordering Somalia to the north and Tanzania to the South. The coastline stretches 600km from 1 42'S to 4 40'E with approximately 200km of beaches. All these beaches are potential turtle rookeries. An estimated 2 million people live in the coastal area. There are more than 7,000 registered fishermen on 2,000 boats operating on Kenya's inshore waters. The key economic activities on the coast are fishing, farming, mangrove harvesting, tourism and trade. Currently Kenya has 6 marine parks and reserves.

Kenya Coast has distinctive biophysical characteristics; It lies under tropical climate with two monsoon seasons. The Northern Monsoon, blowing from November to April, brings dry and calm weather. Contrary the Southeast Monsoon blows from May to September bringing in rain, and colder and rougher weather. The nature of Kenya's coast is influenced by four oceanic currents; the South Equatorial Current, the East African Coastal Current, Equatorial Counter Current and the Somali Current. The Kenyan coast hosts diverse marine ecosystems providing habitats to several internationally recognized threatened wildlife species, including turtles, dugongs and roseate terms. Total area of coral reefs is estimated at 50,000 hectares. A total of 183 species of stony corals belonging to 59 genera have been identified in Kenya. Sea grass beds stretches along the entire coastline, usually adjacent to, or associated with coral reefs. 12 species of sea grass beds have been recorded. Mangrove swamps cover 53,000 ha, providing habitats to 9 mangrove species.

There are only seven species of sea turtles in the world. Five of these species feed on the East African coast and three of the species also breed in Kenyan beaches. They are very important feeding and nesting grounds for Green turtle (*Chelonia mydas*), Hawksbill turtle (*Eretmochelys imbricata*) and Olive Ridley turtle (*Lepidochelys olivacea*). Feeding turtles in Kenyan water include Loggerhead turtle (*Caretta caretta*) and Leatherback turtle (*Dermochelys coriacea*).

Cultural Importance of sea turtles has been well recognized among coastal people. The Bajun people attach great value to sea turtle products and rely on them for commerce, nutrition and cultural use. Meat and eggs serve as food and eggs as aphrodisiac purposes. Oil is used for cooking and protection of body from the cold when diving for lobsters and also against evil sprits. Some are used as medicine such as treatment for asthma, prevention of malaria, liver problems, muscular pain, sexual potency and rejuvenation of youth. Flipper skin and shell serve for ornamental purposes.

There are three levels of legislation to protect sea turtles in Kenya. National Legislation includes The Fisheries Act Cap 378 and The Wildlife Conservation and Management Amendment Act cap 376 passed by the Government of Kenya. These Acts outlaw trade in sea turtles and their by-products and command stiff penalties to anyone found violating them. The law prohibits hunting, removing, holding, moving and trafficking of sea turtle and their products. Violators risk fines up to $270 (Ksh 20, 000/=) or imprisonment of up to 6 years, or both penalties. However, enforcement of legislation is difficult due to insufficient facilities and personnel to conduct enforcement activities.

Regional Legislation was developed at the Western Indian Ocean Sea Turtle Workshop and Strategic Planning Session, which became effective with Sodwana Declaration in 1995. Each representative country has agreed to support the strategy, which endeavors to research, publicize and advocate the responsible management and conservation of turtles through the cooperation of all nations of the Western Indian Ocean.

The Kenyan government is party to the following international agreements, which serve to protect sea turtles. It is the government's responsibility to create national legislation that ensures the implementation of these agreements. Convention for the Conservation of Migratory Species of Wild Animals, CMS (1979), Conservation on International Trade in Endangered Species of Wild Fauna and Flora, CITES (1973), Conservation on Biological Diversity), CBD (1992), Nairobi Conservation of the Protection, Management and Development of the Marine Environment and the coastal areas of the East African Region, RAMSAR Conservation on Wetlands of International Importance Especially as Waterfowl Habitat, MARPOL International Conservation for the Prevention of Pollution from Ships.

On the Kenyan coast there are six active sea turtle conservation groups and a plethora of individuals, hoteliers, local community groups, NGOs and government organization who are involved in sea turtle conservation. They all work under the umbrella of the Kenyan Sea Turtle Conservation Committee (KESCOM). KESCOM was founded in 1993 and now operates under the patronage of the Kenya Wildlife Service (KWS), Fisheries Department, Coastal Development Authority (CDA), National Museums of Kenya (NMK), Kenya Marine and Fisheries Research Institute (KMEFRI). It currently has 73 members who hold a monthly meeting where they discuss the progress and implementation of conservation programs and a quarterly general meeting for the members.

KESCOM's objectives include;
* To carry out field research and monitoring activities
* To build an integrated management approach that will ensure the survival of sustainable sea turtle populations
* To ensure community participation in sea turtle conservation
* To build local capacity for conservation, research and management
* To create public awareness of sea turtle conservation through information and education activities
* To build regional and international cooperation in sea turtle conservation
* To obtain funding for sea turtle conservation

In order to achieve these objectives, KESCOM coordinates effective conservation programs. KESCOM holds regular workshops for local communities and schools, and training programs for organizations in nesting, translocation, netting and tagging methodologies. We also act as an advisory party for governmental organizations on policy and legislation making.

KESCOM is now developing a networking system between different turtle groups, and its database for nesting, hatching and mortality rate for a further analysis. We are expanding in memberships and in areas of working for better liaison. KESCOM continue to encourage regular patrols and beach surveillance to monitor protected areas. We promote an integrated approach to prevent further loss of coastal habitat.

According to a report on key turtle monitoring figures in Kenyan coast, between 1997 and 2000, there have been 612 (Green 522; Hawksbill 76; Olive Ridley 14) nests which successfully released about 40,000 hatchlings. Of which 204 females have been identified. A total of 74 turtles were tagged then released from the nests. Also, 15 nesting turtles were tagged.

SEA TURTLES IN THE LIVING MARINE RESOURCES INFORMATION SYSTEM (LMRIS)

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The Living Marine Resources Information System (LMRIS) is a geographic display system that has been under development for the U.S. Navy since 1997. It will provide detailed information about the distribution and occurrence of sea turtles, marine mammals, and protected areas in the Central and Northeast Pacific (NEPAC) and the Northwest Atlantic (NWATL), including the Gulf of Mexico and Caribbean Sea. The purpose of LMRIS is to provide information about when and where sea turtles and marine mammals occur so that Navy activities can be planned and conducted with minimal impact. At present, the LMRIS includes all Northern Hemisphere sea turtle species and all federally listed (endangered or threatened) marine mammal species. LMRIS is is being amended to include all marine mammals in the geographic regions outlined above. Distribution, occurrence and abundance information is from published sources such as peer-reviewed journals and institutional reports ("gray" literature). An interactive display allows the user to decide which species to display for a particular month and geographic region. The displays for sea turtles focus on nesting density, distribution and timing, although information on wintering areas, feeding areas, tag data, incidental fishery takes, etc., is also included. Information for sea turtles is ranked using a contrived index to reflect relative importance of particular areas. The information is displayed using a vector-based data model consisting of (1) points, representing locations of aggregations and (2) polygons representing areas with significant seasonal or year round distributions.

Although there are other species included in the LMRIS database, this abstract will focus only on sea turtles.

DATA SOURCES

All data currently included in LMRIS are based on referenced sources. References are limited to published (peer-reviewed) literature such as papers in scientific journals and government agency reports (e.g., Federal, State and Local). Because of the paucity of information for sea turtles in some geographic areas, symposium proceedings and Internet sites are used if data are not available elsewhere. Full citations for all references used are included in the LMRIS database. In some cases, supporting information is obtained directly from the researchers (particularly when relevant studies are ongoing or completed so recently that published material is not yet available). In such cases, the name of the researcher and their appropriate affiliation are included in the LMRIS reference database. Researchers are also contacted when data interpretation is necessary to insure that the information from the reference is interpreted correctly or when data are obtained from non-traditional sources (Internet sites, e.g., www.cccturtle.org). Distribution and occurrence data are derived from counts at nesting sites, at-sea sightings, incidental sightings and satellite tag data.

OCCURRENCE DATABASE

Information included in the database is selected based on its relevance and significance. The emphasis is on more recent studies since they more likely reflect current situations, particularly at nesting beaches. However, no specific date cutoff period is used to determine which referenced studies should be included. For some regions and species, data may be relatively old but are used because no other data exist. In other regions and for other species, data are updated annually. Original (primary) references are used in most cases, but on occasion secondary information has to suffice. For some geographic areas, synopsized summaries of occurrence are used if that is the only information available.

Most sea turtles are extremely difficult to detect and identify to species at sea. The amount of data available for each sea turtle species included in LMRIS varies considerably, depending on the location of the nesting sites. Sea turtles in the NEPAC nest almost exclusively in Central and South America. The degree to which countries have been able to dedicate resources to studying sea turtles is quite variable depending on social, cultural, economic and political environments. Those species that nest in U.S. states and territories have generally had a great deal more study effort and therefore there is far greater published information available.

Most of the information available pertains to nesting/hatching sites and associated timing. This information is most often represented as a point, referenced to a single latitude/longitude location. Larger nesting sites, or those that are scattered over several kilometers, may also be represented as polygons. Sea turtle occurrence is ranked using a contrived index, based on the best available information about the relative importance of a particular area to the species. The contrived index format is necessary since LMRIS incorporates data from many different studies that use widely varying techniques. Data from different studies are not normalized or weighted to standardize them in any way. In general, indices derived from any one reference (i.e. study) are independent from those of other references. An index of "2" through "4" is used, with "4" representing highest occurrence (indicating very common), "3" representing moderate occurrence (common), and "2" representing lowest occurrence (uncommon). Occasionally, actual estimates of use (# of nests/year/beach or # females/year) are available, but often the information on which the index is based is qualitative rather than quantitative. The interpretation of the index (e.g., what the "4" represents) is included in the meta-data for that reference. In addition to nesting/hatching areas, information on feeding areas, wintering areas and migration habits is also included whenever possible. Migration habits are largely identified based on flipper and satellite tag information, and therefore usually represent only one or a few animals. Nonetheless, tag return information often represents the only data on turtle behavior at-sea and is therefore quite important. Migration areas identified from flipper and satellite tag return data are identified separately from occurrence in other areas. All information is indexed by month, and includes full references and linked meta-data.

Each occurrence data point or polygon also includes an effort rank that provides a measure of confidence for each data point or polygon. There are three possible levels of effort. A "5" is assigned if the effort consists of systematic observations (e.g., dedicated study effort specifically targeting the species in question), a "3" is assigned if the effort consists mainly of incidental observations obtained during a study effort directed at other species, and a "1" is assigned if the effort is opportunistic, infrequent and/or indirect. If the effort level is uncertain or unknown, a "0" is assigned, and for those time periods during which there is no effort a "-1" is assigned.

The Occurrence Component of LMRIS is meant to provide detailed information on marine species for specific geographic regions during particular times of the year. The LMRIS user will be able to select species, ocean basin, and month of the year to start the search, then will be able to select other parameters, such as a specific operating area, to refine the results. By selecting several species in a particular region during particular times of the year, an environmental planner will gain an accurate picture of what might be found geographically and temporally in that area. This information can then be used to determine the best means of mitigating the activity to ensure minimal impact to marine resources.

POPULATION INFORMATION DATABASE

The Population Information component of LMRIS consists of tabular information, text descriptions and species distribution polygons. Tabular information is included for each recognized stock or breeding population, and includes common name, scientific name, status, population estimate (if available), geographic delimiters, methods used to derive the population estimate and applicable references. With very few exceptions, population estimates are not available for sea turtle stocks. Only a few isolated nesting populations have been estimated, and these populations are generally so small that they do provide any indication of the overall health of the species.

The text description summarizes the natural history of the species or stock, including nesting parameters and locations, relative abundance and population trends, current threats, distribution and known aggregation areas.

Species distribution polygons display the maximum extent of the known distribution of a species or stock. This display provides an overview of distribution, but does not contain the temporal or specific geographic information that the occurrence database has.

The Population Component of LMRIS is meant to provide underlying core information about the species featured in the Occurrence Component. The two components complement each other in providing overview with specifics.

LMRIS undergoes constant revision as new material becomes available for review. Future plans include development of interactive charts and graphs to illustrate changes in use over time (e.g., nesting beaches) and predictive models to indicate likely presence or absence of turtles based on oceanographic parameters.

ACCESS TO LMRIS

The LMRIS prototype is designed to support remote user access through a browser program (e.g. Netscape, Internet Explorer). The choice of a browser-based interface provides platform-independence and avoids the need for end users to purchase licensed software products. LMRIS access is currently restricted to authorized users. Persons desiring additional information about LMRIS should contact the LMRIS Project Manager, Linda Petitpas, at SPAWAR SYSCEN San Diego (petitpas@spawar.navy.mil).

Acknowledgements:

Several individuals have contributed to the building of the LMRIS database in the past four years. Key participants currently include Jim Gregg, Linda Petitpas and David Clark at SPAWAR SYSCEN San Diego, and Tom Norris, Christine Loftus, and Jim Lynch at SAIC. Individuals who are no longer involved in developing LMRIS but who played key roles include Cecilia Burrus (SPAWAR SYSCEN San Diego) and Sue Moore (currently with NMFS-NMML). Funding for LMRIS is provided by Dr. Frank Stone, Program Manager, Chief of Naval Operations (CNO), Environmental Research and Development. Past support was provided by the Office of Naval Research (ONR).

WHAT DO THEY THINK? LOCAL GUIDES ATTITUDES TOWARD GUIDING, ECOTOURISM, AND SEA TURTLE CONSERVATION IN TORTUGUERO, COSTA RICA

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This study evaluates the attitudes of local guides toward ecotourism, sea turtles, and their jobs as guides in Tortuguero, Costa Rica. Guiding is often identified as a local benefit of ecotourism, thus the opinions of these guides are valuable in assessing such claims.

A five point Likert-like survey instrument was used to evaluate attitudes, and 41 of the 42 local guides present in Tortuguero during the time of the study (June 1-25, 2000) participated in the survey. Surveys were conducted in Spanish or English, depending on the preference of the interviewee. Data are analyzed using descriptive statistics and a two-sample t-test assuming equal variance.

Some of the important findings include:

·Guides believe that the income generated from "turtle walks" is unevenly distributed between guides.

·Older residents believe that the community should have limited rights to consume turtles, while younger residents believe turtle consumption should remain completely prohibited.

·Foreign tourists are preferred over national tourists.

PREY DETECTION BY LEATHERBACK HATCHLINGS

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INTRODUCTION

Each species occupies a unique niche, defined by particular biotic and abiotic variables present in its community (Brown, 1995). Defining all niche features is a daunting task, so biologists typically focus on specifics such as what an organism eats and the behavior involved in searching for food.

The leatherback, *Dermochelys coriacea*, is the most specialized of all the extant sea turtles. Although its geographic range is broad (Eckert, 1992), the diet of this species is made up almost entirely of gelatinous prey (Davenport, 1998). Such restrictive feeding habits, in concert with a non-social existence, would no doubt require that young turtles possess a predisposition to respond to particular prey stimuli in appropriate ways, once feeding begins (Gould and Marler, 1987). The nature of these stimuli and the behavioral responses they evoke have not been previously studied.

Here, we explored the role of visual and chemical cues in leatherback prey recognition and behavior under laboratory conditions.

OBJECTIVES

Our goals were to determine if: (i) visual and chemical cues are involved in leatherback prey recognition, (ii) responses to each cue vary, and (iii) there are predispositions to respond to specific stimuli.

METHODS

Hatchlings. Leatherback hatchlings (19 turtles from 6 nests) were collected between early July and late September 2000, in Palm Beach Co., Florida, U.S.A.. They were maintained in five circular plastic pools (0.9 m diameter x 18 cm deep) containing sterile, circulating seawater. Four turtles were held in a single pool, each tethered within a pool quarter (see Jones et al, 2000, for a full description of methods).

Test pools. Tests began when turtles were 18-30 d old. Turtles were tethered alone at the center of a pool, identical to the holding pools, and allowed to acclimate for > 1.5 hr. Tethered hatchlings could swim throughout the pool and orient in any direction, but could not contact the side wall. The pool was subdivided into four quarters to facilitate recording of hatchling orientation.

Test protocol. A 15 min control period (no stimulus) immediately preceded a 15 min test period (stimulus present). Individuals were exposed to a chemical, visual, or combined chemical and visual treatment no more than once each day, in a variable order (two to five treatments/individual). Each 30 min session was stored on videotape for later analysis.

Behavioral measurements. The following responses were quantified.
(1) Stroke rate: (flipper strokes/min for one min at 5 min intervals).
(2) Orientation: (time spent in each quarter of tank [measured every 20 sec]).
(3) Biting: (number observed during control and test periods).
(4) Diving: (number and duration [sec] during control and test periods).

Visual stimuli. These were shapes (circle, diamond, square) made from white plastic sheeting, or a jellyfish model of equal area (22 cm^2) when viewed from above. Each stimulus was fixed to the pool bottom near the side wall with a transparent suction cup. Test periods began with the introduction of a single visual stimulus into one of the four pool quarters, assigned randomly.

Chemical stimuli. We made three homogenates of live prey (two species of cnidarians: *Cyanea capillata* [lion's mane], *Aurelia* sp. [moon jelly]; a ctenophore: *Ocyropsis* sp.). Samples were blended for two min, then aliquoted into 20 ml volumes and stored at -70° C until use. Two of the homogenates maintained the color of the intact organisms (*C. capillata* [reddish-brown] and *Aurelia* sp. [pink]) but at the dilution used in the tests, these colors were not visible. The third was clear (*Ocyropsis* sp.).

Control periods began with an injection of 20 cc of sterile seawater into the pool's filter unit. Test periods began with the injection of 20 cc of prey homogenate into the same filter. Pilot tests with dye indicated that the odorant was distributed throughout the pool in < 1 min.

Visual and chemical stimuli. Control period began as described for chemical stimuli. The test period began with injection of homogenate into the filter. A visual stimulus was then randomly placed in one of the three remaining pool quarters (filter quarter exempted).

Data analysis. Since each animal served as its own control, all data were analyzed using paired Wilcoxon signed rank tests, where N is the number of matched pairs minus the number of pairs for which no change is observed. When $p < 0.05$, we rejected the null hypothesis of no difference between behavior during the control and test period.

RESULTS

Responses to visual stimuli. In the presence of visual stimuli, biting frequency, diving frequency, and time spent diving all increased significantly. Turtles spent significantly more time in the stimulus quarter. Stroke rates increase following the introduction of the jellyfish model or the shapes (pooled response). Stroke rates declined toward the end of the test period.

Responses to chemical stimuli. During the test period, there was a significant increase in biting frequency, but not in diving frequency or duration. Turtles spent significantly more time swimming in the filter quarter. Stroke rates (pooled responses) were unchanged in the presence of *Ocyropsis* and *Aurelia* odors, but changed significantly in the presence of *Cyanea* odor. Responses to odors varied among individuals, especially for *Ocyropsis* (one turtle increased its rate) and *Cyanea* (four turtles increased, three decreased, and seven showed no change in stroke rate).

Responses to paired stimuli. We observed no significant increase in biting or diving behavior. Turtles oriented significantly to the quarter that contained the visual stimulus. In this respect, their behavior differed from the response shown to odorant alone (orientation to the filter quarter). Stroke rates increased significantly when chemical stimuli were paired with either the jellyfish or the shape models.

DISCUSSION AND CONCLUSIONS

1. Our results indicate that both chemical and visual stimuli evoke feeding responses (e. g., searching, diving, biting, and an increase in stroke rate) by leatherbacks. Responses were brief, probably as a consequence of habituation.

2. Visual stimuli, presented alone, evoked strong and complete responses involving changes in locomotion and orientation. These results are consistent with field observations suggesting prey are located visually. Leatherbacks dive directly toward prey (Jones et. al., in prep.). Leatherbacks also possess a retina specialized to detect jellyfish beneath them (Oliver et. al., 2000).

3. Hatchlings may be selectively responsive to visual stimuli, that is, models and shapes that resemble jellyfish (circles that are like round bells; squares that are typical of Cubomedusae). Diamond shapes evoked weak responses (1 bite observed in 4 tests; no diving in any test; stroke rates increase in 1 of 4 turtles).

4. Chemical stimuli evoked no diving and weaker stroke rate responses, but uniquely elicited "upstream" orientation into water currents (produced by the filter outflow). Many marine (and terrestrial) organisms locate odor sources by heading into "currents" (Vickers, 2000). When visual and chemical stimuli were presented together, turtles ignored currents and oriented visually.

5. Visual and chemical stimuli presented together evoked stronger orientation, while shapes paired with chemical stimuli evoked more consistent increases in stroke rate. Thus, two sources of stimuli, when presented together, probably reinforce food searching and feeding behavior.

6. Our study suggests that when hatchlings begin to forage, they already possess predispositions to respond to a subset of prey odors, and to an adaptive array of prey shapes. These predispositions probably enable juveniles to find suitable prey, without previous experience. We hypothesize that with feeding experience, responses initially based upon visual detection and odors may be broadened to include a wider range of odors and/or "shapes". In this manner, young turtles could expand their diet to include the variety of gelatinous prey species consumed by adults (e.g., Bleakney, 1965; Den Hartog, 1980; Eisenberg and Frazier, 1983). Similar mechanisms ("learning by instinct"; Gould and Marler 1987) account for how many other behavior patterns change through development.

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WHO TURNED THE LIGHTS OFF? KEEPING IT DARK ON FLORIDA'S NESTING BEACHES

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With the highest density and diversity of marine turtle nesting in the United States, Florida has ample incentive to develop and implement light management techniques that keep nesting beaches dark. Approximately 850 miles of Florida coastline attracts tourists, requiring coastal communities to maintain safe lighting levels. Many communities have developed innovative methods for restricting and focusing lights on populated areas while minimizing light scatter onto adjacent beaches. Various options exist for coastal communities attempting to manage existing light. Several communities have local ordinances requiring beachfront lights be extinguished during nesting season. Additional options include reducing wattage, strategic vegetation plantings that provide light barriers, and application of shields or filters onto existing lights to manage lighting once the nesting season begins. New information on light sources demonstrating less impact to turtles allows flexibility in the design of lighting for coastal construction. Integration of this information into the early design planning stages is the most effective and efficient option for preventative light control. Planners are encouraged to keep lighting sources low, using bollards or LEDs versus pole-mounted fixtures. Louvered and screened wall packs can be strategically placed to focus light in areas used by humans but not turtles. Motion-detectors can be incorporated into project design so that an area is only illuminated when needed for human use. Successful management of lighting in coastal areas requires flexibility and commitment from all parties. Ongoing light management programs in Florida's coastal communities prove that lighting can be controlled to protect both humans and turtles.

NESTING ACTIVITY OF SEA TURTLES IN OSTIONAL BEACH, COSTA RICA: 30 YEARS OF RESEARCH

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Escuela de Biología-Universidad de Costa Rica

The olive ridley, *Lepidochelys olivacea*, is the most abundant existing species of sea turtles. The "ARRIBADA" or mass synchronous nesting strategy developed in some populations of this species is important for the scientific and conservation purposes.

The Universidad de Costa Rica has recorded data on nesting activity of *L. olivacea* in Ostional, since 1970. These data were analyzed according to the sustainable exploitation project and the conservation of this sea turtle. The results are present here.

Ostional beach is located in the National Wildlife Refuge Ostional (RNVS Ostional), Guanacaste, Costa Rica. This refuge was created for the protection of sea turtles, for this reason it only protects the beach. With exception of mangroves and small forest fragments, the natural vegetation is poor. The natural fauna is represent by abundant coastal birds, and almost anything else.

The "arribada" is defined as the presence of 100 or more sea turtles in one day and in a specific area of the beach. At Ostional the "arribada" ocurred, in the 1970's, in a stretch band the beach of only 880 meters in length and it was named Playa Principal de Anidación (PPA). In recent years other parts of the beach are used as well by the "arribada". In the Ostional beach we found that the total beach length was used during the "arribada", but in the Nosara beach only two kilometers were used. In practice we do not know if we have an extension of the "arribada" phenomenon of the same population visiting the PPA, or several new populations that developed the "arribada" behavior in the RNVS Ostional. Arbitrarily we defined new "arribada" zones, in relation to estuary distribution. The principal zone of "arribada" is the PPA. Others zones are Rayo 1, Rayo 2, Rayo 3, Rayo 4. All these zones have near the same length. In the Nosara beach we define two zones, Nosara 1 and Nosara 2, each with 1 kilometer in length.

The trends in "arribada" are analyzed in relation to population size, days of nesting, extension of the beach occupied and, number of "arribadas" per year. Other information about hatching recruitment per "arribada" is also presented.

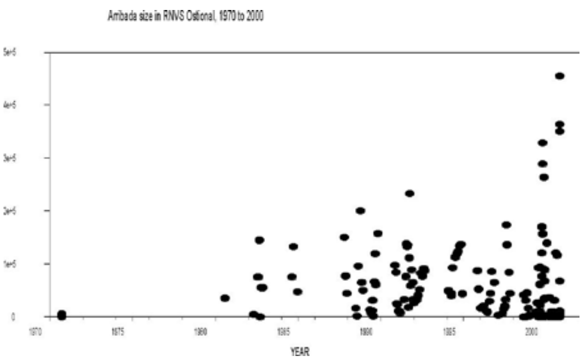
In de 70´s the size of "arribada" was poorly registered. The data were mostly inferred by sight, for this reason few data are shown during this time. Beside, the field work was intermittent, only during the last months of 1971 to 1973 data were taken continuously by Peace Corp volunteers and some university students.

The 80´s was the beginning of systematic data collection for the "arribada". Douglas Robinson and Steve Cornelius were carrying out an intensive study on "arribada" at Nancite and Ostional beaches (the two "arribada" beaches of Costa Rica). They standardized the methods to estimate the "arribada" size and other parameters of the population. University students monitored day by day the nesting activity at Ostional.

During the first eight years of the nineties only the "arribadas" that were exploited by the project were registered. Also, after 1998 the methods to estimate the size of "arribada" were questioned, and replaced by new methods. First the Charles Gates' method and then the Chaves and Morera method, both based on the instantaneous count index. The Cornelius and Robinson's methods and the Gates' methods measure the sea turtles that nest. The Chaves and Morera's method estimates the total sea turtles that come in the "arribada" and analyze the sea turtles nesting by other methods.
Robinson estimated that the "arribadas" during 80´s were small in relation to the "arribadas" in the 70´s, but the data are not report.The

variability in the size of "arribada" and the number of big "arribadas" (100000 to 500000 turtles) tend to increase. The reasons are related with the fact that the small "arribada" (100 to 1000 turtles) were only monitored in the last three years and; the new methods of estimating the size take into account all sea turtles, not only the nesting ones. Also new "arribada" sites show greater size than the "arribada" in the PPA.

Figure 1. Arribada sizes in the Ostional National Wildlife Refuge, Costa ica, between 1970 to 2000.



The number of "arribada" per year tends to increase. The low values during some years represent problems with the monitoring. An "arribada" per month is normal in the year, but in some years more than one "arribada" per month are reported, especially during the wet season.

The extension of the "arribada" tends to increase. In the middle of nineties during the wet season other zones than the PPA were used for the "arribada". In the last three years in some months the "arribada" use an extension close to 6 km.

There is a trend in the "arribada" length that shows a cycle of almost eight years, but with a little increase throughout the time. The meaning of this cycle is not understood. The range of "arribada" duration goes from 1 to 13 days. The "arribada" in the dry season only last 1 to 4 days, but in the wet season the majority last more than a week.

The principal conservation product of management in the RNVS Ostional is the recruitment of little sea turtles.

In the beginning no work was done to know how many hatchling were born at Ostional? But in the 80's Dr. Robinson and his pupils (students of ¨licenciatura¨) studied the hatching success, viability and mortality.
The results were impressive, less than 10% of eggs hatch. This means that millions of eggs per month were dead or lost. Many eggs die by predators (especially by dogs and pigs), erosion of the beach, poachers and the nesting activity of the same sea turtles. In some months the sea turtles destroyed more than 20% of the eggs laid during one night.

This facts support the idea of implementing the exploitation projects to use some part of those eggs.

Though the natality is an important parameter of the population; in Ostional it is not measured all the time. The data before 1999 show only some "arribadas" per year. In recent times we measure almost all the big "arribadas" and in several parts of the refuge. The trend is to increase the number of hatchlings, maybe due to the consistence of data gathering that registers the natality, Although it represents a real increment, because the incubation area has increased, it not necessarily represents an increment of hatching success.

Figura 2. Arribadas number per year and beach section in theOstional Wildlife Refuge, Costa Rica, between 1970 to 2000.

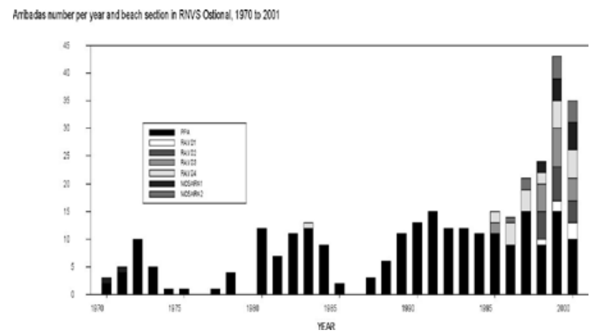


Figura 3. Trends in arribada duration in the nesting major beach of the Ostional Wildlife Refuge, Costa Rica, beteen 1970 to 2000.

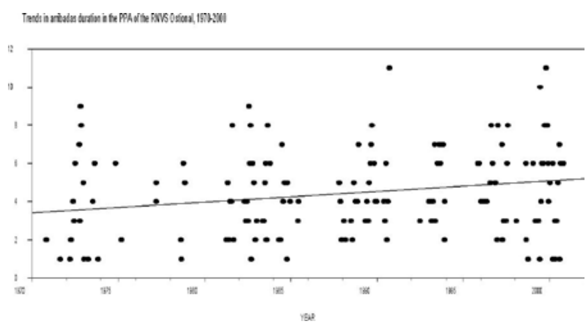
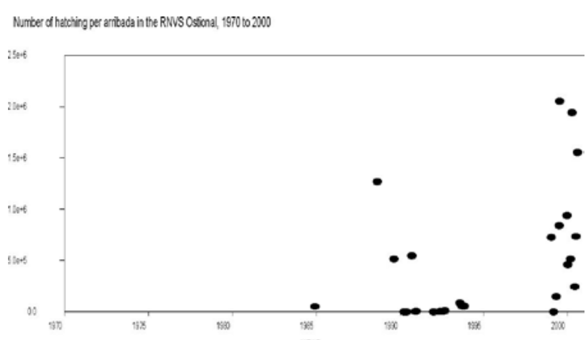


Figura 4. Number of hatchling per arribada in the Ostional Wildlife Refuge, Costa Rica, between 1970 to 2000.



CONCLUSIONS

The trends in "arribada" are to increase, in all parameters measure. This situations is very interesting because the trends in other "arribadas" beaches are clearly.

The size of "arribadas" in Ostional is so large to permits the egg exploitation and keep the population status.

The new "arribada" sites permit the comparison of exploitation and non exploitation zones and the evaluation of the impact of the management in the population parameters.

NESTING ACTIVITY AND HATCHING SUCCESS ON A SOLITARY NESTING BEACH: PLAYA SAN MIGUEL, GUANACASTE, COSTA RICA, 2000

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INTRODUCTION

Endangered Olive ridley, *Lepidochelys olivacea* (Fitzinger, 1843), and Leatherback, *Dermochelys coriacea* (Linnaeus, 1766) sea turtles nest along Playa San Miguel (Fig. 1). Olive ridleys are the most abundant nesters. This solitary nesting site supports annual, non-aggregated, low density nesting, of up to a few hundred individuals. Such sites are important to Olive ridley population maintenance, having higher hatching success rates than "arribada" sites, where later nesters frequently destroy existing nests. Population declines of the Leatherback sea turtle amplifies this sites reproductive importance (Arauz, et al, 2000). This paper describes solitary nesting activity and hatching success monitored on Playa San Miguel from 19th August, 2000 to 2nd January, 2001.

METHODOLOGY

The 4 km beach was divided into 4 zones with different characteristics. Zone 1 (800 m), zones 2-4 (600 m). Zones were monitored for sea turtle activity, nightly (1-2 hours before high tide and 2 hours before low tide, using tide charts; constantly during peak season) and early morning (before dawn) through conducting crawl count surveys. Crawls were categorized as false crawls (FC's) or nesting crawls (NC's) (Pritchard et al, 1983). Nests were carefully relocated to the hatchery or in-situ, on the beach (towards the end of the project), away from turtle tracks, avoiding poacher observation. Other nests were recorded as poached.

Nests were monitored throughout incubation, by continual observation. Live hatchlings were released at the earliest opportunity succeeding emergence: post sunset, and pre dawn, when temperatures were low and predators limited. Releases from several beach locations, at various times, away from the hatchery, aimed to prevent the development of predator "feeding stations" (Mortimer, 1999).

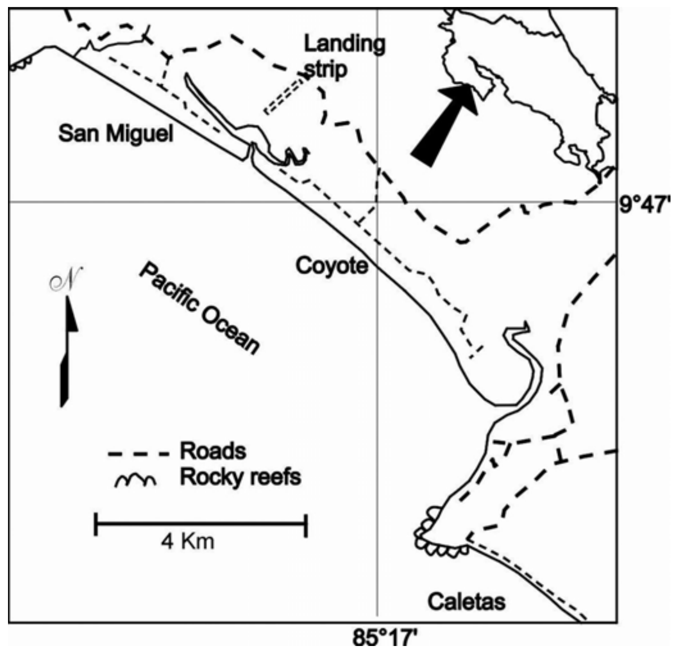
2-3 days after nest eclosion, excavation occurred and contents were counted, examined and categorized as: hatched egg shells (minimum 50% intact), live or dead hatchlings, pipped eggs, infertile eggs (unhatched without a visible embryo), eggs containing dead embryos, depredated eggs and hatchlings and eggs unaccounted for (undetermined fate). Hatching success, (HS), was calculated from these figures. Nest descriptions (presence of vegetation, bacteria, fungi, mould, maggots and evidence of predator activity) were made to help analyse % HS rates.

RESULTS

NESTING ACTIVITY

A total of 251 tracks (248 Olive ridley and 3 Leatherback) were recorded along Playa San Miguel during the 2000 nesting season (Table 1). Olive ridleys made 54 FC's (21.8%) and 194 NC's (78.2%). 1 Leatherback successfully nested, (33.3%), 2 (66.7%) made FC's. Of 195 nests, 126, (64.6%) including the Leatherbacks, were hatchery relocated, 9 (4.6%) were left in-situ, and 60 (30.8%) were poached. Olive ridleys emerged in all 4 zones, Leatherbacks only in zone 2. Activities gradually decreased from zone 1 (95 activities) to zone 4 (36 activities). Olive ridleys emerged each month, Leatherbacks only during October and November. Nesting activities peaked during September and October (Table 1).

Figure. 1: Location map of Playa San Miguel, Guanacaste Province, Costa Rica.



HATCHING SUCCESS

All 126 hatchery nests eclosed. 13,035 Olive ridley eggs were protected in the hatchery, producing 7,685 hatchlings (Table 2). HS was most influenced by vegetation (38 nests affected, mainly those reburied during August: 62.5% and September: 39.66%), maggots (24 nests affected, increasing in severity with time to 54.5% of November's nests) and raccoon and dog depredation (13 of October's nests) (Table 2). Average %HS rates for August, September, October and November were 49.61%, 63.05% (highest), 59.84% and 42.0% (lowest), respectively. The seasons Olive ridley HS was 58.96%. ANOVA analysis indicated that months and %HS varied significantly: df = 3; F = 4.074; P = .009. Scheffe's post-hoc test determined that %HS for September and November varied significantly: P= 0.20 (significant at the .05% level). 107 Leatherback eggs were protected in the hatchery in October producing 4 hatchlings, %HS was 3.74% (Table 2).

DISCUSSION

NESTING ACTIVITY

The Olive ridley was the most common species, with NC's outnumbering FC's. These turtles emerged predominantly in zone 1 (longest zone: more nesting space; close proximity to an estuary, a favoured habitat (Ripple, 1996)) and zone 2. Both zones have non-compacted, smooth sand and limited beach lighting. Emergence was less frequent in zones 3 (pebbly/ shelly sand surface, more litter) and 4 (identical, but additionally has a long constructed wall limiting nesting space, oil pollution, water logging from a pond (compacting sand, complicating nesting), a rocky outcrop and more beach lighting). Leatherback FC's outnumbered NC's. Leatherbacks emerged in zone 2 following large obstacle removal (dead trees, debris), preferring unobstructed, open beach areas. 2/3 emerged when and close to where a bonfire was lit, being attracted to light (Ripple, 1996). These factors together with low tides inundating egg chambers and dog disturbance induced FC's. Controlling beach development / dogs, and masking artificial light could reduce FC's.

Species' activity varied temporally (Table 1). Poaching rates mirrored nesting activity, peaking in busiest zones, during busiest months, including October once Leatherbacks began nesting (rarer species eggs fetching a higher market price), and during December, when tourists arrived in San Miguel (Table 1). Nightly beach patrols limited poaching, but increasing manpower would reduce it further.

HATCHING SUCCESS

Several factors influenced Olive ridley HS (Table 2). Roots of fast growing vegetation: "Goat foot" Beach Morning Glory, (*Ipomoea pes-caprae*) encased and suffocated eggs reburied within 1-2m of hatchery perimeters. The hatchery's 49 day average egg incubation period prevented discovery of this problem until the first nests eclosed, allowing vigorous root growth in many nests reburied up to early October. Utilisation of mesh cages around nests to limit crab depredation (Mortimer, 1999) enhanced the problem by supporting root growth. Following high egg loss from August's nests, surface vegetation was raked and roots dug up around and inside the hatchery to a depth greater than Olive ridley nest reburial (>30cm). Together with nest reburial away from hatchery perimeters, vegetation impact was reduced (Table 2).

When eggs collected in September and October hatched en masse: many eggs split simultaneously, leaking neonatal fluids, producing olfactory cues attracting flies (Chacon, pers. comm.), maggots became more abundant, infesting nests. They were first observed when September's nests began hatching. Once October's nests were eclosing, * nests contained maggots (Table 2). Excavation was conducted 3 days after nest eclosion, originally, but reduced to within 2 days of eclosion when maggots became more abundant, to reduce severity. Healthy eggs from infested nests were removed, placed into buckets containing sand from outside of the hatchery, stored away from the hatchery, and left to develop for a further 2-3 days, being checked every few hours. Several hatchlings emerged following this procedure, which may not have, if left within their original nests. Covering nests with non-impregnated mosquito netting could prevent maggot entry.

Raccoons (*Procyon lotor*) (Rc) and dogs (*Canis familiaris*) (Dg) depredated nests reburied in October, probably sensing olfactory cues produced from hatching eggs (Table 2). They climbed or jumped over the weak hatchery fencing (fishing net). Fencing was heightened, mesh cages (when available) were positioned over existing cages, producing a lid, reducing nest access, and guarding the hatchery all night on several occasions limited depredation. Replacing existing fencing with wire mesh and constructing a hatchery roof would make entry more difficult for mammals.

Bacteria, fungi and mould affected several nests (Table 2), but can be limited if a hatchery is not used during consecutive nesting seasons (Mortimer, 1999), if humid sand at a chosen site for nest reburial is dried at the surface over 3 days, to eliminate these bodies and latex gloves are used during egg handling to prevent bacterial infection from unclean hands (Chacon, pers. comm.).

The Leatherbacks eggs were unaffected by the above factors (Table 2). 99 eggs (92.5%) were infertile, and of the 8 eggs remaining, 4 hatched (Table 2). This species' eggs are very sensitive to manipulation (Marquez, pers. comm.). HS could be improved if the eggs were left in-situ following track and nest disguise.

Efforts to increase project success with beach patrols and HS were made throughout the nesting season. Employing the additional suggested methods would improve results.

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Table 1: Zoned and monthly species' activities on Playa San Miguel, 2000.

Activity	Zone 1	Zone 2	Zone 3	Zone 4	Sp Totals OR LB
n False crawls	21	10/2	13	10	54 / 2
n NC (hatchery)	48	36/1	23	18	125 /1
n NC (in-situ)	4	4	0	1	9 / 0
n NC (poached)	22	18	13	7	60 / 0
Totals	95	68/3	50	36	248/ 3=251

Activity	Month Aug	Sep	Oct	Nov	Dec	Jan	Sp Totals OR LB
n False crawls	4	21	19/1	10/1	0	0	54 / 2
n NC (hatchery)	8	58	48/1	11	0	0	125 /1
n NC (in-situ)	0	0	0	5	4	0	9 / 0
n NC (poached)	2	20	28	2	7	1	60 / 0
Totals	14	99	96/2	28/1	11	1	248/ 3=25

Table 2: Monthly determinants of and results for %HS, Playa San Miguel, 2000.

Months Collected	# nests OR / LB	# nests affected by: Veg	Depred Rc	Depred Dg	Bac	Fun	Mou	Mags	# eggs OR / LB	# hatched OR / LB	%HS OR / LB
August	8	5	0	0	0	1	2	0	901	447	49.61
September	58	23	0	0	1	5	0	6	5984	3773	63.05
October	48 / 1	9	4	9	5	3	0	12	4943 / 107	2958 / 4	59.84 / 3.74
November	11	1	0	0	0	1	0	6	1207	507	42
Totals	125 / 1	38	4	9	6	10	2	24	13035/ 107	7685 / 4	58.96 / 3.74

EVALUATION OF THE PERCENTAGE OF THE HATCHLING SUCCESS AND THE CLUTCH SIZE THE NEST OF THE LEATHERBACK SEA TURTLE (*DERMOCHELYS CORIACEA*)

Libertad Cuellar and Humberto Pineda

Proyecto Laud, INP

INTRODUCTION

Protection works about leatherback sea turtle have been famous in the last years due to the decrement of female nesters in Mexico (Sarti, et al., 1996) and also happening at world level (Ross, 1981), reason to enforce efforts to make more efficient the works of protection of clutches to obtain a bigger hatchling success. Some authors have reported that the percentage of hatchlings success usually increases when the clutches relocated in nest contain few eggs. Balasingam (1967), Hall (1988; 1987) recommends the burial of clutches of less than 55 eggs with the intention of a bigger production of hatchlings.

STUDY AREA

Tierra Colorada beach nesting is located in México, at Guerrero State southeast part and burdening with Oaxaca state, between Barra de Tecoanapa (16° 30 ' 03 " N and 98° 43 ' 40 " W) and Punta Maldonado (16° 22 ' 36 " N and 98° 35 ' 40 " W) in the region known as Costa Chica of Guerrero. This beach remains on 26 km of sandy fringe extension and 48 m wide which is relatively uniform except by the Punta Maldonado near area, where the beach becomes very narrow due the hill proximity, and also caused by invading waters all over the vegetation area at high tide hours. The tides regime of is mixed seminally, with two high and two low tides per maritimes day and different height each one (Peredo, 1990). The water surface temperature fluctuates about 28 °C, and the salinity is 34 0/00 (De la Lanza, 1991).

METHODS

In this study, some clutches with more than 60 eggs were buried in two different nests placing per nest half of the eggs. This number was chosen due the average reported in diverse works for the species (Sarti et al., 1988; 1994; 1995; López et al., 1992; Sánchez, 1994; Guerdes et al., 1995).

The percentage of hatchling success was evaluated in the big clutches and small clutches with the following categories:

· small clutches: nests with less than 46 eggs (n = 42)
· big clutches: nests with over 46 eggs (n = 25)

according in the following formula:

% hatchling success = Shells + pippings / total of buried eggs

After this, a t test was carried out to compare the groups and to watch if significance differences arise in the percentages hatchling success.

RESULTS AND DISCUSSION

It is known, due to diverse studies in Mexico, the eggs average in the leatherback sea turtle clutches oscillates from 57 to 63 eggs (Sarti et al., 1988; 1994; 1995; López et al., 1992; Sánchez, 1994; Guerdes et al., 1995), although in beaches of Puerto Rico (Tucker, 1988; Hall, 1987), Costa Rica (Hirth and Ogren, 1987) and Sandy Point (Eckert et al., 1984; Boulon et al., 1996) these species produce a bigger number of eggs (between 70 and 80 for clutch), and this could be attributed in terms that females of these beaches are bigger in size that those from Mexico (Tucker and Frazer, 1991; Hall, 1987; Eckert et al., 1984; Boulon et al., 1996).

It is important to consider that the production of the clutches is regulated under physiologic processes (Owens, 1980) and that this variation is given in terms of selective pressures over females exposition. According to Frazer and Richardson (1985) big clutches production might be a reproductive strategy, since this could work on behalf a minor nesting effort. On the other hand, the fact that a turtle nest all the eggs in few clutches would increase the probability of destruction in terms of some biotic or unbiotic factors affecting the beaches due the probable favoring to other organisms that produced a lot clutches.

It is evident that these present study results cannot jump to conclusions about nests in situ, but it is probable to consider these as a handling tool to enforce the protection works where the clutches are relocated, the current situation in which leatherback sea turtle populations, an increase in the percentage of hatchling production could be beneficial. However, it is worthwhile to evaluate the possible negative effects when dividing the clutches and if it is not given, it could be an appropriate handling tool, in chase of good values of big and small clutches.

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IMPORTANCE OF THE TIERRA COLORADA BEACH FOR THE NESTING OF THE LEATHERBACK SEA TURTLE (*DERMOCHELYS CORIACEA*)

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INTRODUCTION

The importance of leather back sea turtles in Mexico has been documented for several years; Ross (1981) reported that bigger nesting population of this turtle was given in French Guyana, Malaysia and México. Pritchard (1982) reported a study of this species world population where was estimated that the Mexican Pacific nestings represented little more than half of those that existed at world level. Also, Starbird et al. (1992) recognized this region nesting population like one of the biggest, alike New Guineas.

Mexico population is distributed through the Pacific, from Baja California Sur to Chiapas, where Michoacan, Guerrero and Oaxaca states arise as the most important (Pritchard, 1982; Márquez, et al., 1981; Sarti et al., 1996), stayed that 42% of the nesting of the whole Mexican Pacific (Sarti et al., 1996).

Márquez and collaborators (1981) published reports on 1977 where pointed that Tierra Colorada beach was important for leather back sea turtle nesting, and from then on this has been a reason of attention from scientific investigators to visit the area. In same report they mention that in the phases of new moon on November December and January, there were up to 200 females nesting every night, and this enforce the consideration that could be near of 5,000 female nesting for season. From then on, brief visits were carried out each season with observation purposes for testifies this species nesting however, there are not publications on the subject.

STUDY AREA

Tierra Colorada beach nesting is located in México, at Guerrero State southeast part and burdening with Oaxaca state, between Barra de Tecoanapa (16° 30 ' 03 " N and 98° 43 ' 40 " W) and Punta Maldonado (16° 22 ' 36 " N and 98° 35 ' 40 " W) in the region known as Costa Chica of Guerrero. This beach remains on 26 km of sandy fringe extension and 48 m wide which is relatively uniform except by the Punta Maldonado near area, where the beach becomes very narrow due the hill proximity, and also caused by invading waters all over the vegetation area at high tide hours.

METHODS

Nesting and season clutches quantity

The beach importance was evaluated in regard to total tracks happening through the season. Daily journeys were carried out at the beach in order to number tracks of the turtles who nested in previous night at each. It was consider two types of tracks: "body pit" and "half moon". It was evaluated the real clutches number left in the beach, jumping to the conclusion that night observations to females carrying out the nesting and did not ovipositate, confronting the big total registered in the censuses.

Nesting distribution in beach and natural loss of nests

Nesting density was evaluate with the nestings number per beach kilometer. In night observations it was registered measuring about the location of the nest distance from the sea and from berma. A condition about status for each nesting censuses was indicated according to the following categories:
nest in danger or flooded nest.

RESULTS AND DISCUSSION

Nesting and season clutches quantity

In regard the season results, it was observed that the importance of this beach make it relevant due to the number nesting of leather back sea turtle successes (1034 nesting along the season). This species protection has had a lot of attention in last years due to the decrement in nesting number in the Mexican Pacific beaches (Sarti et al., 1996) and at world wide records (Ross, 1981). From 1983, a monitory program related to population is maintained each season in Mexiquillo Playón, (Michoacán), and reports that leather back sea turtle nesting has gradually diminished, and more drastically in last years (Sarti et al., 1996).

Difficulties arise in Tierra Colorada beach nesting behavior evaluation cause there is not later published information after Márquez and staff reports of (1981), where a nesting population of 5,000 females per season is mentioned. However, this study denotes that it is an area of numerous nestings and protection against eggs looting is fundamentally important. Sarti and collaborates (1996) mentioned that Tierra Colorada beach is one of the most leather back sea turtle density nesting site beaches in Mexico. This was corroborated in later works (1997) where pointed that this was the more nestings number beach in the Mexican Pacific (Sarti et al. 1997; Sarti et al., 1998).

It is observed that there is an evident decrement in nestings numbering in whole Mexican Pacific, and this enforces to double efforts for protection and study. That is why Tierra Colorada beach represents a high potential area for nesting number and due the characteristics and peculiarities of this beach. The present work remains like a basis for later studies since this is the first one elaborated in this area entirety embracing the beach by daily censuses and females marking every night of the season.

A 93% success in setting on was recorded and this is a similar data to the reported by Sarti and collaborators (1996; 1997) for main of the Pacific beaches with a variation of 83.3 to 96.5%. This fact is superior in comparison with that 74.6% reported in Sandy Point (Eckert et al., 1984) and in Malaysia with 81% on the average (Chua and Furtado, 1988).

Nesting distribution in beach and natural loss of nests

Although one knows that the number of the nestings varies year with year in each beach, during this season, Tierra Colorada was one of those that registered bigger nesting density in the Mexican beaches (40 nest per beach kilometer) according to what report Sarti and her group (Sarti et al., 1996), but although the nestings are abundant in the whole beach, they concentrate notably among the area of Agua Dulce to Pico del Monte (with densities over 50 nest per kilometer) inside which the camp is located.

The beach of Tierra Colorada is very dynamic and its relief transforms as they pass the lunar cycles and of tides, that which favorable that some near nests to the sea are flooded, mainly in the area of Jicaro to Punta Maldonado where the beach is narrowed and, when the tide ascends, it arrives until the vegetation, flooding most of the nests. This phenomenon is common in some nesting beaches for the leatherback sea turtle, such as Point Isère, French Guyana, Surinam (Mrosovsky, 1983), Sandy Point, St. Croix (Eckert and Eckert, 1983 and 1985; Eckert et al., 1984; Boulon, 1994), Isla Culebra and Puerto Rico (Tucker, 1988), where they have reported that the loss of nests for flood can vary from 10% until 50% or 60% and, although this fact is low in this beach (1.9%), you cannot discard the importance of the phenomenon, since it is proven that the eggs of flooded nests don't complete its embryonic development (Whitmore and Dutton, 1985).

Mrosovsky (1983) suggests that the turtles should balance the consequences of very distant nestings of the sea somehow (taking a risk the disorientation of the hatchlings for the distance of the sea) with the loss of the on nests very near this. A possible strategy of the turtles to counteract the phenomenon can be the distribution from the nestings to the wide of the beach. In Tierra Colorada the nestings was distributed to all the wide of the beach, although most of they were located in the areas around the berma. In other beaches of Costa Rica (Carr and Ogren, 1959), Trinidad (Bacon, 1970 in Eckert, 1987), St. Croix (Eckert, 1987) and Puerto Rico (Tucker, 1988), the nestings of the leatherback sea turtle are distributed to all the wide of the beach, from the area intermareal until the vegetation supralitoral. However, other authors observed that, seemingly, most of the nestings happens in the next area to the sea (Pritchard, 1971; Whitmore and Dutton, 1983; Mrosovsky, 1983).

The fact is that this phenomenon is variable in each beach, and even among seasons, and the success or failure that it is obtained in the incubation of its nests it influences directly in its populations.

CONCLUSIONS

In this work the data were update on the nesting population of this beach and is as it bases for later investigation. The importance of Tierra Colorada as area of nesting of leatherback sea turtle is relevant, because it presents a considerable number of the nestings that happen in the whole Mexican Pacific. The loss of nests for natural causes is minimum, that which gives a high potential of production of hatchlings.

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ART AS A TOOL FOR MARINE TURTLE CONSERVATION ON ANDROS ISLAND, BAHAMAS

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When considering human needs and human reactions to conservation strategies, we move into areas that are not defined by intellect but are framed by conciousness. Marine Turtle conservation laws in developing countries are in need of translation. Andros Island in the Bahamas is a case in point. A vast reef system stretches for hundreds of miles providing food for all of Andros people. Only a fool would starve on Andros is a common sentiment. Turtles too slow to escape the spear suffer the same fate regardless of species, or the laws in Nassau. This project is attempting to use the language of visual art to translate and interpret the ways of the fisherman, the conservationist, and the turtle. A submerged installation of seven turtle buoys has been placed along the east coast of Andros. The intent is for the fisherman to discover these buoys and to take them back to there homes. The buoys will live marine lives as markers of time past and terrestrial lives as totems of a future of conscious conservation. The objects are intended to then stimulate a dialog between fisherman and conservationist, using the artist as interpreter. Audio documentation of the islanders thoughts on the current status of marine turtles will be compiled and shared with conservationists. The goal being an exchange of ideas that uses the subtlety of art to soften the sometimes heavy handed fisheries enforcement to create a conservation conciousness in the working fisherman of Andros.

LEATHERBACKS, (*DERMOCHELYS CORIACEA*), NESTING AT THE PACUARE NATURE RESERVE, COSTA RICA (2000)

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INTRODUCTION

The leatherback sea turtle (*Dermochelys coriacea*) population of Pacific Costa Rica has suffered a dramatic decline creating concern for populations worldwide. Pacuare Nature Reserve, located on the northeast Caribbean coast of Costa Rica, is an important nesting site for the leatherback. Conservation programs were established in 1994 to monitor the nesting population and protect the nests. Results of the 2000-nesting season at Pacuare are reported.

METHODS

Nightly beach patrols were conducted between the 18th of March and the 4th of August along 5.7 km of nesting beach. Reserve guards, students and volunteers participated in the patrols and data collection. Biometric data (including number of large eggs and yolkless eggs, minimum curved carapace length and width) was collected during the nightly patrols. One Monel tag was placed in each rear flipper of encountered leatherbacks. Tag numbers, evidence of old tag holes and notches, date, time, activity and sector when encountered, were recorded. Daily track surveys, conducted from the 20th of March until the 31st of August, provided demographic and seasonal nesting activity of both leatherbacks and green sea turtles (*Chelonia mydas*) nesting within the reserve. Nest relocation and camouflage were used to mitigate the threat of poaching and erosion within the reserve. Styrofoam boxes were used as hatcheries until beach hatcheries were constructed for nests confiscated outside of the reserve by the environmental unit of the Limon Coast Guard and from within the reserve by reserve guards. Sample nests from hatcheries, relocated and in situ nests were excavated 3-6 days after first emergence in order to compare hatching and emerging success.

RESULTS

Mean curved carapace length of leatherbacks nesting at Pacuare was 152 cm (SD 6.9) and width 110 cm (SD 4.9). Average number of large eggs/nest was 74 and 37 yolkless. A total of 368 individual female leatherbacks were recorded. Of the 368 recorded, 257 were tagged at the reserve in 2000, 64 were tagged at the reserve in previous years and 47 were tagged on other beaches in Costa Rica, Honduras and Panama. Of the 257 tagged at the reserve in 2000, 8% had evidence of old tag holes or notches indicating a high number of new recruits. Tag loss from tags placed at Pacuare previous years and from turtles tagged on other beaches was 20%. Peak leatherback nesting occurred in April and May. 814 nests were recorded along the 5.7-kilometer beach. 53% of the nests were relocated on the beach, 5 % were camouflaged, 3% were relocated to a hatchery and 35% were left in situ (untouched). A total of 4% of the nests were lost to poaching and animals. Each turtle laid an average of 2.2 nests per season with an internesting interval of 9 days. The number of individual nesting females is high, however the number of nests laid per nesting female is low. In addition, a total of over 7698 leatherback eggs along with 5732 green turtle eggs were confiscated outside of the reserve by the Coast Guard and relocated to hatcheries located at the reserve. Poaching activity was minimal due to nightly beach patrols and nest relocation.

DISCUSSION

Recovery of nesting information is necessary to determine the population status of leatherbacks nesting along the Caribbean shore of Costa Rica. Track counts officially started on the 20th of March, however leatherback nesting was reported to have begun in February. Track counts were extended until the 31st of August to include an unexpected high number of greens nesting at the reserve. The low number of nests laid per female indicates the possibility of low nest site fidelity and the need for increased protection and monitoring of leatherback nesting beaches along the Caribbean coast of Costa Rica. Tag loss of remigrant turtles was high and may cause an overestimation on new recruits. The use of PIT (passive integrated transponder) tags along with monel tags will increase the accuracy and recovery of long term nesting data. To improve hatching success data collection, a piece of tape stating proper information should be placed in the nest at oviposition or time of relocation. The use of styrofoam box hatcheries should be discouraged until proper temperature and humidity conditions can be manipulated to eliminate the possibility of counteracting conservation efforts by influencing sex hatchling ratios. The number of nests lost to dogs was identified as an increasing threat to nests. Continued studies using improved research techniques are imperative in determining the stability and contribution of Pacuare's nesting leatherback population to populations worldwide.

Acknowledgements:

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BIOENERGETICS OF DEVELOPMENT FOR LOGGERHEAD SEA TURTLES AT GULF ISLANDS NATIONAL SEASHORE, FLORIDA

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Loggerhead sea turtle (*Caretta caretta*) eggs, embryos, and hatchlings from Gulf Islands National Seashore, Florida were analyzed for lipid, protein, and carbohydrate content to determine distribution and usage during development. Total caloric energy was examined via oxygen bomb calorimetry to determine the energetic cost of reproduction and development. Lipids were extracted utilizing a solvent of 2:1 chloroform:methanol in Soxhlet reflux condensers. Protein and carbohydrate content was determined using colorimetric methods with Biuret's reagent and phenol-sulfuric acid respectively. Undeveloped eggs averaged 42,770 calories. Hatchlings averaged 28,613 calories and utilized 14,147 calories during development. Eggshells contained 4970 calories thus requiring 47,740 calories to produce an entire egg. Nests averaged 112 eggs requiring 5,346,880 calories (5,347 Kcal) by the nesting female. Undeveloped eggs averaged 6.296 grams dry weight and contained 48.2% soluble protein, 36.6% lipid, and 0.56% carbohydrate. Hatchlings averaged 4.533 grams dry weight and contained 41.2% soluble protein, 34.4% lipid, and 0.43% carbohydrate. Through development, the percentage of protein in the yolk sac decreased while the percentage of lipid increased. By pipping stage, embryonic yolk sacs were over 80% lipid. Carbohydrate percentage declined slightly during development. The results illustrate that protein is selectively utilized from eggs during development. Remaining lipids likely provide energy for hatchling emergence and swim frenzy.

INDIGENOUS KNOWLEDGE ON SEA TURTLES IN THE COMMUNITY OF HILABAAN AND TIKLING ISLANDS, EASTERN SAMAR, PHILIPPINES

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ABSTRACT

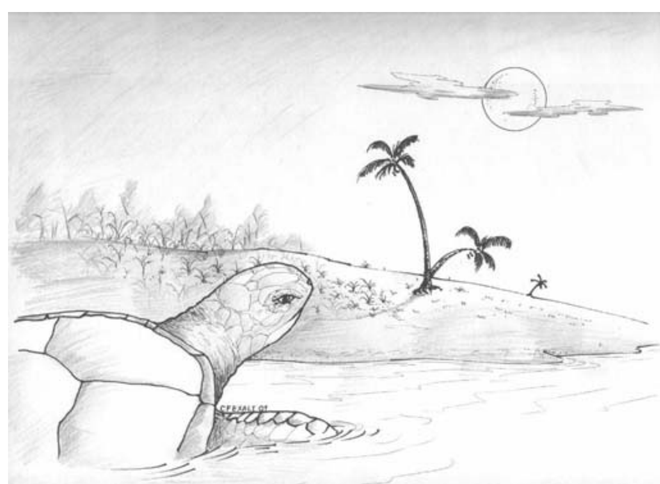
A semi-structured interview was conducted among the identified key informants from the community to document local knowledge and beliefs on sea turtles, particularly the hawksbill and green sea turtles, which are most common in the area. Sea turtles incidentally caught in the fish net are believed to bring bad luck among fisherfolk. Moon phases, crawl tracts, and bite marks are among the signs used in determining the nest, the time and location of the next clutch of eggs to be laid. These knowledge from the local people of Hilabaan and Tikling group of islands on the nesting behavior of sea turtles make these creatures more vulnerable to human exploitation. Since indigenous knowledge and beliefs directly impact on a community's way of resource utilization, their integration in the design of resource management strategies is significant.

INTRODUCTION

The communities of Hilabaan and Tikling are not strangers to sea turtles. As far as the oldest living member of these communities can remember, sea turtles have been nesting and foraging in these islands and the surrounding areas. From the local own encounter with sea turtles and the accounts from previous generations, they developed their own set of understanding and beliefs on these creatures which in turn have influence their utilization of sea turtle as a resource. Knowing what it contains, how it is acquired and when integrated with scientific explanation, indigenous knowledge and beliefs could form a very good basis for conservation.

METHODOLOGY

The study is an inventory of indigenous knowledge and beliefs obtained from key informant interview. Seven informants participated. The respondents are in their late 40's to 80's in age, have stayed in the island for most of their lives and have been engaged in the taking of sea turtles and its eggs. The data gathered are largely quantitative.



RESULTS

There are three (3) observations that the locals have developed on the nesting behavior of sea turtles. These are:

1. Moon phase signals the time for sea turtles nesting. The locals observe that nesting occur during full moon and new moon. Thus, sea turtle egg collection is patterned with this observation. (Fig. 1)

2. Sea turtles are known to camouflage their nest. To locate the nest, the locals look for bite marks on trunks of plants or rocks for they believe that sea turtles always bite on to something when laying eggs. (Fig. 2)

3. The locals believe that the crawl tracks of the sea turtle gives the location of the next nesting area. If the returning tracks are on the right side from the emerging tracks, the next clutch of eggs will be laid somewhere to the direction of the returning tracts. If the returning tracks are the same of that of the emerging tracks, the next nest will be located in the same area. (Fig. 3)

Through the years of encounter with sea turtles, the locals have also developed some beliefs on these creatures.

1. Sea turtles are believed to have feelings. Thus they shed tears when about to be slaughtered. This belief sometimes spares them out of mercy.

2. Sea turtles incidentally caught in the fish net are believed to bring bad luck to the fisherfolk. The net will not be able to catch any fish on their succeeding fishing trip. Some believe that it is because of the stench of the sea turtle. To drive away the bad luck, they pass the net over the smoke coming from the burnt local herbs. (Fig. 4)

3. Any body parts of a sea turtle secretly placed to either male or female having an illicit affair will result to a situation similar to that of sea turtles mating. Both partners will find difficulty in disengaging themselves from the sexual act. (Fig. 5)

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ASSESSMENT OF COMMERCIAL FISHING ACTIVITY ON SEA TURTLE STRANDINGS IN GEORGIA, USA, 1999-2000

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INTRODUCTION

Sea turtle strandings have been periodically monitored on Georgia's barrier island beaches since 1964. Comprehensive statewide monitoring of strandings was first established in 1989. Strandings are used as an index of sea turtle mortality associated with commercial fisheries. Sea turtle mortality rates are affected by turtle abundance, fishing effort, fishing gear (nets and TEDs), and law enforcement activity. Environmental variables including wind direction, near-shore ocean currents, water temperature, and scavenger abundance affect the number of carcasses that strand.

Over the last 11 years, sea turtle strandings in Georgia have increased from 171 in 1989 to 291 in 1999. A trend line fitted to the data indicates a statistically significant 11-year increasing trend ($F=5.40$, $df=10$, $P=0.045$). In 2000, stranding totals were approximately 39% (Figure 1) below the previous years total and 28% below the previous 6-year average ($x=247$).

In this preliminary summary, we examine all available fishery data to determine factors potentially responsible for lower stranding totals observed in 2000. Although we are not able to establish cause/effect relationships between stranding totals and changes in fishery management, a careful examination of the data may allow us to eliminate some variables from consideration, and by process of elimination, focus on the important factors influencing strandings in Georgia.

SHRIMP FISHING EFFORT

Shrimp trawling is thought to be the largest single source of mortality for sea turtles in the southeastern U.S. (Magnuson et al. 1990). Currently, estimates of fishing effort are not available for the Georgia shrimp fishery (ie. no. of 100 ft. net/hrs) making it difficult to assess the affects of the shrimp fishery on sea turtle strandings.

SPATIAL DISTRIBUTION OF SHRIMP TRAWLERS

During 1999 and 2000, we conducted bi-monthly aerial surveys to determine the spatial distribution of shrimp trawlers in Georgia's coastal waters. Surveys were flown perpendicular to the coast (south-north) with the pilot positioning the plane over each trawler while an observer recorded a latitude and longitude coordinate using a global positioning unit (GPS).

In both years, the distribution of trawlers appeared clumped with shrimpers favoring nearshore sloughs (2 to 5 miles from the beach) as well as man-made and natural channels, and the mouths of the sounds. Based on a qualitative assessment of the data, it does not appear that a large-scale change in the spatial distribution of trawling effort was responsible for the reduction in strandings observed in 2000.

SHARK DRIFT GILLNET FISHERY EFFORT

Shark gillnet fisherman employ 12.7-27.9 cm (5-11 inch) stretch mesh nets ranging in length from 275-1800 m (Trent et al. 1997, Carlson and Lee 2000). Nets are generally deployed in federal waters (EEZ) at night approximately 3-5 miles from shore.

Unfortunately, the data necessary to evaluate changes in shark fishing effort in Georgia are currently not available. As a result of the small number of boats participating in the fishery(<3), information submitted during the 1999 and 2000 seasons is protected by confidentiality provisions of the Magnuson Act (M. Smith-Brunello, NMFS, pers. comm.).

LAW ENFORCEMENT ACTIVITY

Federal regulations require shrimp fisherman in the southern Atlantic and Gulf of Mexico to use Turtle Excluder Devices (TEDs) in their nets to reduce incidental capture of sea turtles. Incorrect installation or illegal modification of TEDs may result in increased turtle mortality. Law enforcement presence on the fishing grounds serves as a deterrent to illegal modification of TEDs and may have an effect on stranding rates.

GADNR Law Enforcement does not keep records of the number of commercial shrimp boats checked for gear violations each season. However, enforcement strategies varied considerably between 1999 and 2000. In 1999, at the request of the shrimp fisherman, GADNR law enforcement personnel did not conduct gear checks during the first 3 weeks of the opening of shrimp season in state waters. Two weeks following the opening (weeks 22-23, Figure 2.), we documented the largest single week stranding event in Georgia history (n=46, Figure. 2).

Following intensive gear checks in St. Andrews and St. Simons Sounds during week 23 and 24, strandings dropped to normal levels. By contrast, in 2000, GADNR law enforcement personnel began checking vessels 2 weeks prior to the opening of the shrimp season in state waters. Intensive gear checks continued through the first 2 weeks of the season. The peak in strandings observed in 1999 did not occur in 2000.

Differences in the overall strategy in conducting gear checks by GADNR Law Enforcement personnel could potentially be responsible for the decrease in strandings in 2000. However, the lack of accurate boarding records make it difficult to assess the effects of enforcement activity on strandings.

TURTLE EXCLUDER DEVICE (TED)

The National Marine Fisheries Service requires the use of TEDs in shrimp trawl nets to reduce the incidental catch of sea turtles. Epperly and Teas (1999) found that since 1986, 26% to 40% of stranded loggerhead turtles in the south Atlantic were too large to fit through the required minimum size opening. In the spring of 1998 and 1999, high densities of migrating leatherback turtles along the Georgia and South Carolina coasts resulted in fishery restrictions requiring the use of the leatherback TED in all shrimp trawls. The leatherback TED has an opening large enough to allow all adult loggerhead and green turtles to escape. Many Georgia shrimpers continued to use the leatherback TED following the fishery closures because the 24" flap was thought to reduce shrimp loss and large opening helped minimize unwanted bycatch and trash.

To determine the extent to which shrimp fisherman are using the leatherback TED in Georgia, we surveyed 90 boat captains at 18 docks coastwide (Fernandina Beach, FL to Savannah). Eight of the 90 trawlers (9%) used more than 1 TED configuration simultaneously or switched TED configurations multiple times during either season. Of the remaining 82 vessels, 18% (n=15/82) were using leatherback TEDs during 1999. By contrast, 51% (n=42/82) of the trawlers surveyed were using leatherback TEDs in 2000. The widespread use of the leatherback TED in 2000 may have contributed to lower standing totals in 2000. The leatherback opening configuration allows the largest adult loggerheads (and theoretically leatherbacks) to escape from the net and has an added advantage of reducing escape times for smaller turtles (J. Mitchell, NMFS, pers. comm.).

CONCLUSIONS

The evaluation of sea turtle strandings is difficult as a result of the large number of variables influencing mortality and stranding rates. We were unable to evaluate the effects of the shrimp and shark drift gillnet fisheries on stranding totals as a result of insufficient effort data or confidentiality provisions of the Magnuson Act. Differences in law enforcement activity and the use of leatherback TEDs by Georgia fisherman may have contributed to lower stranding rates in 2000.

Acknowledgements:

We thank the project leaders of the Georgia Sea Turtle Stranding and Salvage Network including: Jennifer Bjork, Rebecca Bell, Jan Caton, Kate Quinn, Tom Henslee, Eric Kellon, Debra Barnard-Keinath, Dr. Gale Bishop, Kris Carol, Mike Frick, and Billy Pye for stranding data.

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Figure 1. Sea turtle strandings in Georgia, 1989-2000.

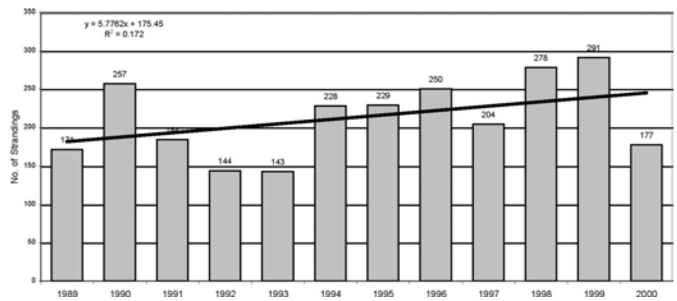
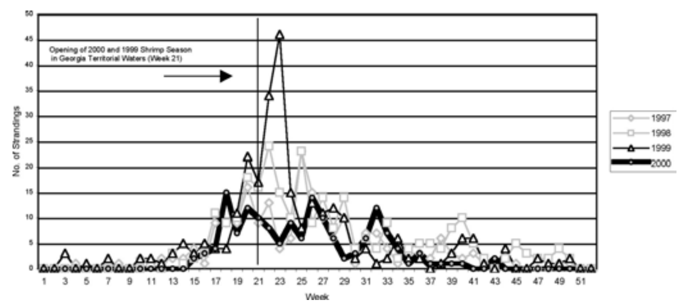


Figure 2. Sea turtle strandings in Georgia by week, 1997-2000.



RECOMMODATIONS FOR ALTERNATIVE INCOMES FOR POACHERS OF SEA TURTLE EGGS ON THREE BEACHES:- SAN MIGUEL, COYOTE AND CALETAS IN GUANACASTE, COSTA RICA

Sarah Dougan , Suzanne Crossland , and Randall Arauz

Sea Turtle Restoration Project

AIMS

There are several aims involved in this project. Firstly, to protect sea turtle eggs laid on these beaches. Also, to establish alternative incomes for communities in the area. The protection of the surrounding environment as a whole and the education of the people about sea turtles, and the environment in general. Showing them the benefits on an economic and environmental level.

INTRODUCTION

Playas San Miguel, Coyote and Caletas are in, Guanacaste, on the Pacific coast of Costa Rica. The town of San Miguel has a population of approximately 200 people. Playas San Miguel, Coyote and Caletas are all accessible from this town. The Sea turtle species which nest on these beaches are Olive Ridley (*Lepidochelys olivacea*), Pacific Green (*Chelonia mydas agassizii*), and Leatherback (*Dermochelys coriacea*). It has been noted solitary nesting beaches (such as the beaches named above) have a higher hatching success rate, 80% (Castro, 1986) then “arribada” beaches (Cornelius, 1986), for the Olive Ridley (*Lepidochelys olivacea*) population.

Rufino Quiró, from the community of San Miguel, originally set up the project in San Miguel and has been in contact with STRP since 1996. He is also the president of the Asociación Conservacionista Pacifico Chorotega (ACPC). PRETOMA (STRP) has been working in San Miguel for the last 3 years, data has only been collected for these years. International interns and local beach monitors (ex poachers) collect eggs for the hatchery by patrolling the local beaches.

Future Projects Proposals

These include, students coming from abroad and staying with local families in San Miguel. They will pay a lump sum to cover broad, transportation to Coyote and Caletas, and also for an ex-poacher to guide them once on the nesting beaches. Tourist coming to the area, also paying a lump sum, can stay in the local hotel, the Blue Pelican. This money will cover food, broad, transportation to Coyote and Caletas and again for an ex-poacher to guide them on the turtle beaches. The eggs found on San Miguel and Coyote will be moved to the local hatchery, while eggs on Caletas will be resituated.

The money, which is left over from the students and the tourists, will be put into a community bank account and used for environmentally sound projects. Ex-poachers can conduct tours of the local mangrove swamps. These can be done either in a boat at high tide or on foot at low tide. Horse riding trips into the surrounding mountains and areas can be organized. Also boat trips and kayaking out to sea, which are both already owned by members of the community. T-shirts, crafts and postcards can be designed, made and sold too tourists.

The ACPC has been designated two sites by the Costa Rican government. The community has also one site, which has half a building already built on it. The site on the beach will be used as a research station were the interns will be staying, carrying out research from and coordinating all the patrols from here. The other site owned by the ACPC will be used as an education center. The material donated by organizations and governments for educational purposes. The center will educate people into how to protect sea turtles and the surrounding environment, also explaining why this is necessary. Lectures will be held for local people, tourists, students and also local school children. Experts from different environmental backgrounds will be invited to talk about matters and hold conferences from the building. Training sessions will be held for locals who want to be guides, for example on the mangrove swamps. Also in how to make crafts and craft artists will be invited to stay in the research station and teach about craft making. The building owned by the local community can be made into a tourist information center. This will contain information about different environments in Costa Rica and what is affecting these areas in positive and negative ways. This way tourists can make educated decisions on where they want to go. This can also be a shop selling T-shirt's, crafts, post cards.

There are also plans by a resident to purchase land for an alternative therapy center. Natural herbs from the surrounding area and information on alternative therapies can be obtained from here this is also where locals can be trained in natural therapies. An alternative way of looking and respecting the earth will be taught here.

Leaflets need to be made and distributed in San Jose and other areas of Costa Rica advertising the area as a local community working together towards a better environment and natural health. An internet page also needs to be designed stating what's on offer, also what the community has done to improve the environment and in protection of sea turtles. Guidebooks also need to be invited into the area to see all the new improvements and be encouraged to write about it in their guides. Write to international and national television companies explaining what this small town has achieved and how it has been carried out. Posters and leaflets have also got to be distributed about lights and walls on the beaches and how it affects sea turtles.

RESULTS

The poaching rate (figure 1) on San Miguel has been reduced from nearly 100% to 29% due to nightly patrols. While on Coyote and Caletas it is nearly 100%, due to lack of routine nightly patrols. The local beach monitors now work towards the protection of sea turtle rather then selling the eggs. The community of San Miguel is already beginning to see the benefits from conserving the turtles on their beach and starting to realize the economical value of these projects. The beaches Coyote (figure 2) and Caletas (Table 1) have a higher number of turtles nesting on them, compared with Playa San Miguel.

Steps have already been made to gather information and obtain public involvement in some of the named project proposals for alternative income sources, such as a natural therapy center. The tourist information center is also under construction. Education material is being gathered to teach, this year, in the local school.

Table 1. Showing the number of nests observed on Caletas on two different nights, 20.10.00 and 15.12.00 Three leatherbacks (*Dermochelys coriacea*) were observed on the 20.10.00, while four olive ridley nests were observed and protected on the 20.10.00.

	Number of nests	Number Protected
Leatherback (Dermochelys coriacea)	24	0
Olive Ridley (Lepidochelys olivcea)	38	4

Figure 1. Graph showing number of nests, false crawls and poached nests on Playa San Miguel was monitored twice a night every night between 22/08/00 to the 10/01/01.

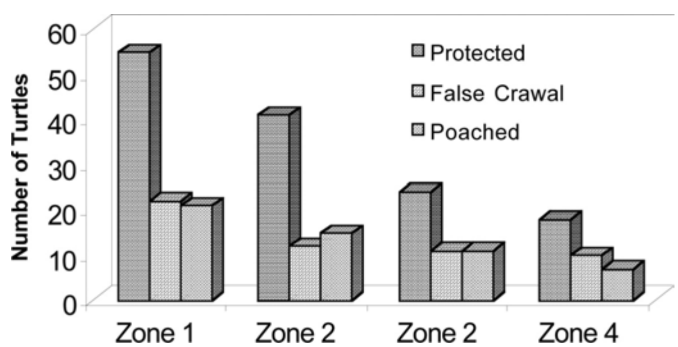
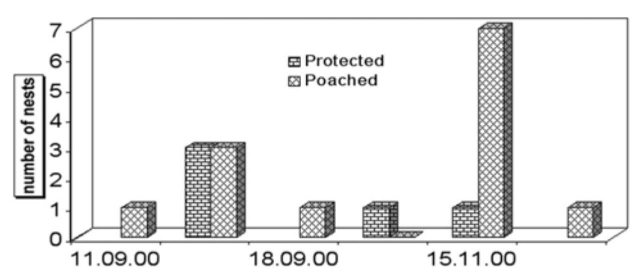


Figure 2. A graph showing the number of nests observed on Coyote, also the numbers which were protected and poached. This beach is known to have more turtles nesting on it than San Miguel.



DISCUSSION

There is little or no education about the status of sea turtles in this area or their life cycles. The education center will inform people of the threats to sea turtles and why it is important to protect them. Steps are already been made to arrange the building of this center.

The main reason for poachers to take eggs is that it is an easy way of making money, the guides will be doing roughly the same job as before but instead they will be respected. A lot of the other ways that have been suggested to make money are activities the local community carries out anyway, like going into the mangrove swamps, but they normally take parrots, fish and shellfish. This way they will be getting a regular amount of money, which is not at the expense of the wildlife. The tourist information center, the education center and the alternative therapy center will attract more tourists to the area therefore bring in more money. The research center will be a place for the interns to stay and other biologists wanting to make studies in the area. It will also be a good base for all the research to be carried out from.

If all recommendations are put into action this community will be working with the environment and protecting not only turtles but also other species and habitats, as well, while gaining a regular income. They will also have rewarding benefits from putting into actions all the suggested alternative incomes.

CONTINUED INCREASE IN NUMBERS OF LEATHERBACKS NESTING ON ST. CROIX, U.S. VIRGIN ISLANDS

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INTRODUCTION

The Sandy Point National Wildlife Refuge in St. Croix, U.S. Virgin Islands supports the largest and best studied population of nesting leatherback sea turtles in the United States and northern Caribbean. Since 1981, saturation tagging and consistent night patrols during the nesting season have yielded a comprehensive database of information on each female nesting at Sandy Point. In 2000, twenty years after conservation efforts began at Sandy Point, approximately five times as many leatherbacks nested compared to the first few years. Nightly patrols and a concerted relocation effort have reduced the major historical threats of poaching and erosion, although there is still poaching of both eggs and adults of greens (*Chelonia mydas*) and hawksbills (*Eretmochelys imbricata*) after nightly patrols cease.

The objectives of the project are to assess the size, productivity, and management priorities of this population by documenting and tagging all nesting females, to protect adults, nests and hatchlings from predators and poachers, and to protect nests from erosion and inundation.

METHODS

Beach coverage began on April 1, and we patrolled nightly on foot from 2000-0500 hours beginning April 5 until August 5th, 10 days after the last nesting activity was observed. Patrol intervals were 40 minutes to one hour. We recorded morphological, nesting, and behavioral data and nest parameters and location each time we encountered a turtle. Carapace length was measured with a metal tape from the nuchal notch to the posterior tip alongside the vertebral ridge. We attached a Monel tag in the inguinal skin flap between the rear flipper and the tail on every untagged turtle. We also injected a PIT tag (AVID, Inc.) directly into the left or right shoulder muscle of each turtle as described in McDonald and Dutton (1996). We used AVID Power Tracker II and IV scanners to detect PIT tags. PIT tagging was carried out during or shortly after egg-laying in order not to disturb the nesting process. If a nest appeared threatened at the time of laying by imminent erosion or inundation, if it was situated in a previously identified erosion zone, or if there was standing water in the nest, we collected the eggs upon deposition and reburied them in a stable area of the beach. After emergence, we excavated nests and categorized their contents to determine hatching success. We opened unhatched eggs to determine stage of development, using criteria described by Whitmore and Dutton (1985).

RESULTS

The 2000 nesting season began on March 5 and ended with a final nest on July 27, with activity being highest from April 22 – May 26 (Figure 1). One hundred seven leatherbacks were observed, laying a total of 548 nests (average of 5.1 nests / turtle) with an average of 77.95 yolked eggs per clutch. Of the 441 nests analyzed, mean overall hatch success (# hatched shells / # eggs laid) was 60.6%. Corresponding emergence success (# hatched shells - # dead hatchlings / # eggs laid) was 58.0%. We estimate that over 25,000 hatchlings emerged in 2000. Of nests laid in 2000, 161 (29.4%) were relocated.

Sixty two of the turtles were previously untagged. There were 45 remigrants, including six first tagged ten or more years ago (one was tagged eighteen years ago). Of the known remigrants, 10 (22%) nested on a two year remigration interval, 28 on a three year, 2 on a four year, 3 on a five year, 1 on a seven year, and 1 that last nested eight years ago. Carapace lengths of 101 turtles ranged from 139.0 cm to 179.0 cm, with a mean of 150.3 cm (6.45 SD).

All remigrants had detectable PIT tags, and 67 new PIT tags were applied in 2000 (some turtle were double-tagged, with a separate PIT in each shoulder). Sixty of the 62 new turtles were PIT tagged. All of these tags were detectable at the end of the season. It should be noted, however, that on some occasions during the season a PIT tag was not detected, and a new one applied to the same shoulder. In all cases the tag was later detected, although not every time the turtle was scanned. Low batteries and poor scanning technique can affect the detectability of PIT tags. Forty four of the remigrants were PIT tagged in previous years; all of their tags were detected. Sixteen of those turtles had lost all flipper tags. Continued tagging and monitoring over the next few years will provide more long term data on the reliability of this tagging method; however, the seven years of data we have collected (we first applied the tags in 1992) show a retention rate of virtually 100%.

DISCUSSION

The 2000 season was a near record year for nesting turtles, second only to 1997 when 117 individuals nested (Figure 2). The season extended from March 5 to July 27. With the addition of 62 new animals in 2000, a total of 498 individuals has been tagged since 1977. This number likely overestimates the population size, since some untagged turtles are remigrants that lost their tags from previous years. This has been confirmed by PIT tag returns and photoidentification (McDonald and Dutton, 1996). However, this is a more accurate estimate than shown in previous years' reports of this project, as it takes into account the percentage of untagged individuals photoidentified as remigrants. We began PIT tagging on Sandy Point in 1992. Continued use of PIT tags and photoidentification will provide more accurate information on population size and remigration rates, and allow estimates of adult mortality to be made (Dutton et al., In press). Due to the relocation effort, less than 5% of the nests were lost to erosion, whereas past history has shown that 50-60% might otherwise be lost. As in past years, several turtles originally tagged on different beaches in Puerto Rico nested at Sandy Point during the 2000 season. This (combined with results of genetic studies; Dutton, unpublished data) continues to suggest that St. Croix and Puerto Rico leatherbacks are part of a larger, regional population rather than two distinct groups.

As recently as a decade ago, there were only 13 significant nesting sites worldwide (Sternberg 1981), including six in the western Atlantic (Carr et al. 1982). However, leatherbacks have been virtually eliminated from some of these nesting sites, and have declined on almost all beaches where they are known to nest (Betz and Welch 1992, Chan and Liew 1996, Sarti et al. 1996, Spotila et al. 1996). In contrast, numbers are increasing on Sandy Point and on Culebra, Puerto Rico, where a similar project has been ongoing since 1984 (McDonald Dutton and Soler 1997). This could be due to intensive long-term conservation efforts on these beaches. A dramatic increase in the numbers of females nesting on Sandy Point was observed in 1997, fifteen years after intense nest protection began. These management activities were initiated with the belief that increased hatchling production would result in more females returning to nest on their natal beaches. There is genetic evidence that suggests new turtles nesting at Sandy Point in recent years are the offspring of some of the old-timers (Dutton et al., In Press). If this is the case, the trends observed are consistent with age of maturity on the order of 10-15 years, within the range proposed by Zug and Parham (1996), and we expect the population to continue increasing. This project provides a unique opportunity to study recruitment into a population that appears to be recovering from previously declining numbers.

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FOLLOWING CHINA GIRL, SATELLITE TRACKING A LEATHERBACK SEA TURTLE FROM THE ARCHIE CARR NATIONAL WILDLIFE REFUGE

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Why track leatherbacks from Florida?

The Archie Carr National Wildlife Refuge is the northern extent of regular nesting by leatherbacks in the Atlantic Ocean. This colony has exhibited an increase in leatherback nesting activity from a few nests per year (0-4) to 25 in 1999. There has also been an increase in leatherback strandings in Florida in the last 2 years comparable to large increases in strandings in N. Carolina, S. Carolina and Georgia. These strandings may be attributed to an increase in the number of leatherbacks frequenting the nearshore waters of those states. To better understand how leatherbacks are using the Atlantic coastal waters of the United States, we initiated a satellite tracking project of leatherbacks from the east coast of Florida.

Leatherback # 1: "China Girl"

In May 19, 2000 we deployed our first satellite transmitter (PTT) to a 158.5 cm CCL female nicknamed "China Girl". China Girl has been nesting every 2 years since 1994 at ACNWR and thus represented an excellent 1st candidate for this research. The PTT, manufactured by Sirtrack Ltd of New Zealand is a 1 watt output instrument capable of 50,000 transmissions.

Where did she go?

After nesting on May 19, China Girl moved 45 km offshore and 120 NE of the nesting beach, returning to nest again on May 29. Subsequently she left the area and moved directly up the coast traveling at a rate of 37.7 km per day. Once she reached an area just east of the border between N. Carolina and Virginia on the 2nd of July, she slowed to an average of 18.14 km per day and resided in nearshore waters between N. Carolina and New Jersey until the batteries expired in her transmitter on 27 November. Minimum distance traveled by China Girl was 4,063 km during the 6 months she was tracked.

What have we learned?

China girl has provided us with a unique opportunity to study the behavior of leatherbacks who remain in coastal waters. Her activities are in direct contrast to our usual expectations of the species as a pelagic wanderer. China Girl remained within 100 km of the coast at all times, and in fact spent extended periods within 2 km of shore. Such movements indicate that some leatherbacks may actually be resident in areas quite close to the coast rather than transiting through these areas during migrations to northern feeding habitats. Further research is planned in 2001 to determine if her post-nesting movements and habitat choices are typical for Florida nesting leatherbacks. We will also be characterizing foraging habitats and seasonality of the movements to improve regulatory regimes designed to reduce mortality by coastal fishing fleets.

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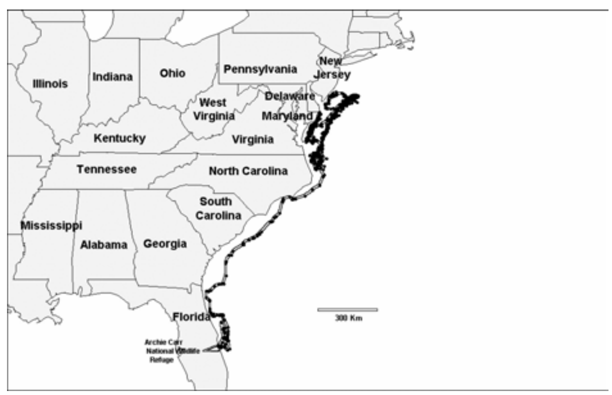

ESTIMATION OF THE AVERAGE NUMBER OF NEST FOR GREEN TURTLE, ON REKAWA BEACH IN SOUTHERN SRI LANKA. THREE YEAR STUDY FROM SEPTEMBER 1996 TO SEPTEMBER 1999

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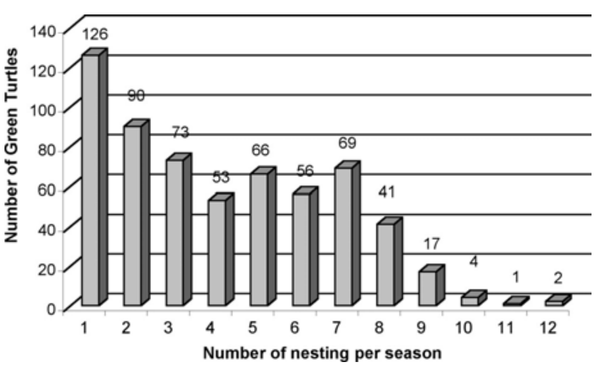
INTRODUCTION

Many marine turtle research programmes around the world involve the tagging of the nesting female turtles for obtaining information on the life history of the species (Broderick and Godley, 1999). The information could be the reproductive biology, movements (migration), stranding, and residency, re-nesting and growth rates (Balazs, 1999). The Turtle Conservation Project (TCP) is conducted an in-situ nest conservation program on Rekawa beach in southern Sri Lanka. A two-kilometer stretch of beach was patrolled for 24 hours per day and 365 days per year. Five species of the world's seven species of marine turtles come ashore to nest on this beach (Kapurusingha and Ekanayake, 2000). The species are Green turtle (*Chelonia mydas*), Olive ridley (*Lepidochelys olivacea*), Leatherback (*Dermochelys coriacea*), Hawksbill (*Eretmochelys imbricata*) and Loggerhead (*Caretta caretta*). Of this five species more than 90% was green turtle and therefore this species was selected for this study. Most of the turtle populations have individuals that display both regular and irregular re-nesting behaviour (Hughes, 1982) and Green turtles show a high degree of nest site selection. It has been observed that in Rekawa, Sri Lanka eight green turtles nested within this 2km stretch of beach was reappeared during the next nesting season, which occurred after a gap of 2.5 to 3.5 years.

METHODS

About 2050 m stretch of beach on the project site was marked by wooden posts with 50-meter intervals starting from 0 to 41. The numbering of the posts started from right side to the left side. Each post was marked with a number and the distance in meters that the post represents. While the survey was in progress, it was noticed that some turtles are laying to the right of the beach from the post 0. Therefore, another post was erected as beach post –1, thus extending the survey area by another 50 m. When a turtle comes to nest, the nesting site is marked on the data sheet indicating the location of the nest between a pair of beach posts. With the commencement of the project, turtles coming to nest at Rekawa beach are tagged. The best time I found for the tagging turtles was when they were covering their egg chamber. Therefore, most of the tagging was done during this time and the turtle was tagged on both hind flippers. For this I used the plastic tags (The Dalton Supplies Ltd, England). A number and address printed on both male and female part of the tag. About ninety five percent of the nesting green turtles and the re-nesting were recorded from September 1996 to September 1999.

Figure 1. The number of green turtles vs the number of nesting per season.



RESULTS

The total number of nests laid on the beach is 2442 and 598 green turtles were tagged during the reporting period. The lowest number of nest per season is one and, the highest number of nest per season for the green turtles is twelve (Table 1 and Figure 1). Out of 598 green turtles 21.14 % laid only one time per one nesting season and 0.34% green turtles laid twelve nest per nesting season. The mean number of nesting per season was four times.

DISCUSSION

All the species of turtles lay several clutches of eggs during a nesting season (Hirth, 1980: Miller, 1997) and the nesting behavior could be regular or irregular (Hughes, 1982). The inter nesting duration vary from nine to thirty days for the sea turtles and for green turtle it is vary ten to 14 days (Miller, 1997). However the number of clutch laying in a season vary with the species, population and different individuals. Carr (1952) cited that green turtle lay two to five times in a single nesting season. Chan (1999) recorded that one green turtle laid 12 nests per season in Redang Island, east cost peninsula in Malaysia. In the past there was lack of study in Sri Lanka about re-nesting times of turtles. In this study I observed twelve nesting for two green turtles which came to nest on Rekawa beach.

Table 1. The number of nests per green turtle for a single nesting season.

Number of nests	Number of turtles	Total nests
One time	126	126
Two time	90	180
Three time	73	219
Four time	53	212
Five time	66	330
Six time	56	336
Seven time	69	483
Eight time	41	328
nine time	17	153
Ten time	4	40
Eleven time	1	11
Twelve time	2	24
Total	**598**	**2442**

Acknowledgements:

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CAUSES OF SEA TURTLE MORTALITY IN THE PROVINCE OF BOCAS DEL TORO, PANAMA

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INTRODUCTION

On the Caribbean side of Panama many diverse habitats exist for the nesting, funding and migration of sea turtles, including pelagic and costal waters, coral reefs, seaweed beds, lagoons, areas of mangrove growth, estuaries and sand beaches.

During the past four years, the Institute for Tropical Ecology and Conservation (ITEC), concerned by the present endangered status of sea turtles and aware of the important role played by sea turtles in the history, culture, and economy of the communities near areas of turtle nesting and migration, has conducted numerous research projects, in coordination with the Instituto Nacional de Recursos Naturales Renovables (National Institute for Renewable Natural Resources or INRENARE-ANAM), in order to understand the current threats to the survival of the sea turtle populations in this region.

In the Bocas del Toro Province, various local communities depend on sea turtles of source of food, as a source of monetary income, and as a medicinal resource, thus confronting the turtles with several serious threats to their survival. The majority of sea turtle species are hunted for their meat, their eggs, and in the case of the Hawksbill turtle, their carapaces. In order to better understand the present situation of sea turtles in this region, we established the following objectives. OBJECTIVES

--Evaluate the causes of turtle egg loss due to: depredation, poaching, and natural factors

--Evaluate the causes of adult turtle mortality

METHODS

The Bocas del Toro Province is located at the western extreme of Panama, between 82°56'10" and 81°08' west longitude and 8°30' and 9°40' north latitude. The beaches studied were: Soropta and San-San beaches on Isla Bastimentos, Bluff and Courney beaches on Isla Colon, Zapatillas Cays one and two, and Chiriqui beach.

Morning censuses were conducted on nesting beaches in order to indentify;

1) Nest conditions, with respect to its location on nesting beaches, in order to identify natural threats to the nest such as flooding, erosion, and vegetation.

2) Fate of the nest, with respect to the following classifications:

a. Poached: eggs stolen by humans

b. Depredated: nest decimated by domestic or wild animal

c. In Situ: nest located where it was left by the turtle

3) Causes of nesting female mortality

RESULTS AND DISCUSSION

In the Province of Bocas del Toro, Panama, areas for nesting, feeding, and migration exist principally for four sea turtle species: Leatherback (*Dermochelys coriacea*), Hawksbill (*Eretmochelys imbricata*), Green (*Chelonia mydas*), and the Loggerhead (*Caretta caretta*). During these four years of study, we have observed that the local sea turtle populations are being affected mainly by human as well as natural factors.

Natural Factors.

The Beaches of Bluff, Larga, Zapatillas, and Changuinola experience constant changes during the sea turtle nesting season, since the high tide on these beaches can reach the zone of vegetation, thus endangering turtle nests on these beaches. During the nesting season of 1996, approximately 50% of the nests were lost due to the drastic climactic impact of El Niño. In additon, nests were observed close to the tide line, since nesting females were unable to scale the steep slopes formed during certain periods of the year on certain beaches. Also, occasional nests were found in the mouths of rivers and streams, areas highly prone to flooding. Neither situation allows for favorable conditions for the development of sea turtle eggs.

Depredation.

Various wild and domestic animals prey upon the eggs and hatchlings of sea turtles. On the beaches Larga, Bluff, and Chiriqui, the most commonly observed predators are: birds, dogs, raccoons, and crabs. Upon emerging from the nests hatchlings are attacked by these predators, thus increasing the overall mortality of the local populations of sea turtles.

Finally, the human impact has been the most difficult problem to control to date on Changuinola beach where each year, approximately 80% of turtle nest have been poached. This beach is located near the town of Changuinola, where there exists a local market for the sale and purchase of turtle eggs. Another aspect of the overall human impact on these turtles that has more important implications on the survival of these populations is the slaughter of nesting turtles, which are hacked with machetes before or after oviposition in order to obtain the eggs, while sometimes a flipper or the majority of the body is taken for consumptive purposes.

Small, flat-bottomed canoes have been consistently found near Isla Bastimentos, Zapatilla Cays, and Peninsula Valiente, which are devoted to the harpoon hunting of the Green and Hawksbill turtles for the consumption and sale of the meat and shell. In these areas, thickly-meshed nets are also found where turtles can become entangled and drown.

RECOMMENDATIONS

Several local communities do not believe that entire populations of sea turtles can be extinguished by the killing of only a few individuals, and changing such ideas in order to raise awareness in these communities is thus very challenging. The hope is that in the coming years, these communities can join forces with other concerned organizations of the Bocas del Toro Province in order to establish areas of protection, conservation, and research for the local sea turtle populations.

It is important that stronger laws are made to protect the sea turtles from the numerous human causes of mortality, due to the fact that, as we have observed each year on many occasions, existing laws have not been effectively enforced.

Environmental education programs involving children and adults in order to raise awareness concerning the sea turtles as natural resources should be continued in the communities near important nesting and migration areas. Also, alternative work opportunities should be explored that can benefit the community, in order to deter community members from continuing to exploit sea turtles as a resource, practices which not only threaten the survival of the turtle populations themselves, but also the communities that depend on them.

UNDERSTANDING BEHAVIORS OF LOCAL COMMUNITIES IN HILABAAN AND TIKLING, EASTERN SAMAR, PHILIPPINES TOWARD SEA TURTLE CONSERVATION

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Now, more than ever, sea turtles in Hilabaan and Tikling are facing a variety of anthropogenic threats. Almost every day, juvenile sea turtles are intentionally caught in the surrounding reef edge using spears and home-made blasts. Those incidentally caught in the fish traps in the shallower waters are brought to the islands as well to be slaughtered. Meat is either sold to the locals or cooked as a dish eaten with alcoholic beverages. Carapaces are collected and used as home ornaments. Eggs from the nests are also collected and eaten as a delicacy among locals. Hatchlings are caught before they can reach the sea to be domesticated and later sold. Beaches that used to be nesting grounds are now sites of human settlements or are berthing areas for the fishing vessels of the fisherfolk. Locals use the coastal areas as their dumpsite for garbage.

The local communities who once witnessed the abundance of the Hawksbill (*Eretmochelys imbricata*) and the Green sea turtles (*Chelonia mydas*) nesting in the islands up to the late 1980s have admitted to the rarity of sightings at present (pers. comm.). Although aware of the situation, locals still continue to exert pressure on the sea turtles. Conserving the sea turtles, therefore, means being able to work effectively with the people in changing their existing practices which in turn requires an understanding of the social factors that motivate them to behave in such ways.

This study was conducted under the premise that behavior towards the environment is influenced by the beliefs and feelings of the individual which are in turn related to the level of information the person possesses on the state of the environment and on the effects of human actions on it.

HOW DID WE DO IT?

The study covered the coastal villages of Hilabaan and Tikling which have a combined land area of 161.2 ha. Population size is estimated to be more than 3000 individuals based on the 1995 census. The survey was conducted among individuals from 92 different households. The respondents were categorized into young (12-18 y.o.) and adult (19 y.o. and above) groups. Due to limitations in time and the unavailability of list of residents by age group, the survey employed the non-probability sampling method (i.e., quota sampling). Each enumerator was assigned an age group to interview in a pre-defined geographical area. All interviewed within the 3-day survey were considered the respondents of the study.

The survey was aided by a 50-item questionnaire aimed to gather data on the respondents' characteristics, environmental knowledge, attitude, and behavior specifically on sea turtles and the coastal habitat conservation. Analyses of data was done using the Statistical Package for the Social Sciences (Norusis 1993) with frequency and correlation procedures.

WHAT DID WE LEARN?

Sixty-one percent of respondents are aged 19 y.o. and above while the remaining 39% are 12-18 years of age. Majority (55%) have reached the high school level, the rest are either elementary graduates or have no formal education at all. Sixty percent of those interviewed are members of households whose main source of income is fishing. Others are engaged in farming and small business.

Level of knowledge on sea turtle conservation among respondents is generally low based on overall correct response rate of 56%. Table 1 lists the knowledge items with the highest and the lowest correct response rates by age group. Both age groups have high scores on knowledge on the existence of law against sea turtle poaching but this has not stopped them from taking the sea turtles.

Attitudes toward sea turtles in general appeared to be positive for both age groups although only 56% of the responses were positive to strongly positive. Those belonging to younger age group have negative to strongly negative attitude toward the use of the marine resources particularly the sea turtles. On the other hand, the older group expressed that community members will help in conservation efforts only if they will get something in return. Most of the respondents from both age groups also believe that the sea turtles will never go extinct despite decreasing population because they nest often.

Results of the correlation analyses reveal that knowledge on sea turtle conservation is not significantly correlated with age and educational level but on gender, (i.e. males are more knowledgeable on certain issues than females). Attitude is correlated with age, educational level, gender, source of livelihood, and on some knowledge items. Specific behaviors are also correlated with age, educational level, gender, household income, place of origin, and attitude. Table 2 lists the knowledge items with highly significant ($P<0.01$) and significant ($P<0.05$) correlation with attitude items. Table 3 lists the attitude items with highly significant ($P<0.01$) and significant (P<0.05) correlation with behavior items.

Table 1. Knowledge items with the highest and the lowest correct response rates by age group.

	Youth (12-18 y.o.)	Adult (19 y.o. and above)
Highest correct response rates	1. Existence of a law prohibiting the taking and selling of sea turtles and their by-products (68%) 2. Sea turtles return to their natal beach to lay their nests (68%) 3. Effect of human settlements in the beach to sea turtle nesting (65%)	1. Existence of a law prohibiting the taking and selling of sea turtles and their by-products (89%) 2. Sea turtles only come ashore to nest (87%) 3. Effect of human settlements in the beach to sea turtle nesting (87%)
Lowest correct response rates	1. Sea turtles are facing threats of extinction (32%) 2. Diet of sea turtles (39%) 3. Nesting periodicity of sea turtles 39%)	1. Nesting periodicity of sea turtles 23%) 2. Sea turtles return to their natal beach to lay their nests (39%) 3. Sex of sea turtles that come ashore to nest (46%)

Table 2. Knowledge items with highly significant (P<0.01) and significant (P<0.05) correlation with attitude items.

(P<0.01)	*(P<0.05)*
1. Knowledge on nesting behavior of sea turtles and the attitude on the utilization of marine resources 2. Knowledge on the law prohibiting the taking and selling of sea turtles and belief on the role of sea turtles in saving those who are drowning 3. Knowledge on penalty for the violation of law on sea turtles and attitude on the use of the marine resources	1. Knowledge on nesting behavior of sea turtles and the attitude on imposition of penalties for violators and the belief that sea turtles rescue those who are drowning 2. Knowledge on diet of sea turtles and the attitude toward extinction and sea turtle conservation 3. Knowledge on nesting behavior and attitude toward using the beach areas for settlement and wise use of resources 4. Knowledge on physical factors affecting survival of hatchlings and attitude towards extinction of sea turtles 5. Knowledge on law prohibiting the collection of eggs and attitude on the stringency of penalty 6. Knowledge of law prohibiting the taking and selling of sea turtles and attitude on the use of the marine resources

WE COULDN'T HAVE DONE IT WITHOUT THEM

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Table 3. Attitude items with highly significant (P<0.01) and significant (P<0.05) correlation to behavior items.

(P<0.01)	*(P<0.05)*
1. Attitude on egg collection and action to report illegal practices to the authority 2. Attitude on allowing people to build houses in the beaches and the act of collecting of eggs for subsistence 3. Attitude on responsibility of community members and practice of talking with other community members on conservation issues 4. Attitude on participating in conservation practices in exchange for incentives and practice of protecting sea turtle eggs for incentives 5. Belief that collection of eggs has nothing to do with population decline and practice of buying sea turtle products and avoidance of beaches where sea turtles nest 6. Attitude on the wise use of resources and behavior in terms of voluntary services in support of conservation efforts	1. Attitude on the use of marine resources and practice to protect sea turtle eggs in exchange for incentives 2. Attitude on egg collection and conservation actions such as protecting nest and leaving crawl tracks undisturbed 3. Attitude on participating in conservation practices in exchange for incentives and actions on relating to conservation such as leaving crawl tracks undisturbed and talking with other community members 4. Belief that collection of eggs has nothing to do with population decline and support to conservation efforts

IMPORTANCE OF THE TRAINING OF VOLUNTEERS FOR RESEARCH AND CONSERVATION OF MARINE TURTLES IN LATIN AMERICA

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INTRODUCTION

Nowadays, when we talk about 'globalization', we forget about the migratory capacity of marine turtles that has for a long time allowed us integration and fluidity of communication between countries. The marine turtle situation is critical. An example of this is the diminishing leatherback turtle (*Dermochelys coriacea*) population in the Pacific - one of the principle causes of its decline in numbers is the pelagic fishery in Chile and Peru (Eckert & Sarti, 1997). In these countries and as well as in Argentina and Uruguay, there hardly exists any sea turtle research and conservation; although there have been a few instances where studies have been done (González et al, 1999; Fallabrino et al, 1999). On the other hand, Ecuador started taking interest in the biology and conservation of marine turtles in the 70's, banning the export of goods made of sea turtles (Frazier & Salas, 1982), but unfortunately this declined drastically in the 80's and 90's. Colombia and Venezuela have been researching sea turtles for as long as 3 decades. At the same time, countries like Costa Rica, Mexico and Brazil started researching and conserving sea turtles with regularity and on a much higher level. Therefore, an imbalance exists between the Latin American counties. To revert this situation, many students and university professionals from Argentina, Colombia, Chile, Ecuador, Peru, Mexico, Uruguay and Venezuela have been undergoing training for the last 4 years by participating in different projects, courses and workshops involving sea turtles. This training has borne fruits in the sense that these countries are now carrying out intense research that has helped us to learn more about their biology and conservation as well as initiated cooperation internationally generating dialogue between countries that are facing the same problems.

SOME EXPERIENCES OF THE VOLUNTEERS

Working in the project of the Leatherback turtle in Mexico was great

!!!. In Peru, we just find 4 species of sea turtles, the destruction of their habitats, fisheries and the pollution of the oceans are deteriorating the populations of the sea turtles that we got there. For that reason I am working in a project of environmental education to teach to the children to conserve the sea turtles in Perú.

Luciana Kingle, Perú

The knowledge that I got in the project of Cipara in Venezuela, had been rich my professional life that can be apply in my country. The field work that I made gave me an special experience that can not be learned in the University. That include sistematic collection of data, the contact with the people of the community, learned from other scientists and the solution of problems in the field.

Esteban Carabelli , Argentina

Work with marine turtles in Mexiquillo (Leatherback Project, Mexico) had been a great experience because it gave me the opportunity to know the endanger species and make me feel helpful in their conservation. It is important the training of volunteers for research and conservation of the future. We can learn the methods, how to deal with the people and learn more about the species. This train will be very helpful in particular areas where none projects had been developed and where it is urgent to protect them from the illegal trade.

Camelia Manrique, Perú

I worked in the project of the CCC in Tortuguero, Costa Rica. Between nocturne patrols and daily nests revisions, almost four months passed. In all this time I learned a lot about sea turtles biology, their problematical and their conservation. When I came back to Peru, I began to collect and read all the information as I could about this animals in my country. With two partners from the faculty, we began to write a proposal to collect data about artisanal fishery to work with the fishermen in environmental education. At the same time we decided to make some surveys about the feeding of green turtle and olive ridley with samples donated by the fishermen from the Peruvian ports. All this thanks to the volunteer system, which give the opportunity of qualify in the management of sea turtles.

Shaleyla Kelez, Perú

I participated on the X Short Course on Sea Turtles Biology and Conservation in Venezuela. Considering the quantity, quality of contents, and discourses aptitude, I think it was very good, because it counted with an equipment of professionals from different countries, who not only did dictate their themes with an excellent dedication, but at the same time enriched with their personal experiences this course, making constant reference to the local problematical. Without a doubt the concurrence of people from different countries, who participated in the course, had a great importance, because in many cases there is not this kind of events in all the countries of South America. This course has influenced in my professional and personal formation, given that the experience obtained will permit to myself develop projects on sea turtles in Argentina.

Jose Luis di Paola, Argentina

My experiences working with marine turtles in Proyecto Cipara, Venezuela has had a profound effect on me. The magic of the turtles has entered my sense of peace and love. It has me confirmed in the importance of the people that work with marine turtles, the hardships they face and the value of friendship. Seeing the fruits of their labour in beaches that were not protected even a year ago; educating people, even youngsters and children, about the importance of turtles, their eggs and their nesting beaches. Indirectly, I see the same requirements that exist in my country, Mexico. It is extremely important and urgent to focus ourselves and realise that we need to look after Mother Earth and Her resources.

These were my experiences that have motivated me to work for marine turtles that nest on Mexican beaches. The work of a volunteer, whatever it be, is extremely important - important like the same volunteer that you assign.
Sofía Gómez, Mexico

INFORMATION NETWORK

The Internet network "Ecovoluntarios" was created in 1997. The goal of this network is to offer information about all the marine turtles projects around the world that need volunteers. Throw this network was possible to connect many students that were anxious to learn how to take care of this mystical animals. The network "Tortugas Marinas Neotropicales (TMN)" or "Neotropical Marine Turtles" was also created where you can find a list of all the marine turtles investigators in Latin America. With this network it will be possible to interchange information and to
http://www.geocities.com/ecovoluntarios and
http://www.geocities.com/tmneotropicales

THE PRESENT AND FUTURE

Most Latin American projects involving sea turtles have flourished, at some time or the other, because of the participation of volunteers. This experience has given us an opening in the research and conservation of sea turtles and we hope that in this new century to continue accepting volunteers and give them importance in what they do for the project. This in turn will provide us with many benefits for the investigation of these long living animals.

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PRODUCTIVITY OF FEMALES LOGGERHEAD FROM CAPE VERDE ISLANDS

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INTRODUCTION

The nesting colony of *Caretta caretta* has been recently described for the island of Boavista (Cabo Verde, 500 km off the coast of Senegal, Western Africa, FIGURE 1). Although more data is needed, it represents one of the most important populations in the North Atlantic (Brongersma, 1982; López-Jurado & Andreu, 1998; Ross, 1995). Since 1998, a tagging and management campaign was established in Boavista to study this nesting population.

We present next data on reproductive biology of nesting females of *Caretta caretta* in Boavista during the year 2000 nesting season, in which we obtained twice as much than those tagged in 1998 and 1999 seasons; we also found some recaptures of females from preceding years, our first data on remigration interval. The data obtained were compared with those of other populations.

MATERIAL AND METHODS

During the summer of the year 2000, 17 km of beaches were surveyed daily in the southeastern part of the island. Night patrols were performed each night from 14 July to 27 October, searching for nesting turtles. When a turtle was met, and after she started to lay the eggs, it was measured (straight and curved carapace length and width), tagged with monel metal tags, and released. It was recorded the occurrence and position of a nest, the number of eggs laid, and the size of the eggs for comparisons; then the nest was marked for further research.

RESULTS

Nesting season begins in late June and ends in late October, whereas hatchlings are seen till late January. A total of 1487 emergences of females of *Caretta caretta* were recorded during the year 2000 nesting season in Boavista. From these, a total of 781 emergences belonging to new females tagged, apart of 277 emergences of females that could not be tagged. 408 recaptures of the same individuals emerged more than once in the year 2000 season were recorded. Therefore, we obtained 13 recaptures of individuals tagged in 1998, and 8 from 1999, some of them also emerging more than once in the year 2000 season.

Mean body size of females (TABLA I) was 81.1 cm of curve carapace length (SD=3.94, Range=70.0-104.0, N=940) and 75.8 cm of straight carapace length (SD=3.80, Range=60.2-96.5, N=933).

Internesting period for *Caretta caretta* in Boavista (FIGURE 2) averages 15.3 days (SD=1.76, Range=11-20, N=97, TABLE I). We excluded data on intervals more than 21 days of difference between two consecutive emergences of the same female, due to the doubt of a possible nesting event in the middle.

Mean clutch size of females is 82.7 eggs (SD=16.939, Range=24-143, N=353), and the mean diameter of egg size is 38.8 mm (SD=2.26, Range=30.8-43.1, N=79).

There exists a relationship between female body size (curve carapace length) and clutch size ($F_{1,232}=22.238$, $r^2=0.08$, $p<0.0001$), and also between female body size and egg size ($F_{1,52}=6.00$, $r^2=0.10$, $p=0.017$).

DISCUSSION

The number of nesting sea turtles on every season exhibit fluctuations, that is why it is necessary to cover several years of tagging effort to better know a population (Margaritoulis, 1982). In Boavista, the number of turtles tagged in the year 2000 compared to 1998 and 1999 is remarkably higher. In spite of that the sampling effort in this year has been most important than in preceding seasons, the number of females observed is higher than expected. It is necessary to continue research in further seasons to better know the population of *C. caretta* in Boavista. As a preliminary result, in this season we obtained first data on remigration interval.

Internesting period of *C. caretta* in Boavista averages 15.3 days, a value that results similar in other populations (Broderick & Godley, 1996), and see revision in Dodd Jr (1988), except in Turkey where the value is 23.4 days, more than any other (Geldiay et al., 1995).

In general, clutch size of loggerheads in Boavista is low, but if we compare this value with data obtained from other populations, we see that, for example, in Cyprus (Broderick & Godley, 1996) and Turkey (Erk'akan, 1993), the clutch size is lower, possibly due to the lesser mean female body size (see revision in Dodd Jr, 1988; Lutz & Musick, 1997). This agrees with our results because in Boavista female body size is positively correlated with clutch size. However, we can find different results concerning to this in other works, where there is no relationship between female body size and clutch size (see also Dodd Jr, 1988; Lutz & Musick, 1997). Likewise, egg size of loggerheads is also small compared to other populations, except Turkey (Erk'akan, 1993). As in the case before, this could be related with the female body size.

Figure 1. Map showing Cape Verde Islands, and the position of Boavista.

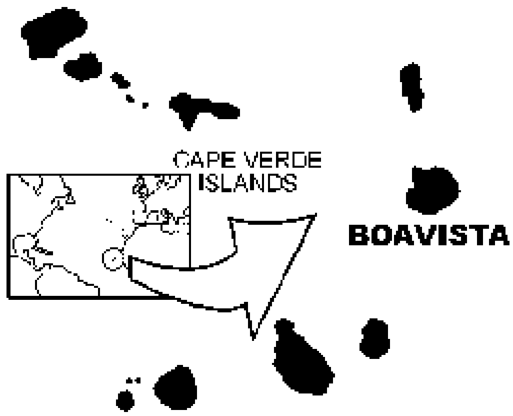

Figure 2. internesting interval of *C. caretta* in Boavista.

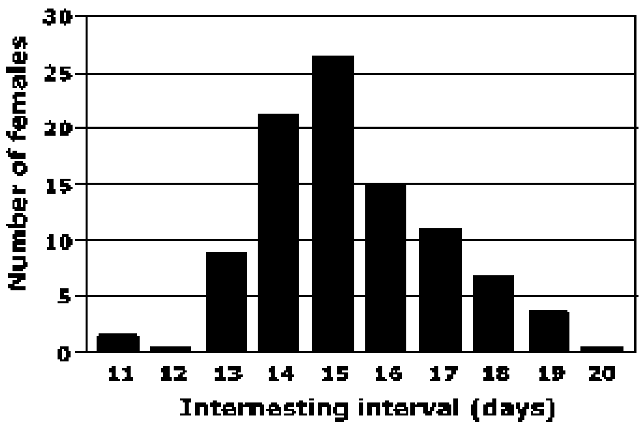

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Figure 3. Clutch size of *C. caretta* along the 2000 season.

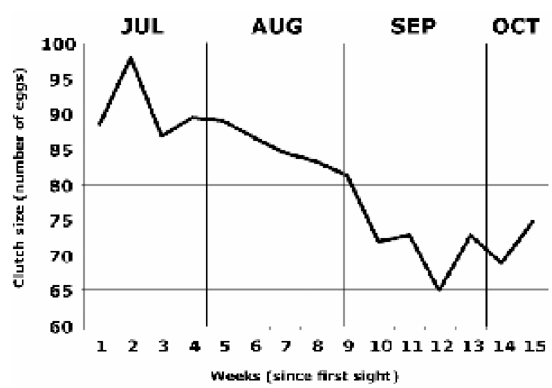

Table 1. Mean, range and sample size of CCL , SCL, clutch size, and internesting period of *C. caretta* in Boavista.

		CCL (cm)	SCL (cm)	CLUTCH SIZE	EGG SIZE*	INTERNESTING PERIOD (days)	SOURCE
	Mean	**81.1**	**75.8**	**82.7**	**38.8**	**15.3**	
Boavista	**SD**	**3.94**	**3.80**	**16.93**	**2.26**	**1.76**	
(Cabo Verde)	**Range**	**70-104**	**60.2-96.5**	**24-143**	**30.8-43.1**	**11-20**	
	N	**940**	**933**	**353**	**79/787**	**97**	
South Carolina	Mean		92.7	126	41.5	13.0	Caldwell (1959)
(USA)	Range		84.5-102.9	64-198	35-49	-	Talbert et al (1980)
	N		18	71	44/827	44	
Florida	Mean	98.9	93.9	149	42.3	14	Ehrhart & Witherington (1987)
(USA)	Range	87.9-108.9	82.5-104.4	70-165	40.2-44.8	11-17	Ehrhart (1979)
	N	119	114	26	6/702	18	Worth and Smith (1976)
Colombia	Mean		87.0	107.0	43.3	14.7	Kaufmann (1975)
	Range		70-100	58-163	39.7-47.5	13-17	
	N		78	185	3/370	7	
Tongaland	Mean	93.7	87.6	105.3	49.9	15	Hughes (1974, 1975)
(South Africa)	Range	82.0-106.5	76-98	39-154	36-44	13-17	Hughes et al. (1967)
	N	254	320	72	26/260	-	
Masirah Island	Mean		92	101	42.1	-	Ross (1979)
(Oman)	Range		79-101	72-130	38-46	14-16	Hirth (1980)
	N		-	29	29/_	-	
Queensland	Mean	95.0		127.0	40.1	13.9	Limpus (1985)
(Australia)	Range	80.0-113.5		48-190	37.6-42.3	9-23	
	N	2,207		1,056	29/290	2,959	
Zakynthos	Mean	80.4		100.2	-	14.6	Margaritoulis (1982, 1985)
(Greece)	Range	69.5-95.0		-	35-40	13-20	
	N	27		9	2-12	14	
Dalyan Beach	Mean		73.1	73.4	37	23.4	Erk'akan et al. (1993)
(Turkey)	Range		60.2-83.9	24-148	33-41	18-28	Geldiay et al. (1980)
	N		49	235	65	-	
Northern Cyprus	Mean	73.4		70.0		13.4	Broderick & Godley (1996)
	Range	65-86.5		-		11-17	
	N	78		323		67	

* N (sample size) in egg size separated by bars represents number of nests and total number of eggs

SATELLITE TRACKING OF LEATHERBACK TURTLES NESTING IN FRENCH GUIANA

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BACKGROUND

The nesting colony of leatherbacks located in French Guiana is the largest of the world (Spotila et al., 1996). Since the 1970s, research on the leatherback population in French Guiana has focused on the main nesting at beach Yalimapo. Despite severe preservation measures, the number of nests on the main Guiana nesting site has decreased from 50,000 to below 10,000 between 1992 and 2000 (Chevalier et al., 1999). Since leatherbacks entangled in fishing nets are often found near the beach, this decrease has been partly attributed to increased mortality at sea. The tag recovery data have demonstrated that these leatherbacks also range widely throughout the northern Atlantic Ocean (Pritchard, 1976; Goff et al., 1994; WWF-France, 1995; Girondot & Fretey, 1996 and personal communications.). However little is known about the routes taken by this species as it moves throughout the Atlantic. Two years ago, we initiated a study of oceanic movements of leatherbacks using satellite telemetry. This study is providing valuable information on the movements of these turtles during the nesting season and once they leave the nesting area.

METHODS

Tracking technology and attachment methods have improved since the first attempt of satellite tracking leatherbacks from French Guiana (Duron-Dufrenne, 1987) and we are now able to monitor the movements of turtles for several months. During the last two years, we have used harnesses to deploy Platform Terminal Transmitters (PTT) on 9 leatherbacks nesting at Awala-Yalimapo Beach.

RESULTS AND DISCUSSION

Tag recoveries show the remarkable capacity of leatherbacks to cover great distances. With satellite tracking the detailed movement routes are now being described. Our data suggest that post-nesting movements of leatherbacks from French Guiana can occur in any direction (e.g. towards the Eastern coast of Florida, Newfoundland, Western coast of Africa). Why the turtles choose these routes is unclear and should now be discussed with respect to marine currents, sea surface temperatures, bathymetry, open fronts and magnetic cues. Our next effort will be to identify the threats that occur along these routes and to further understand why this species makes these spectacular migrations. We will also intensify the tracking survey on the inter-nesting period to determine the critical habitats used by turtles during the nesting season.

CONCLUSIONS

In order to preserve the largest nesting colony of leatherback sea turtles it is important to have a better understanding of the critical habitats being used by the turtles and the sources of mortality encountered by this species at sea. Our research efforts are dedicated towards this goal.

Acknowledgements:

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SEA TURTLE BYCATCH FROM THE SWORDFISH FISHERY IN THE AZORES

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ABSTRACT

Bycatch from the swordfish (*Xiphias gladius*) fisheries in the Azores includes loggerhead sea turtles (*Caretta caretta*) and occasionally leatherback sea turtles (*Dermochelys coriacea*) that are either hooked or entangled in the lines. Of 203 turtles recorded by longline vessels since 1994, 198 were measured and 108 observed for hook location. Of the last, 84 were hooked in the mouth, 17 in the throat, 5 in the gut and 2 were hooked externally. Two turtles were dead by drowning. All the others were put back in the sea. Their fate is unknown. The size classes of loggerheads sea turtles being impacted (35-70cm curved carapace length) are considered very important for the survivorship of the population. In one of the boats that had an observer on board the mean capture per 1000 hooks by month (May-December) ranged between a minimum of 0.04 in May and a maximum of 0.79 in July. October and November also registered high values. Total capture of loggerhead sea turtles are estimated to be around 4200 for the entire fleet fishing in the Exclusive Economic Zone of the Azores during the swordfish season (May to December) of 1998.

INTRODUCTION

Bycatch from the swordfish (*Xiphias gladius*) floating longline fisheries in the Azores is mainly blue sharks (*Prionace glauca*), but includes loggerhead sea turtles (*Caretta caretta*) and, less frequent, leatherback sea turtles (*Dermochelys coriacea*) that are either hooked or entangled in the lines. Hooks are generally set at depths of 15 to 50m and baited with squid, mackerel, or sometimes with shark meat. Here we present a summary of publish data from Azores and some considerations for future study.

MATERIAL AND METHODS

Of 203 turtles recorded by Bolten et al. (1994), Martins et al. (in press) and Ferreira et al. (in press) that were caught by longline fishery from the Azores since 1994, 198 were measured and 108 were observed for hook location.

RESULTS AND DISCUSSION

Of the 108 turtles with known hook location, 84 were hooked in the mouth, 17 in the throat, 5 in the gut and 2 were hooked externally (Figure 1). Two turtles were dead by drowning. All the others were put back in the sea, most often with the hook still inside. Their rate of survivorship is unknown. However, when an observer was on board and whenever possible, the turtles were released free of hooks and lines.

In relation to the hook location we can see that the highest percent of the turtles were captured by the mouth. We believe that the turtles captured by the throat or gut will have less chance to survive. Aguilar in 1995 kept, in captivity, turtles caught by longline boats and found that almost 30% died, but it is our belief that this rate could be higher in the natural environment because turtles have to face predators and the need to find food.

A comparison of the sizes of the 198 turtles measured by longliners (35-70cm CCL) with the rest of the population from the Azores caught by dipnets (Bolten et al., 1993) are shown in Figure 2. As can be seen, the size class being impacted belongs to the larger size classes of loggerheads present in Azores. This impact in the larger size classes becomes an important factor, as the survival of large juveniles is critical for the sustainability of the population (Crouse et al., 1987).

In one of the boats that had an observer on board, the mean catch per 1000 hooks by month (May-December of 1998) was calculated (Ferreira et al., in press), ranging between a minimum of 0.04 in May and a maximum of 0.79 in July. October and November also registered high values and corresponds to the time when the fishing selectivity for the target species is higher (Silva and Pereira, 1998). By applying the weighted mean catch per 1000 hooks (0.27) to the entire fleet, Ferreira et al. (in press) estimated that around 4200 loggerheads were caught during the 1998 swordfish season.

Final Considerations

In the Azores some actions in order to resolve the problem of accidental captures of turtles are under way. A Workshop concerning sea turtle bycatch was held in Horta (Bolten et al., 2000) and an experiment to determine the effects of longline gear modification on sea turtles bycatch rates was planned. This experiment was conducted from July to December 2000. Another action was the creation of an observer program with the collaboration of the Archie Carr Center for Sea Turtle Research funded by the NMFS. Its aim is to quantify and describe the sea turtle bycatch, motivate fishermen for sea turtle conservation, demonstrate how to extract hooks and release turtles carefully.

To better understand the problem, some questions need to be answered. What happens to the turtle after having been captured and released? Especially to those hooked in the throat, will they die from the injury? Will they become more susceptible to predators? Will they continue to feed normally?

Acknowledgements:

We are grateful to the Captains and crew of the F/Vs Mar da Prata, Altair and Pérola do Corvo for their cooperation. This study was funded by a U.S. National Marine Fisheries Service (NMFS) (contract to ABB). Additional support was provided by the University of Azores (DOP) and the University of Florida (ACCSTR).

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Figure 1. Hook location in 108 loggerheads caught by longline boats.

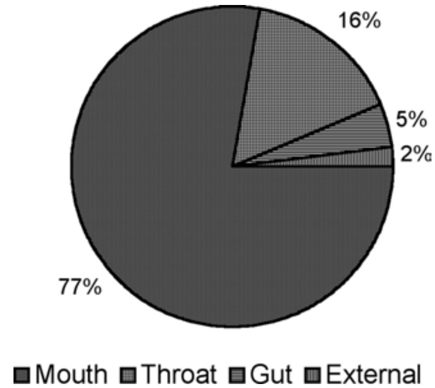
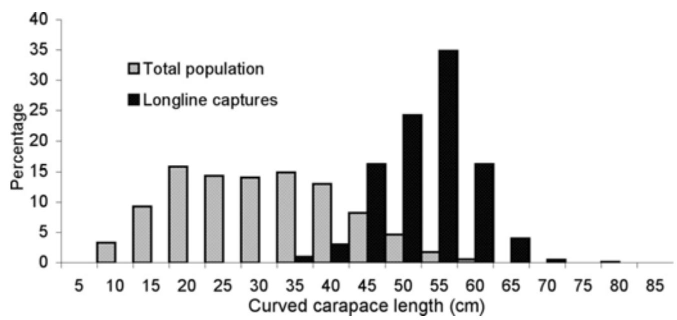


Figure 2. Size classes distribution from turtles (*C. caretta*) caught by longliners (n=198; mean, 54.6cm; range, 35-70cm; SD, 6.1) compared with the rest of the population from the Azores caught by dipnets (n=731; mean, 33.6cm; range, 10-82cm; SD, 11.3) (Bolten et al., 1993). Kolmogorov-Swirnov Test, ks=0.7966, p<0.001.



EVIDENCE OF GASTROINTESTINAL TRACT INFLAMMATION IN WILD LOGGERHEAD SEA TURTLES

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INTRODUCTION

Seven loggerhead turtles, *Caretta caretta*, that were necropsied between April and November 2000 at Mote Marine Laboratory (MML) exhibited lesions of extreme inflammation of the gastrointestinal tract. These cases represent 100% of the fresh dead loggerhead sea turtles necropsied during this time period. Six were retrieved from the central Gulf coast of Florida, (Sarasota and Manatee Counties) and one from the southwest Gulf coast (Lee County). Five of the turtles presented alive, lethargic, with slight to severe emaciation and one of these died prior to arrival at the Sea Turtle Rehabilitation Hospital. The blood work on the four that arrived alive was generally unremarkable except for a slight heterophilia, but all four died following a brief period of rehabilitation. The turtles, three males and four females, ranged in size from 68.8 cm to 97.0 cm straight carapace length with an average of 78.6 cm. Gross necropsy revealed severe thickening of the intestines, either segmentally or through the entire intestinal tract, which completely occluded the lumen of the intestine. Other internal organs appeared to be variably affected. Histopathology results indicated acute, subacute or chronic granulomatous inflammation of the entire gastrointestinal tract (stomach, small intestine, and colon) as well as in some or all of the following organs: pancreas, spleen, liver, urinary bladder and kidneys. Trematodiasis was seen in multiple organs of all seven turtles with the most common being the spleen (5 cases), intestines (5 cases), stomach (5 cases), kidney (4 cases), heart (4 cases), and lung (3 cases). No causative agent was obvious with any of the cases and the etiology of the condition is currently under investigation.

Gross findings

• Segmental thickening of intestine, most severe cases had complete closure of lumen of intestinal tract
• Liver often shrunken in size, friable, and/or mottled (5 cases)
• Hemorrhagic areas including coelomic cavity, small intestine, colon, kidney, lungs (4 cases)
• Dilated vasculature (3 cases)
• Straw colored fluid in pericardium (3 cases)
• Trematodes present in the intestinal tract

Histological findings

• Subacute to chronic, multifocal, fibrinonecrotic, ulcerative, lymphocytic, or granulomatous enteritis
• Variable involvement of kidneys, liver, spleen, pancreas and myocardium
• Trematodiasis, multifocal involving multiple organs

DISCUSSION

The etiology of the gastrointestinal lesions is unknown. Data indicate that the majority of loggerhead turtles that strand are too decomposed to provide information on the cause of death. For the six years between 1995 and 2000 MML documented 122 loggerhead turtle strandings, of which 13 of the 21 fresh dead or moderately decomposed turtles were necropsied. The year 2000 is significant in that 100% of the loggerhead turtles necropsied by MML presented evidence of fibrinonecrotic enteritis or gastrointestinal tract inflammation. Prior to this only one loggerhead turtle, necropsied during 1997, exhibited a similar condition. One possible etiology is parasites. The trematodes were not identified as to species but is of interest to note that spirorchids, commonly found in loggerhead sea turtles, can cause cachexia, anemia, enteritis and mortality (Wolke et al, 1982). However, while some of the lesions characteristic of spirorchidiasis were present in the above cases, other hallmark signs such as anemia and pale internal organs were not seen. Other potential causative agents for the gastrointestinal tract lesions may be bacterial, viral, fungal or environmental contaminants.

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MARINE TURTLE CONSERVATION IN SÃO TOME AND PRINCIPE

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In São Tome and Principe, since 1996, marine turtle conservation actions are carried out through ECOFAC (Ecosystèmes Forestiers d'Afrique Centrale) by the "Tàtô Project". This poject is a part of the PROTOMAC (PROtection des Tortues Marines en Afrique Centrale) program, working on marine turtle conservation in the Gulf of Guinea, West Africa.

Field studies are giving several interesting results, and are showing the importance of the archipelago in the Gulf of Guinea and on the West African Coast. The beaches of these small islands are nesting sites for 4 species of marine turtle (*Lepidochelys olivacea*, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*). A few *Caretta caretta* turtles were observed, but there is no proof to date that they are nesting here. It was possible to observe males, females, adults and immatures of all four nesting species (*Lepidochelys olivacea*, *Chelonia mydas*, *Dermochelys coriacea*, *Eretmochelys imbricata*), which is an exceptional circumstance. In the 3 years of tagging program, 2300 turtles were tagged and more than 150,000 hatchlings released.

The Tàtô project was designed to manage the different actions necessary for species protection, conservation and valuing (this is a bit of a strange word, actually) in the archipelago: a tagging campaign, relocation and incubation of nests in safe areas, ending the consumption of meat and eggs, attempted reconversion of shell artisans, raising awareness among local people, preparation of legislation, development of ecotourism.

A genetic study on *Chelonia mydas* was carried out by Angela Formia (Cardiff University, UK). This study shows very interesting results on the genetic diversity of the nesting and feeding populations and reinforces the importance of leading conservation activities to protect them.

At the end of 2000/2001, the Government of São Tomé e Principe has not yet approved the marine turtle conservation law. This will make fund raising for the next nesting season more difficult, and will signify the end of Project Tato activities and a great amount of lost data.

We thank the David and Lucile Packard Foundation and the Sea Turtle Symposium for travel support.

PRESENCE, NESTING AND CONSERVATION OF *LEPIDOCHELYS OLIVACEA* IN THE GULF OF GUINEA

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The establishment of field projects on sea turtles in the countries of the Gulf of Guinea within a vast programme of regional coordination established by the CMS and the IUCN-France allows us to describe the status of *Lepidochelys olivacea* in this area.

Significant nesting activity has been recorded on several beaches along the coast between Liberia and Nigeria. The slaughter of nesting females for meat and poaching of eggs is widespread in this region. In Cameroon, olive ridley nesting is low but regular on the beaches of the Campo Ma'an nature reserve, and certainly higher northward to Etisah. The exploitation of meat and eggs is frequent, as well as the sale of shells sometimes used to make masks. Nesting has also been recorded throughout Equatorial Guinea, Gabon, Congo, Cabinda and even near Lobito, Angola. There are interesting zones with clusters of nests. Contrary to what has been stated, the olive ridley does not nest in Namibia, where it is very rare, perhaps at the southern limit of its distribution.

Some interesting nesting sites have been discovered on islands , which is unusual for the *L. olivacea* :Bioko, São Tomé, Corisco, Mbanye, Hoco. No data is available for Annobón. Surprisingly, the species is unknown on the beaches of Principe Island. Adult males have often been spotted around the island of São Tomé, and matings have been observed.

We recommend the creation of a task force on the olive ridley in this African region, allowing the definition of a global conservation strategy.

NESTING HABITAT CHARACTERIZATION, COMPOSITION AND UTILIZATION BY LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) ON WASSAW ISLAND, GEORGIA

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HABITAT COMPOSITION

The sand from Georgia's beaches and dunes are of finer median grain size than those farther north and south. The sand on Wassaw Island is comprised mainly of quartz and an uneven mixture off the following minerals: epidote, garnet, hornblende, illmenite, kyanite, leucoxene, monazite, rutile, sillimanite, staurolite, tourmaline and zircon. The principle sources of the aforementioned sand (minerals) on Wassaw Island are the Savannah River watersheds that originate in the Piedmont and mountain areas of the state and the suspended material from the continental shelf adjacent to the island. Although molluscan gravel and calcium carbonate are present, in relatively minute quantities, they are not important contributors to Wassaw's beach sediments

Several types of vegetation can be encountered throughout the loggerhead's nesting habitat on Wassaw Island. This habitat includes areas located in front of the foredune area, the lee slope of the foredune, and herbaceous flats located between the foredune and the maritime forest. The following dune vegetation occurs, in varying frequencies, in these areas: sea oats (*Uniola paniculata*), sea rocket (*Cakile endentula*), beach croton (*Croton punctatus*), beach sand spur (*Cenchrus tribuloides*), salt meadow cord-grass (*Spartina patens*), Russian thistle (*Salsola kali*), sea purslane (*Sesuvium portulacastrum*), beach spurge (*Euphorbia polygonifolia*), seashore elder (*Iva imbricata*), railroad vine (*Ipomoea stolonifera*), beach pennywort (*Hydrocotyle bonariensis*), Spanish bayonet (*Yucca aloifolia*), camphor weed (*Heterotheca subaxillaris*), little blue-stem (*Andropogon scoparius*), prickly pear (*Opuntia humifusa*), hitch-hiker cactus (*Opuntia pusilla*), seaside goldenrod (*Solidago sempervirens*), evening primrose (*Oenothera humifusa*), juniper (*Juniperus virginiana*), yaupon holly (*Ilex vomitoria*), wax myrtle (*Myrica cerifera*), live oak (*Quercus virginiana*), red bay (*Persea borbonia*), cabbage palm (*Sabal palmetto*), saw palmetto (*Serenoa repens*), groundsel bush (*Baccharis halimifolia*) and slash pine (*Pinus elliottii*).

HABITAT CHARACTERIZATION AND UTILIZATION

The average number of loggerhead crawls observed on Wassaw Island per year from 1973-2000 is 147 (range = 54 – 287, n=4103 crawls). There is an average of 81 false crawls per year (range = 29-170, n=2256 false crawls) and an average of 66 nests per year (range = 23-135, n=1848 nests). Crawl frequencies in respect to the associated habitat type (as defined by Caldwell, 1959) were determined for all turtle crawls observed during the 1980-1990 nesting seasons.

Nesting emergences occur throughout all six beach types on Wassaw Island, as defined by Caldwell (1959). Most emergences occur in beach types with the greatest visual slopes. Relatively flat beach types receive the fewest nesting emergences. Conversely, flatter beaches received a higher frequency of false crawling events, whereas, sloping beaches received substantially fewer false crawling events. Thus, loggerheads are more likely to nest when they emerge into sloping habitat types than if they emerge into flatter habitat types.

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ECOLOGICAL, BEHAVIORAL AND PHYSICAL CHARACTERISTICS OF EPIBIOTIC CRABS (*MENIPPE MERCENARIA* AND *PORCELLANA SAYANA*) ASSOCIATED WITH NESTING SEA TURTLES (*CARETTA CARETTA*) IN GEORGIA, USA

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Caine (1986), Dodd (1988), Frick et al. (1998), and Frick et al. (2000) report seven species of epibiotic crabs associated with nesting loggerhead turtles, *Caretta caretta* (L.): *Neopanope sayi* (Smith), *Neopanope texana* (Stimpson), *Pachygrapsus* sp., *Panopeus herbstii* (Milne-Edwards), *Planes cyaneus* (Dana) and *Planes minutus* (L.). To our knowledge the spotted porcelain crab, *Porcellana sayana* (Leach), and the stone crab, *Menippe mercenaria* (Say), have not been reported as epibionts of loggerhead turtles. The present investigation reports the occurrence of *P. sayana* and *M. mercenaria* as an epibionts of nesting loggerhead turtles in Georgia, USA. Additionally, we present data on the ecological, behavioral and physical characteristics of epizoic *P. sayana* and *M. mercenaria*.

Epibionts were collected from 99 *C. caretta* nesting on Wassaw Island (31o53'N, 80o50'W) and Jekyll Island (31o4'N, 81o25'W), Georgia. Samples were collected during the 1998 and 2000 nesting seasons from May to August using a pair of stainless steel forceps. Specimens were preserved in 70% isopropyl alcohol, sorted and identified. Fecal strings and stomach contents were collected from *M. mercenaria* specimens and were examined under light microscopy (10-100x).

Ten *P. sayana* were collected from 10 individual loggerhead turtles. No turtles were found to host more than one *P. sayana* at a time. However, Telford and Daxboeck (1978) found *P. sayana* to commonly occur in groups of up to 11 individuals when symbiotic with queen conchs, *Strombus gigas* (L.), and hermit crabs, *Petrochirus diogenes* (L.), *Dardanus venosus* (Milne-Edwards) and *Paguristes grayi* (Benedict).

Both male and female porcelain crabs were collected. Carapace morphometrics of male *P. sayana* (length: 4.0-9.0 mm; width: 3.0-8.7 mm; n=2) were smaller than those of females (length: 10.5-12.6 mm; width: 9.0-10.4mm; n=8). Three females were ovigerous. Ovigerous females were the largest specimens (length: 10.9-12.6 mm; width: 10.1-10.4 mm).

All *P. sayana* were found from the postero-dorsal region of the turtle carapace, clinging with their walking legs. The first three pairs of walking legs possess strongly hooked dactyls, allowing porcelain crabs to cling tightly to the irregular surface of the loggerhead carapace. Larger *P. sayana* (> 8.0 mm) proved to be very difficult to remove and frequently shed their walking legs instead of releasing their grip from the turtle. The postero-dorsal region is frequently the first area of the turtle carapace to experience epibiont colonization (Caine, 1986). It is believed that the hydrodynamic nature of the turtle carapace makes postero-dorsal attachment especially attractive to sessile epibionts like *Chelonibia testudinaria* (L.), a commensal barnacle (Caine, 1986). Barnacles in this region are often the largest specimens on the turtle carapace, indicating that the rear of the turtle carapace may be the most productive attachment site for filter feeders (Matsuura and Nakamura, 1993). As all porcellanid crabs from Georgia are filter feeders (Ruppert and Fox, 1988), such observations might explain *P. sayana*'s affinity for the postero-dorsal region of the loggerhead turtle carapace.

Only loggerheads with little or no epibiota hosted *P. sayana*. This is similar to Telford and Daxboeck's (1978) finding that *P. sayana* were only symbiotic with *S. gigas* or hermit crabs utilizing *S. gigas* shells when there was little or no epibiota present. Several points might explain *P. sayana*'s affinity for relatively bare attachment sites upon their respective hosts. It is possible that *P. sayana* prefers active hosts to cling to in an attempt to aid in the crab's filter feeding ability. Substrates heavily encrusted by epibiota may reflect the host's rather sedentary behavior and may not provide a suitable feeding platform for *P. sayana*. It is also possible that epibiotic communities may deter *P. sayana* emigration onto the host because of competition for space and/or resources. Additionally, epibiotic mud crabs (*N. sayi* and *P. herbstii*) and Columbus crabs (*P. minutus*) abound on nesting *C. caretta* that host large and well-developed epibiont communities (MGF personal observation). Davenport (1994) and Frick et al. (2000) report that the aforementioned crab species routinely feed upon the loggerhead's epibiotic community, including other epibiotic crabs. Porcelain crabs might be lowering their chances of predation by only emigrating onto relatively 'clean' hosts.

The coloration and pattern of each *P. sayana* were slightly variable. Most specimens were generally dark red and were covered with an irregular pattern of pink or white spots and stripes. All specimens had a strong, white mid-dorsal stripe that became its widest between the eyes. Smaller specimens, with a carapace length < 5 mm, lacked irregular spotting of the carapace but did have a white mid-dorsal stripe. The walking legs of all specimens were either spotted or banded with white. Hildebrand (1954) and Telford and Daxboeck (1978) remarked on *P. sayana*'s ability to achieve coloration very similar to that of their hermit crab host. However, *P. sayana* were very obvious against the dull brownish-green coloration of the loggerhead turtle carapace. It is possible that *P. sayana* were colored to match a former host hermit crab before attaching to *C. caretta*. If *P. sayana* are long-term symbionts of *C. caretta* than one would expect specimens to achieve either a less conspicuous ground color or a similar coloration to that of the turtle carapace.

Very little is known concerning the natural history of *P. sayana* in Georgia. Future investigations may help to clarify the information presented herein. At this time, our observations suggest that *P. sayana* is a short-term commensal of *C. caretta* that utilizes the host turtle as a filter feeding platform.

All *M. mercenaria* collected from *C. caretta* (n=12) were juveniles (< 30 mm carapace width). Juvenile stone crabs commonly occur in deep riverine channels, on grass beds, under molluscan gravel, in crevices created by oysters and other fouling organisms, and even clinging to buoys (Hay and Shore, 1918; Lunz, 1937; Wass, 1955; Manning, 1961; Williams, 1984). In one instance, Clark (1965) found a juvenile *M. mercenaria* residing on the carapace of a hawksbill turtle, *Eretmochelys imbricata* (L.). The crab was located on the postero-dorsal region of the carapace and was situated inside a crevice that was apparently created by a shell injury or deformation. Clark (1965) suggested that the juvenile stone crab might have been parasitic on the hawksbill turtle, although no supporting data were provided to support such a relationship.

The number of *M. mercenaria* we collected from a single loggerhead turtle ranged from 1-4 individuals. Stone crabs that had the smallest carapace widths (5.0-9.9 mm, n=8) were collected from turtles that hosted more than one *M. mercenaria* (n=4). The largest crabs (14.7-29.8 mm, n=4) were sampled from turtles that hosted only one *M. mercenaria*. Sex was determinable for stone crabs > 14.7 mm long (n=4). Carapace widths of males (18.8-29.8 mm; n=3) were greater than that of a single female (14.7 mm; n=1).

Specimen ground color ranged from light tan (for the smallest individuals < 9.9 mm) to dark purple (for the largest > 14.7mm). Tan individuals had a white spot on carpus, similar to individuals of the same size class reported by Manning (1961). Chelipeds were the same ground color as the carapace, only lighter. Fingers were black and occasionally tipped with bright white on purple individuals.

Stone crabs were collected from any area of the posterior turtle carapace that hosted dense aggregations of sessile epibiota. It is possible that *M. mercenaria* may also be found on the ventral surfaces of nesting loggerheads. However, our methodology did not allow for such an investigation. The smallest stone crabs collected (< 9.9 mm), occurred within mats of the green algae *Chaetomorpha* sp., a hydrozoan *Bougainvillia rugosa* (Clarke), and an eroded sponge *Haliclona loosanoffi* (Hartman). The juvenile stone crabs (n=4) that were collected from *H. loosanoffi* were observed moving in and out of the sponge's exhalation apertures and external crevices and folds. It is possible that the sponge housed more *M. mercenaria* than the 4 previously mentioned individuals since *H. loosanoffi* covered more than 75 % of the turtle carapace and the entire sponge mass was not scraped from the host turtle. Additional inhabitants of *H. loosanoffi* were amphipods *Colomastix halichondriae* (Bousfield) and *Podocerus chelonophilus* (Chevereux and DeGuerne). Fecal strings from crabs collected from *H. loosanoffi* contained diatoms, algal matter, amphipod C. *halichondriae* gnathopods, and *H. loosanoffi* spicules.

Stone crabs (n=2) that were collected from *Chaetomorpha* sp. had fecal strings containing algal matter, presumably digested *Chaetomorpha*. Juvenile *M. mercenaria* that were collected from B. *rugosa* (n=2) deposited fecal strings containing tentacles from hydroid polyps. Sea spiders, *Callipallene brevirostris* (Johnston), were also found clinging to the B. *rugosa* that contained stone crabs. Larger stone crabs (>14.7 mm; n=3) were collected amongst aggregations of barnacles *C. testudinaria* and within propeller scars. Amongst *C. testudinaria*, stone crabs inhabited the shells of dead barnacles and also the crevices between two or more overlapping barnacles. The stomach contents of these individuals contained *C. testudinaria* cirri and eggs.

One *M. mercenaria* was found in a deep propeller scar (~ 2 cm deep) also containing amphipods *P. chelonophilus*, anemones *Diadumene leucolena* (Verrill), and mussels *Brachidontes exustus* (L.). In addition to the stone crab, six mussels were also collected from the propeller scar. Three mussels housed oyster pea crabs *Pinnotheres ostreum* (Say). Four *P. ostreum* were collected (1 male and 3 females). Pea crab chelipeds and legs (male and female) were found in the stomach contents of the aforementioned *M. mercenaria*. It is possible that the stone crab was retrieving *P. ostreum* from the neighboring mussels. Additional stomach contents of the stone crab included *P. chelonophilus* antennae and gnathopods, and unidentified animal matter.

Our observations suggest that juvenile *M. mercenaria* occasionally utilize the loggerhead sea turtle as a feeding platform by consuming carapace epibionts. It is possible that stone crabs, as well as other species of epibiotic crabs, may ultimately influence the overall health of their host turtle by ridding the turtle of potentially debilitating epibionts or by maintaining the hydrodynamic nature of the turtle's carapace (see Frick et al., 2000). However, the extent to which this relationship benefits the host or the commensal needs further elucidation.

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EFECTO DIRECTO DE MOSCAS SOBRE LA SOBREVIVENCIA DE TORTUGUILLOS DE *DERMOCHELYS CORIACEA* EN PLAYA CIPARA. EDO. SUCRE. VENEZUELA

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In Venezuela there are no studies that indicate that absence of diptera in nests of Dermochelys coriacea. Very little is know about their effects on hatchlings and on hatching success. The principal objective of this study was to identify the type of diptera involved in the infection of eggs and the death of hatchling leatherbacks. The work was carried out in agust of 2000 on Cipara beach, in Sucre state, eastern Venezuela. The flys were collected by hand, preserved in 10% formalin, and taken to the laboratory. Apparently, a parasitic species that infects cattle is involved. If this is the case, then how is it possible that some hatchlings die from infections from these flys? How do these diptera dig to the depth of the nest to infect the eggs? And, if they do not do this, how do the occur in the nests and at what level do the invect? Posible responses to these questions could be found in management for nests at the time when hatching occcurs, as well as the direct correlation with the reproductive biology of these insects.

PREDICTED SEX RATIOS OF HATCHLING KEMP'S RIDLEYS PRODUCED IN EGG CORRALS DURING THE 1998, 1999, AND 2000 NESTING SEASONS

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Incubation temperatures were recorded in Kemp's ridley sea turtle, *Lepidochelys* kempi, nests during the 1998, 1999, and 2000 nesting seasons. Temperatures were monitored in approximately 90 nests per nesting season in three egg corrals located on the coast of Tamaulipas, Mexico (i.e. Rancho Nuevo, Tepehuajes, and Playa Dos). These nests spanned each nesting season and included major arribadas. Sex ratios were predicted for the nests based on incubation temperature during the middle third of incubation. During all three nesting seasons, the incubation temperatures in the majority of the nests were relatively warm, suggesting that significant female biases were produced.

INTRODUCTION

The Kemp's ridley sea turtle, *Lepidochelys* kempii, is the most endangered sea turtle in the world. Their range is primarily restricted to the Gulf of Mexico, where they are commonly found in the bays and near shore waters. Like all species of sea turtles, the Kemp's ridley possesses temperature dependent sex determination (TSD), in which egg incubation temperature during the middle third of incubation, determines the sex of the hatchling (reviewed by Mrosrovsky, 1994; Wibbels et al., 1994). In contrast to other sea turtle species, the Kemp's ridley nests during the day in large groups called "arribadas". The primary nesting beach is located on the coast of Tamaulipas, Mexico. Nesting season usually begins in April and extends through July (Marquez-M, 1994; Ernst et al., 1994). The majority of nesting occurs over a wide stretch of beach extending approximately 20 km north and south of Rancho Nuevo, Mexico, and has been divided into three main camps (Rancho Nuevo, Tepehuajes, and Playa Dos). The Instituto Nacional de la Pesca coordinates a joint conservation program between Mexico and the United States at Rancho Nuevo that monitors all nesting and relocates all nests to protected areas called egg corrals.

TSD has the potential of producing a wide variety of sex ratios, which could alter the effectiveness of sea turtle conservation programs. Therefore, it is important to monitor hatchling sex ratios. However, there are logistical difficulties involved in studying hatchling sex ratios, the foremost being the inability to sex hatchlings based on external morphology. Historically, hatchlings have been sexed through gonadal histology, which requires the sacrifice of the hatchling (Yntema and Mrosovsky, 1980). Alternative methods have since been examined, and nest incubation temperature has been used effectively to predict sex ratios of hatchlings in a variety of previous studies (Mrosovsky et al. 1984; Mrosovsky and Provancha 1989; 1992; Mrosovsky et al. 1992; Marcovaldi et al. 1997; Hanson et al., 1997). However, before a sex ratio can be accurately estimated, the transitional range of temperatures, where the sex ratio shifts from 100% male to 100% female and the pivotal temperature, the temperature at which a 1:1 sex ratio is produced, must be known (Mrosrovsky and Pieau, 1991). These parameters have been estimated for this species (Aguilar, 1987, and Shaver et al., 1988) therefore, nest incubation temperature during the middle third of incubation can be utilized to predict hatchling sex ratios.

In the current study, nest incubation temperatures were monitored in relatively large numbers of Kemp's ridley nests throughout the 1998, 1999, and 2000 nesting seasons. The temperature data was then used to predict hatchling sex ratios. Such information is a prerequisite to evaluating and potentially enhancing the management strategy for this endangered species.

METHODS AND MATERIALS

Nest temperatures were monitored with Hobo temperature data loggers and Optic Stowaway data loggers (Onset Computer Corp., Poccasett, MA). These are relatively small, battery-powered units that consist of a microprocessor, data storage unit, and sensor mounted on a circuit board, which can be used to electronically collect and store temperatures. They contain a thermistor probe, which at temperatures common to those in sea turtle nests, have a precision of approximately 0.3 °C. They are programmed to record temperature at regular time intervals by temporarily connecting them to a personal computer loaded with the appropriate software (BoxCar Pro 3.51). After they have acquired the temperature data, the units are reconnected to a personal computer to download data. The data loggers were calibrated in custom incubators, which maintain a constant internal temperature of $\pm$ 0.2 °C.

Data loggers were used to monitor nest temperatures in egg corrals located at Rancho Nuevo, Tepehuajes, and Playa Dos. Data loggers were placed directly into the approximate center of the egg clutches to monitor temperatures within individual nests in all three egg corrals throughout the nesting season. Approximately 80 to 100 nests were monitored each nesting season, including approximately 3 to 5 nests per arribada. During the 1998 and 1999 nesting seasons, temperature variation within nests was also investigated by placing data loggers at the top, middle, and bottom of the egg mass in several nests. Additionally, a fourth data logger was buried adjacent to each of these nests at mid-nest depth, in order to compare sand temperature to nest temperature.

Previous studies of the Kemp's ridley suggest that temperatures above 31.0 °C produce 100% females, while temperatures below approximately 28.0 °C produce 100% males, and the pivotal temperature is approximately 30.2 °C (Aguilar, 1987; Shaver et al., 1988). Incubation temperatures between the pivotal and the all-female and all-male ranges are predicted to produce female biased and male biased sex ratios, respectively. For all nests which contained data loggers, average temperature, maximum temperature, and minimum temperature during the middle third of incubation was calculated. The average temperature during the middle third of incubation was then used as a predictor of the clutch's overall sex ratio. Thus, nests were assigned all-male, male biased, female biased, or all-female sex ratios based on the above temperature parameters.

RESULTS AND DISCUSSION

The nest incubation temperature data indicate that the translocation of nests to protected egg corrals has resulted in the production of female biased sex ratios over the 1998, 1999, and 2000 nesting seasons. In general, nest incubation temperatures and the duration of incubation of nests in all three egg corrals were similar between nesting seasons. Average temperature during the middle third of incubation ranged from 28 to 34 °C during each of the three nesting seasons. Incubation temperatures tended to increase throughout each nesting season (reaching temperatures above 31 °C by May, during the start of heavy nesting), with the lowest temperatures occurring at the start of the nesting season (near 28 °C in early April). Nests laid during early April included nests predicted to produce male biased sex ratios, while nests laid from mid-April through the end of July were predicted to produce only female biased and all-female nests. Of the 269 nests examined, approximately 70% produced 100% females, while the remainder produced a mixture of males and females. A majority of the nest incubation temperatures were well over the minimum temperature that produces 100% females, thus enhancing the accuracy of the sex ratio predictions. The overall average temperature during the middle third of incubation for all 269 nests was 31.9 °C.

Temperature variation was monitored within 9 individual nests throughout the 1998 and 1999 nesting seasons. During the first two thirds of the total incubation period, the temperatures within the nest varied by a maximum of approximately 1.0 °C. During the last third of incubation, the temperature in the middle of the egg mass of some nests was higher than regions at the top or bottom of the egg mass, presumably due to metabolic heat. Sand temperatures at mid-nest depth adjacent to the nest were typically within 1.0 °C or less of the temperatures within the nest.

A major aspect of the conservation effort at Rancho Nuevo, Mexico is the translocation of nests to egg corrals, which has the potential of biasing hatchling sex ratios. The results of this study suggest a significantly biased female sex ratio during the 1998, 1999, and 2000 nesting seasons. The Kemp's ridley has been making a steady recovery over the past 15 years. It is plausible that this recovery may have been enhanced by the production of a female biased hatchling sex ratio in the egg corral at Rancho Nuevo, Mexico. Thus, the female bias of the hatching sex ratio may be advantageous to this highly endangered sea turtle species.

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A TURTLE GAME

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Games are a useful component of environmental education because they provide an informal context for discussion and sharing of ideas, and a memorable learning experience. The board game shown on the poster has been designed to explain threats to marine turtles at each stage of their lifecycle, and to start people thinking about responses to these threats on an emotional and practical level. It was developed with support from Wildlife Watch UK and piloted at a Wildlife Watch meeting for children interested in wildlife conservation. Versions for schools and community groups in Madagascar are being developed through translation and pictorial representation of the instruction cards. Local turtle specialists and educators have been consulted about the specific threats and conservation actions to include on the instruction cards.

We thank the David and Lucile Packard Foundation and the Sea Turtle Symposium for travel support.

THE UPS AND DOWNS OF DIVING; HOW DIVE ANGLE CHANGES DURING ASCENT AND DESCENT.

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The depth and swim speed of a green turtle (*Chelonia mydas*) were measured during the internesting period in Cyprus. For dives to the seabed (U-dives) we used these data to determine angles of descent and ascent. Typically the turtle initially descended at a steep angle (around 60º) but as the dive continued this angle lessened until the turtle approached the seabed at a typical angle of about 15º. This systematic change in descent angle is consistent with the prediction that the energetic implications of dive angle are most important at the start of the dive when the turtle is fighting to overcome its positive buoyancy. On leaving the seabed, the turtle often seemed to rise passively and then approached the surface at a shallow angle (around 30º).

TWO ALTERNATIVE APPROACHES TO MEASURING CARAPACE LENGTH IN LEATHERBACK SEA TURTLES

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PROBLEM 1:

Straight Carapace Length (SCL) is not so easy to measure in leatherback turtles.

Background: SCL must be measured by some kind of rigid device, such as calipers. Devices large enough to measure leatherbacks are usually awkward and difficult to carry in the field, especially at remote sites, and can be difficult for one person to use.

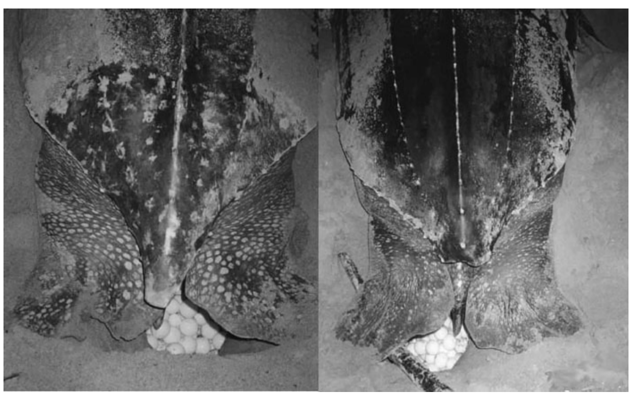
Solution: We have designed a simple device in the form of a compass can be used to measure SCL. It is more easily transported on the beach, and measurements are taken simply by one person.

Comments: Calibration is important, and should be regularly checked (as with all measurement equipment)>

PROBLEM 2:

Leatherback carapaces are sometimes damaged at the anterior end, making carapace measurements at the midline impossible.

Background: Leatherbacks lack the thick plated carapace like sea turtles; they are more easily injured. On nesting beaches, it is common to see female leatherbacks with damage to their posterior end, especially at the peduncle. If the peduncle is missing, then traditional measurement of CCL and SCL cannot be done (Figure 1).

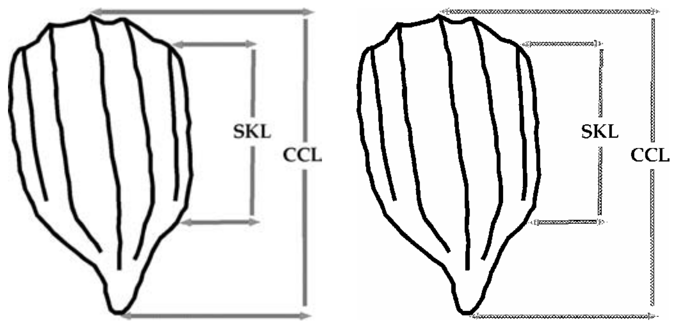


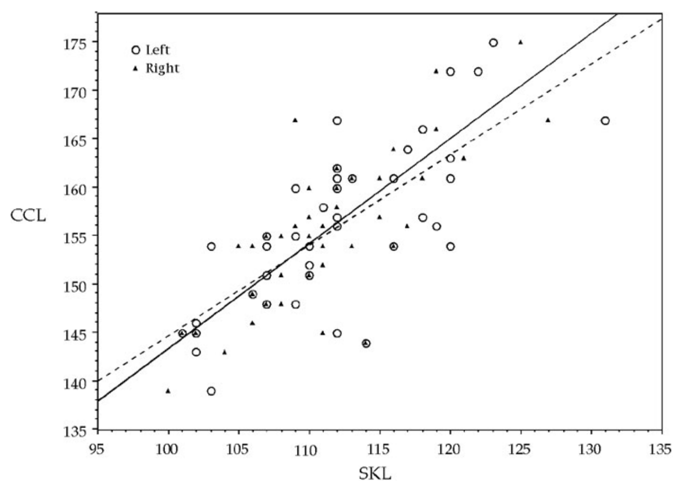
Solution: We measured both center curved carapace length and side curved carapace length (from the second side parallel keel) (Figure 2). We found that the curved length of one of the side keels, parallel to midline, is a good index of CCL, based on data from 42 females in the Reserve Naturelle de l'Amana, French Guiana (Figure 3). For females with damage, CCL can be calculated from the value of the curved side keel length (SKL).

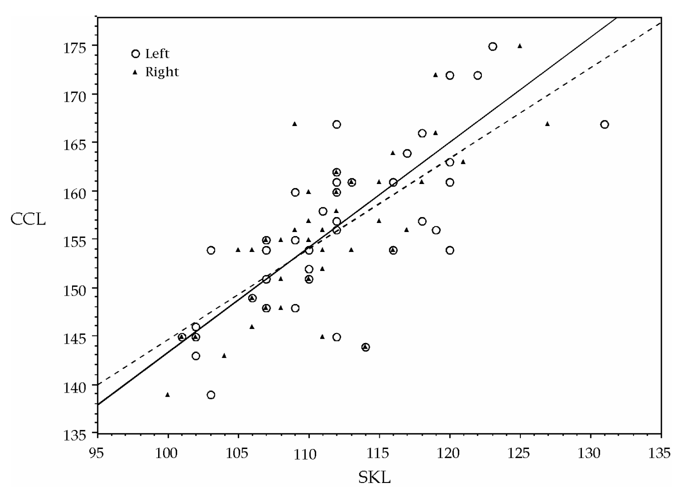
Comments: The relationship between SKL and CCL has been studied in French Guiana only. We recommend that prior to use of this method in other nesting populations, researchers investigate this relationship in their target population.

Acknowledgements:

Thanks to Xavier Desbois, F. Johan Chevalier, and Freddy Sehoe for help and support. Funding for sea turtle conservation and management in French Guiana is provided by DIREN-Guyane, and SIVU-Amana is responsible for sea turtle conservation in the Réserve Naturelle de l'Amana. Funding for MHG came from the Natural Sciences and Engineering Research Council of Canada. The David and Lucile Packard Foundation and the Sea Turtle Symposium graciously provided for travel support.







SEASONAL SAND TEMPERATURE PROFILES OF 3 MAJOR LEATHERBACK NESTING BEACHES IN THE GUYUANA PLATEAU

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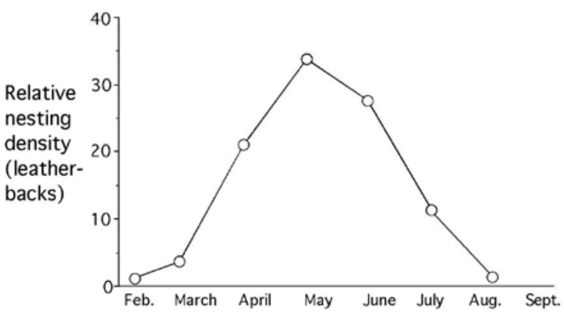
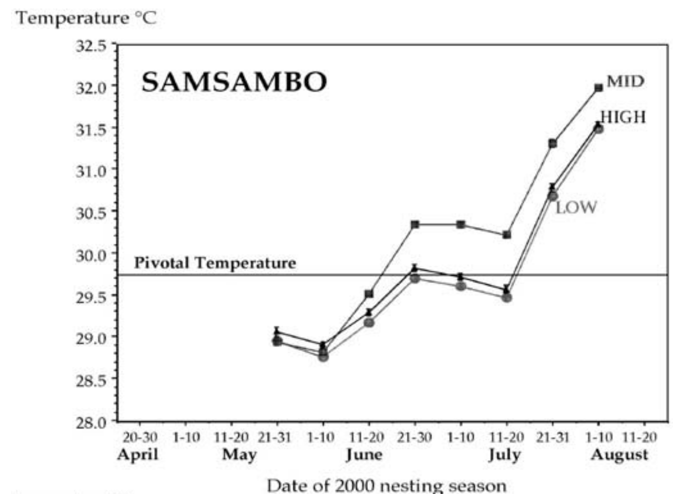
INTRODUCTION

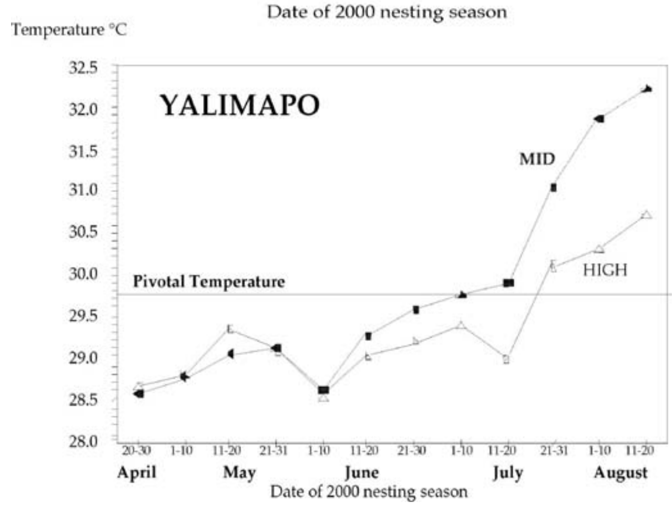
The nesting beaches found in the Plateau Guyane extend from eastern Venezuela to NE Brazil, with the highest density of clutches laid on beaches occurring in eastern Suriname and western French Guiana. Nesting occurs year round, with a well-defined peak between the months of April and July (Figure 1). In 2000, we attempted to monitor sand temperatures at three major nesting beaches for Leatherback sea turtles: Samsambo in Suriname, Awala-Yalimapo and Montjoly (in French Guiana). The objective was to study the interbeach variance of the thermal environment of leatherback nests.



METHODS AND MATERIALS

Calibrated temperature dataloggers were deployed at 60cm depth at transects (HIGH, MID, AND LOW perpendicular to the sea) on the different beaches at the beginning of the season and recovered at the end of the nesting season (Figure 2). Data were collected each hour for the entire period. Data were grouped by 10 day time-bins, and the average temperature was calculated. Comparisons among sites was based on Analysis of Variance, followed by individual t-tests.





RESULTS AND DISCUSSION

We were unable to retrieve the dataloggers from Montjoly, so no data were analysed from the eastern end of French Guiana. Sand temperatures fluctuated during the season, with a gradual increase towards the end of the season (Figure 3). Sand temperatures from both beaches followed the same pattern, although from June through July, the sites in Samsambo were significantly warmer than the corresponding sites in Yalimapo. The MID sites of the transects were significantly warmer than the other site(s) (no data from the LOW site were collected in Yalimapo, due to threat of erosion). Most nests are laid in areas corresponding to the MID site. The pivotal temperature for leatherbacks in the Guianas is 29.75 °C, with 100% females being produced above 30.0 °C and 100% males being produced below 29.0 °C (Rimblot-Baly et al. 1987). As the thermosensitive period for the determination of sex occurs in the middle third of development (Desevages et al. 1993), probably all nests laid after the first weeks of May in the MID zone in Samsambo produced females; for Yalimapo, all nests laid in the MID zone in early June and after produced all females. Prior to these dates for the specific beachs, males were more likely to be produced. Overall, more females appear to be produced in Samsambo than Yalimapo, although it is not clear if this is typical. We aim to answer this question by continuing these comparative studies in future nesting seasons, and we hope to include more beaches in the studies.

Acknowledgements:

Thane Wibbels provided technical advice and equipment; F. Johan Chevalier had many good ideas and comments, and Ouissem Drif helped with the final shape of the poster. Funding for sea turtle conservation in French Guiana comes from DIREN-Guyane, and is administered by SIVU-Amana in western French Guiana. STINASU provides logistic support and WWF provides financial support for sea turtle research in eastern Suriname. NSERC (Canada) provided funding for MHG. We are grateful to the David and Lucile Packard Foundation and the Sea Turtle Symposium for travel support.

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MARINE TURTLES IN IVORY COAST (WEST AFRICA)

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SUMMARY

In Ivory Coast, presence of marine turtles in the coastal waters and beaches was unknown until very recently. Some observations show that, along the 600 km of coast, turtles are captured in nests of fishermen and killed on the beaches, for consumption of meat and eggs.

In order to determine the status of marine turtles in Ivory Coast and to contribute to regional protection efforts in West Africa, the Ivorian NGO “SOS Forets” (with EMF funding) has undertaken to assess the presence and distribution of these species during the 2000-2001 nesting season. Because of the socio-political problems that the country has been inmersed in, an efficient project start was unfortunately not possible until mid- January 2001. The end of the project is planned for July 2001.

As first activity, training sessions in Biology, Ecology, Conservation and Collection of data were held for teachers and students of the Faculty of Animal Biology of the University of Cocody-Abidjan, on 15-17 January 2001. Two Ivorian students of this University were chosen to begin field work in the southwest of the Ivory Coast at the end of the month of January 2001. The study area is a 45 km section of coast between Grand Bereby and Tabou. This work is part of a project which students of D.E.A. in Animal Biology must turn in at the end of their studies.

Despite being late in the nesting season, during 15 days of work, they were able to observe the nesting and unfortunately, the subsequent slaughter, of 6 leatherback turtles and 4 olive ridley turtles. In addition they gathered other abundant evidence of the marine turtle presence in the West coastal region of the Ivory Coast. The dominant species in the area are the leatherback and olive ridley, both of which nest frequently. Green turtles nesting is more sporadic. Feeding zones for green turtles and hawksbills have also been identified. Poaching activities are widespread, as shown by the recovery of 47 carapaces of olive ridleys (all of them from adult females killed on the beach), 39 of green turtles and 2 of hawksbills.

We are planning protection and conservation efforts for the next nesting season (October 2001-February 2002) along the 20 km of beach between the villages of Many and Pitiké, where significant sea turtle activities have been observed.

EXPECTED RESULTS

1. Identification of the marine turtles species frequenting the Ivorian coast, as well as the distribution and number of each species at different sites.
2. Identification of the nesting beaches, nesting seasons and feeding areas of adults and juveniles.
3. Identification and evaluation of the threats to sea turtles.
4. Evaluation of the volume of the market for marine turtle products in every village.
5. Training of two Ivorian students in Biology, Ecology and marine turtle conservation.
6. Raising awareness of coastal villagers, authorities, restaurant and hotel owners.
7. Reinforcing local capacities concerning protection and marine turtle conservation awareness.
8. Elaboration of a national plan to protect marine turtle.

PROJECT ACTIVITIES

The project takes place in western Ivory Coast, from Jaqueville to the Liberian border, during the nesting season. The activities are being carried out by 2 students, who assists the project coordinator. In the task of data collection they are helped by poachers who intervene locally. The students are in charge of assuring the scientific coordination of all the data collected by different local poachers. Regular night patrols on the beach are being carried out in order to count the numbers of nesting females as well as to carry out interviews with local villagers.

The activities are:

1. Training Session for the project assistants on sea turtle biology, species identification, data collection, conservation strategies and

techniques in marine turtle first aid.
2. Data collection.

A detailed survey of the coast is essential to project success. This must include:
· Direct observations on all beaches and fishing harbours in the area included in the project.
· Counting and identification of all turtles observed, as well as tagging, measuring, photographing and collecting genetic samples.
· Counting and identification of nests, and assessing the need for nest protection in hatcheries on beaches with significant numbers of nests.
· Evaluation of other indicators of sea turtle presence, including fresh tracks, carapaces for sale, etc.
· Surveys of fishermen, poachers and tradesmen based on interviews using a rigorous questionnaire.
· Other surveys to governmental organisms, agencies, universities and other institutions that developed or develop some marine programs, including the Ivorian Antipollution Center (CIAPOL), the Center for Oceanographic Research (CRO), the Center for Research in Ecology (CRE).
· All data collected will be entered in a database for subsequent analysis.

3. Education and communication

Although not a main goal, we will introduce the project and begin to raise awareness on the importance of protection activities. These efforts are directed:

· To the authorities, to gather their advice and opinions.
· To the fishermen, villagers, and poachers. Meetings will be held in all villages and camps along the coast. The aim is to seek a common solution leading to sustainable use of the resources. Local people must understand the dangers of overexploitation and the need for them to become involved in preserving and increasing their marine turtle populations.
· To the hotel-owners: education efforts are essential because of the influence that they can have on their customers. Hotel-owners could promote some kind of ecoturism based on turtle watching in collaboration with villagers.
· To the large public, with the publication of brochures and posters on the threatened status of marine turtles in the country, to be distributed in hotels, restaurants,...

4. Final project report and management plan focusing on recommendations for the protection of the marine turtles in Ivory Coast.

Table 1. Number of nests of leatherback and olive ridley counted in the study area (February 2001).

Location	Km	Leatherback	Olive Ridley	Sub Total
Many-Dodo	5	29	16	45
Dodo-Pitiké	18	123	30	153
Pitiké-Tolou	6	28	13	41
Tolou-Ombloké	8	26	12	38
Omobloké-Tabou	4	12	5	17
TOTAL	41	218	76	294

PRELIMINARY RESULTS

· First study area: Bereby-Tabou (Southwestern Ivory Coast).
· Size and characteristics of the study area: 40 km of beach with scattered rocky outcrops.

Following extensive field work at the end of the 2000-2001 nesting season (between January 29th to February 13th) we can draw the following general conclusions:

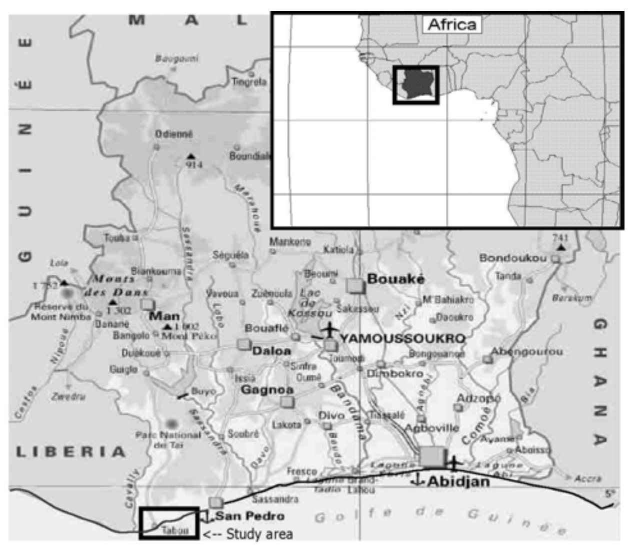
1. The nesting season extends from October to February, with a peak in November-December-January.
2. Three species nest in the study area: *Dermochelys coriacea*, *Lepidochelys olivacea*, and *Chelonia mydas*.
3. The most important nesting beach is from Mani to Pitiké (20 km long.)

At least 6 leatherbacks (2 in Mani, 2 in Omboké, 1 in Boubélé and 1 in Pitiké) and 4 olive ridleys (2 in Mani, 1 in Pitiké and 1 in Tolou) nested during this time in the study zone. In addition, a hatched nest (probably dating from December) was found on Pitiké beach. 88 carapaces were measured and photographed : 47 of olive ridleys (all of them adult females captured during the 00-01 nesting season), 39 of green turtles (9 of which were adult females captured on the beach) and 2 of hawksbills. A preliminary evaluation, based primarily on local interviews, indicates that approximately 100 leatherbacks and 100 olive ridleys are slaughtered each year within the study area.

Green turtles nest less frequently and hawksbill nests appear extremely rare. On the other hand, the capture of immatures of these two species seen feeding among nearshore reefs and rocks, is common. In fact, many villagers consider the hawksbill, sometimes called the“turtle of stones”, the smallest of the sea turtle species because they only ever see juveniles. These are often captured with nets called “epervier” which are thrown from the beach.

Captured turtles are traditionally, shared between poachers and villagers, although sometimes poachers secretly sell their catches. The price for a leatherback is $25 and for an olive ridley is $7. Three leatherback or four olive ridley eggs can be sold for $0.1.

The most interesting beach seems to be Mani-Pitiké, which extends over 20 km and is interrupted 5 km from Mani by the mouth of Dodo river. Poachers from Mani (very active and numerous) rarely cross the Dodo, and those from Pitiké exercise less pressure over the turtles and are definitely less active because of their difficulties selling turtle meat due to poor road connections to Pitiké.



The location and detail of the study area in Ivory Coast

Successful meetings were held with the relevant local governors and authorities, as well as meetings with the hotel-owners from Bereby (Baie des Sirenes, le Beau Rivage) who indicated their support for our protection efforts. Three poachers have been hired to cooperate in the data collection. Finally three teachers (Dr. KOUMÉ, Dr. Marcellin GOMES, Dr. Mattieu EGNANKOU) and two local student (Mamadou KARAMOKO, Sory BAMBA) have been trained in Biology, Ecology and marine turtle Conservation. They will eventually prepare a research thesis on their work, and they are enthusiastic and hard working.

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XTH COURSE ON SEA TURTLE BIOLOGY AND CONSERVATION IN VENEZUELA: EMPOWERING THE SEA TURTLE NETWORK

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BACKGROUND

The "Courses on Sea Turtle Biology and Conservation" in Venezuela have been organized since almost a decade. We have had 174 participants in the ten previous editions of the courses. With the goal to provide a regional view of the sea turtle research and conservation efforts we have had important foreigner instructors from Colombia, Brazil, Mexico and Puerto Rico. Institutional and funding support has been provided by important in country and foreigner governmental and non-governmental institutions.

DEVELOPMENT OF THE COURSE

The Xth Course was conducted in Puy Puy (Peninsula de Paria, Sucre State, Venezuela) between May 4 to 10, 2000 and it had 13 participants. The attendants came from Venezuela, Argentina, Ecuador, Peru, Guatemala, Mexico and France. The main instructors were Laura Sarti (Instituto Nacional de la Pesca, Mexico) Felix Moncada (Centro de Investigaciones Pesqueras, Cuba), Joaquin Buitrago (EDIMAR-FLASA), Hedelvy Guada (WIDECAST-Universidad Simon Bolivar), Vicente Vera (Direccion de Fauna-MARN) and Ana Trujillo (PROVITA). The other invited lecturers were Alejandro Fallabrino (Proyecto Karumbe, Uruguay and Field Coordinator of the Cipara Project in 2000), Pedro Molina (Fundacion Thomas Merle) and Marcos Yánez and Henry Benavente (Al Frente de Paria).

Our focus is addressed to the research and conservation of the sea turtles, but for this edition of the course we were interested to show a different approach, as the presented by our cuban colleague which includes a controlled fishery of sea turtles in the waters of his country.

The course covered 56 hours of instruction distributed between theoretical sessions, field activities, laboratory sessions and video sessions. The field sessions were conducted in Puy Puy and at Querepare beaches. We could not find nesting females during the night surveys, but the leatherbacks left tracks and made nests in the beach while we were sleeping. A killed leatherback turtle was found at Querepare beach. The students received a set of references including those provided by the invited instructors and copies of the MTSG manual of "Research and management techniques for the conservation of sea turtles" (Eckert et al., 1999). All the participants approved the course.

The main auspicers of the Xth Sea Turtle Course were WIDECAST, the BP Conservation Programme, SARPA, Tulsa Zoo, the Columbus Zoo, and an anonimous donor. In-kind contributions were provided by Fundacion Thomas Merle, Al Frente de Paria, Corpomedina, Avior, Provita and the Ateneo de Carupano. Additionally, in Querepare it was conducted a lecture about sea turtles for local inhabitants and children and in San Juan de las Galdonas it was denounced the killing of the leatherbacks to the authorities. People from Puy Puy was invited to see sea turtle videos during the course and they received educational materials.

FOLLOW-UP OF THE PARTICIPANTS

One of the attendants participated as volunteer in the green turtle research and conservation program of the Caribbean Conservation Corporation in Tortuguero (Costa Rica) and he will begin his undergraduate thesis on sea turtles for the nesting season of 2001 in Isla de Margarita. Two of the students participated in the leatherback research and conservation project in the Peninsula de Paria of WIDECAST. These two girls have not stopped: the french biologist is participating in the leatherback conservation project of the Instituto Nacional de la Pesca in Tierra Colorada (Guerrero, Mexico) and is planning to go to the French Guiana and, the mexican oceanologist has incorporated her new background to her work on ecotourism in Puerto Vallarta (Mexico). Two of the venezuelan students have began a deep bibliographical research about the mithochondrial DNA studies. Five of the course participants (from Venezuela, Guatemala, Peru, Ecuador and Argentina) and one of the national instructors were attending by first time the 21th Annual Sea Turtle Symposium in Philadelphia.

THE XIth COURSE ON SEA TURTLE BIOLOGY AND CONSERVATION IN 2001

The XIth Short Course on Sea Turtle Biology and Conservation will be held between June 4 to 10, 2001 in Puy Puy. We are seeking to encourage an inmediate action toward sea turtle conservation whatever in our sea turtle project in Cipara or in other projects in our country or in their countries of origin.

Acknowledgements:

We are deeply recognized to the support provided by WIDECAST, the Universidad Simon Bolivar, the BP Conservation Programme, SARPA, Tulsa Zoo, the Columbus Zoo and an anonimous donor and the contributions of Fundacion Thomas Merle, Al Frente de Paria, Corpomedina, Provita, Avior and the Ateneo de Carupano. Additionally we are deeply recognized to Instituto Nacional de la Pesca (Mexico), the Centro de Investigaciones Pesqueras (Cuba) and EDIMAR-FLASA (Isla de Margarita, Venezuela) to have permitted the participation of Laura Sarti, Felix Moncada and Joaquin Buitrago, respectively. Dr. Karen Eckert (WIDECAST) made a great effort to get support for the course, as well Dr. Heather Kalb. We are indebted with their highly valuable contribution.

The financial support to present this poster has been made possible thanks to the support of the International Travel Committee of the 21th Annual Symposium of Sea Turtle Biology and Conservation, as courtesy of a grant from the David and Lucile Packard Foundation and WIDECAST, as a courtesy of a grant from the UNEP Caribbean Environment Programme (Kingston, Jamaica).

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THE IMPINGEMENT AND ENTRAINMENT OF SEA TURTLES AT U.S. COASTAL NUCLEAR REACTORS

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The cooling water intake systems of nuclear power stations along the Atlantic, Pacific and Gulf coastlines of the United States adversely impact sea turtles. The poster project identifies and illustrates, where and how sea turtles are being taken through entrainment and impingement and as a result stressed, injured and killed during routine operation at nuclear power stations, some taking in over 3 billion gallons of water per day. The "odyssey" of a sea turtle at a nuclear power plant shows the threats to these animals from the "once-through cooling" technology used at a majority of U.S. reactors. Specific examples illustrate the risks at the Oyster Creek, NJ and St. Lucie, FL plants as well as the ways these and others advertise themselves as "environmentally-friendly" wildlife sanctuaries. Poster display is accompanied by a seven-minute video highlighting the issues of entrainment and impingement and their short- and long-term consequences. The video can be obtained by calling: (202) 483-8491.

SEA TURTLES CONSERVATION PROGRAM IN CAMPECHE, MEXICO. ADVANCES AND PERSPECTIVES

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SUMMARY

This paper takes a retrospective look at the sea turtle protection programs in Campeche, Mexico. It considers the historic aspects as well as the culture setting during the pre-Hispanic period. When early written reports reached the Spanish in the Yucatan, a capture industry developed without control through the middle of the Century that put sea turtles on the border of extinction. It sites pioneering efforts realized by INP, discusses protection in the state, and outlines the slow increase in the program with the addition of more protection camps sites. Currently, nine (9) campsites operate with participation from three levels of government, the NGO´s and academia. It mentions the progress in the recuperation of the Hawksbill turtle (*E. imbricata*); red listed as threatened animals by the International Union for Natural Conservation (IUCN). It discusses the multidisciplinary analysis addressing progress of the state program in the area of human resources and finances, considering the problems and limitations. Also, considering the operations with the current advances in Research, Protection, Legislation, Education, and Environment, it proposes broad recommendations for the development of progress in the program.

HISTORY

Upon the arrival of the Spanish during the conquest of Mexico, historical records describe the Yucatan peninsula beaches and sea with an abundance of sea turtles. None the less, although the term “sustainable” was undefined, among the native groups existed a culture which lived on harvests of sea turtles as can be observed in paintings, drawings and pottery of the Maya. During the period of the pirates, William Dampier wrote a description of the species of marine turtles of the region in correspondence to the royalty of England, (Leriche, 1995).

In the state of Campeche, there existed a tradition of eating turtle meat and eggs through the beginning of the century. In the communities of the coastal state during the 50-70’s, locals established fishing without control for turtles where few records exist. In these years, fishermen captured four species of turtles: Hawksbill, Green Turtle, Loggerhead, and Kemp’s Ridley, which were sold in the markets of Ciudad del Carmen and Campeche, (Fuentes, 1967). The principal communities where fishing occurred were Isla Aguada, Sabancuy and Champotón.

FISHING AND DECLINE

During the mating period, the adults were captured in the webbing of nets and were confined in fences along the beach, with the majority of them sold live in the Yucatan. According to Solorzano (1963) and Ramos P. (1974), and Márquez (1976), the estimated annual capture fluctuated between 100 to 300 animals a year, depending upon their abundance during the season. Groombridge and Luxmoore, (1989) mention that since that time, most of the Hawksbill shell production came from the coasts of the Peninsula. In addition, because of their extreme vulnerability during laying periods, all along the coast of the state fishermen and "turtle men" practiced the opportunistic capture for their own subsistence living.

The shrimp fleet accidentally captured adults and juvenile between the 50's and 70's when they operated close to the mating areas or migratory routes. None the less, it is assumed that incidental shrimp catches were the least important cause for their decline. The abrupt fall in the captures of turtles at the end of the 60's caused this activity to no longer be cost-effective, which in turn forced the fishermen to look for other alternatives. None the less, intermittent clandestine captures continued through the end of the 80's.

ACTIONS TO SAVE TURTLES

First Prohibition

From 1971 to 1972 Mexico prohibited the harvest of all species of marine turtles in the Gulf of Mexico, and declared them as protected under Mexican law. Since these actions did not reverse the fall in the abundance of the populations of marine turtles, Mexico established in 1977, the National Fish Institute established the program of studies and protection of marine turtles in Campeche with the first campsite for their protection at Isla Aguada. National Institute of Ecology established the second campsite in Chenkan in 1986. Beginning in 1992, with the integration of various state departments, municipalities, and NGO's, the number of campsites increased to six (6), covering 80% of the laying areas in the state. Currently, between 8 to 10 conservation campsites situated strategically on the length of the state operated regularly, covering 90 % of the seacoast.

Strengthening of the National Legislation: General law of Ecological Balance, 1988.

Total and permanent closed season for all species of marine turtles in Mexico in 1990. Modified penal code in 1991, classifying as a federal offense. The 1992 fishing law mentions the sanctions for infractions. In 1993, Mexican regulations decree the mandatory use of turtle excluder devices, (TEDs); And In 1994, Mexican ecological regulations specify the protection of species of plants and animals in danger, threatened, rare, and subject to special protection.

RESULTS

In the past two decades, four species of sea turtles have been observed laying eggs in Campeche. The distribution of laying has been 83.1 % for *E. imbricata*, 16.8 % for *C. mydas* and 0.07 % between the Kemp's Ridley y Loggerhead turtles. This program covers 150 KM of patches of beach, which excludes 10 % of the habitat.

The recovery of the Hawksbill sea turtles in 24 years has been gradual and sustained, and rated as effective by the IUCN, (1999). In the last 10 years, the population of hawksbills has doubled every 3 years with a medium annual increase of 31.3 %. We have detected the repopulation of historical habitats where no activity had been recorded for several decades.

Campeche encompasses 56 % of habitat in the Yucatan peninsula and is considered the most important geopolitical unit in the Northern Hemisphere, (Meylan, 1997), and (Meylan and Donnelly, 1999). Since the fishing industry is not dedicated to harvesting turtles, the conservation program has been successful permitting the birth of hatchlings. The gradual recuperation has been explained by the effect of an uninterrupted protection program in effect during many years.

The population of Green turtles has manifested cyclical laying periods; with high laying rates on even years, and low laying rates on odd years. Although both periods are unstable due to oscillations, the overall tendency has been increasing, Márquez, et al (to be published). In the last few years, the high year's births have occurred outside the traditional habitats in Carmen Island and Sabancuy. In recent years turtles have been reported living in neighboring states of Yucatan.

The 14 laying of Kemp's Ridley turtles have occurred in Sabancuy, Isla Aguada and the Island of Carmen. Although sporadic, they have been constant since 1984, and have grown in the range of layings to 80 kilometers. Occasional layings of the Loggerhead turtles have been reported in the center and north of the state, in Punta Xen and in Isla Arena, respectively.

There exist zones where protection activities are not being implemented, like in the Atasta peninsula and others like Cayo Arcas, where the nests are protected, but no official information is available. In these zones, the potential for conservation activities is known to from occasional inspections of the area.

We can conclude that it is probable that if we maintain the present levels of recruitment of Hawksbill turtles, in a few years we can say that the population has recuperated. For the Yucatan Peninsula, based upon the simulation models, recuperation could be achieved by year 2010, with 3 million eggs, 15,000 nests, 60,000 juveniles larger than 24 cm, and 2,000,000 hatchlings liberated per season, Garduño et al, (in preparation).

The biannual extreme oscillations between the laying among the populations of green turtle suggest instability, but none the less, show a tendency to increase with time. Therefore, the prospects look positive in the near future. The laying of the Kemp's Ridley turtles, although sporadic maintain persistent, suggesting a repopulation to zones where earlier they were surely abundant. The occasional laying of the Loggerhead turtle, suggest that they previously lived in this area.

PROGRAM CHALLENGES

Financial Resources

Four campsites are operated by official institutions, two by federal, two by state, four by NGO's and one by a University). The majority of the campsites lack operating budgets, but those which do have them have inadequate budgets. Different companies have provided outside financing, but these have been variable and inconsistent. There has been difficulty in agreeing to budgets on federal and state levels, and the allocation of such funds is not adequate.

Material Resources

Only two campsites have appropriate and sufficient equipment. The other campsites suffer from these limitations by completing activities without the necessary efficiency. Because of the unmet needs, the majority of the campsites improvise in their operations each year.

Human Resources

The majority of the campsites lack management personnel with adequate academic training. However, campsites have excellent technicians in the field. Each year, the campsites receive occasional assistance from university students and volunteers who are being taught.

Environmental Protection

No coordination exists between the authorities responsible for the protected natural areas and the special protection on protected natural reserves. Authorities change the allowed use of lands inside the hatching zones, making them incompatible with conservation. There is no consensus about the environmental impact of costal development projects inside the natural living habitat. No control exists for the continual removal of sand from beaches or the increased number of lights from the summer homes on the beaches.

FUTURE PROSPECTS

The future success of conservation of the marine turtles in Campeche, can only be possible if the following conditions are met: Maintain the same level of effort and coverage in the field with adequate budgets. Formalize the existing ad hoc investigation programs into a larger strategy consistent with the global needs for marine turtle Conservation. Implement an efficient parallel program of inspection and surveillance oriented toward turtles. Enforce the existing legislation for protected species in danger of extinction with all of the legal consequences. Apply regional planning for the development of historical costal habitats making the plans compatible with conservation programs oriented toward not disturbing marine turtles and Establish formal programs for environmental education and encourage conservationist.

Acknowledgements:

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MALACHLEMYS TERRAPIN IN NORTH CAROLINA: PRELIMINARY RESULTS FROM POPULATION MODELING, MARK-RECAPTURE EFFORTS, GENETIC ANALYSIS, EXPERIMENTAL FISHING, AND RADIOTELEMETRY

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Listed as a species of special concern in North Carolina, diamondback terrapin (*Malachlemys terrapin*) populations are declining due to habitat loss and anthropogenic mortality. Because we have only limited information on the population dynamics and distribution and abundance of terrapins within the state, we have focused these research questions and survey efforts at the population level. Our goal is to delineate the full extent of their distribution within our study areas and determine the basic parameters of terrapin populations in eastern North Carolina. Specific studies center on (1) population modeling, (2) population dynamics, (3) population genetics, (4) mortality mitigation, and (5) home range, habitat use, and seasonal movement of terrapins. To date, we have developed a general terrapin population model and calculated the first survival rates for adult terrapins (0.83). Additionally, we have documented the presence of 4 separate terrapin populations at individual sites in eastern North Carolina. Results from the field so far indicate that overall terrapin population size in North Carolina is small and individual terrapins display extreme site fidelity from May-October. Techniques for drawing blood from terrapins will be presented and preliminary genetic results revealed. We will discuss significant results from statistical analyses of data obtained by fishing experimental crab pots with a local commercial crabber. We have found that despite considerable overlap of terrapin habitat with the fishery for blue crabs (*Callinectes sapidus*), bycatch reduction devices (BRDs) and time-area closures offer promise for mitigating terrapin mortality in crab pots.

ESTIMATED NATURAL AND HATCHERY SEX RATIOS OF THE BLACK TURTLE IN COLOLA BEACH, MICHOACAN, MEXICO

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Colola, an east Pacific beach located on the west coast of Mexico is the main nesting area for the black turtle. As part of the conservation strategy thousands of eggs are relocated to beach hatcheries. To evaluate possible negative effects of this practice, natural and hatchery sex ratios were estimated. Data of hatchery nest temperatures of 1991, 1997 and 1998 were utilized to estimate hatchery sex ratio.data of nesting frecuency of the black turtle and of the beach thermal dynamics(spatial and temporal)(1991, 1997 and 1998) were used to estimate the natural sex ratio. In 1991 the sex ratios estimated were 71.2% females for hatchery nests and 71.7% females for natural nests. In 1997 the sex ratios estimated were 65% females for hatchery nests and 85% females for natural nests. In 1998 the estimated sex ratios were 88% females for hatchery nests and 85% females for natural nests.

LOGGERHEAD (*CARETTA CARETTA*) GROWTH RATES FROM NEARSHORE ATLANTIC WATERS

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INTRODUCTION

Defining sea turtle growth is critical for estimating life history traits and developing appropriate conservation measures. Despite recent gains in understanding growth in the wild, large gaps remain. For example, green turtle (*Chelonia mydas*) growth rates have been published for many different populations (Limpus and Chaloupka, 1997; Bjorndal et al., 2000a). In comparison, growth in wild loggerheads (*Caretta caretta*) is less known, especially from open water habitats (Bjorndal et al., 2000b). The objective of this study was to measure loggerhead growth rates from Florida's nearshore Atlantic waters and to compare our data to that of other published studies. Due to the unique sampling methodology, we were able to obtain a relatively large sample of turtles utilizing open water habitat.

METHODS

This research was conducted from 1988 to 2000 at the St. Lucie Power Plant intake canal on Hutchinson Island, Florida (27° 20.8' N; 80° 14.7' W). The Plant uses three 3.7 to 4.9 m diameter pipes that extend 365 m offshore to draw cooling water into a canal system. Loggerheads entering the intake structures become entrained and are transported into the canal relatively unharmed. In this study, turtles were captured in the canal primarily with 40 cm stretch mesh tangle nets, 30 to 60 m in length and six meters deep.

Before release into the surf, an inconel # 681 tag was applied at the proximal trailing edge of each front flipper. Minimum straight carapace length (SCLmin; nuchal to the supracaudal notch) and straight carapace length (SCL; nuchal to the longest supracaudal) were measured with forestry calipers to the nearest 0.1 cm. Observer measurement error can obscure growth so we quantified it by using loggerheads recaptured within 15 days. Assuming no growth during this time, absolute changes in SCLmin and SCL were calculated and compared using a paired t -test to examine which measurement had the least error.

Growth rates were calculated from recaptured loggerheads that were at large at least 11 months to minimize seasonal variation (van Dam, 1999). The methodology employed was mixed longitudinal sampling (Chaloupka and Musick, 1997). We used both positive and negative changes to calculate absolute growth in centimeters per year. In each interval, individual growth was expressed as a function of the mean between the initial and recapture sizes (Bjorndal and Bolten, 1988). Growth rates were also averaged within 10 cm size classes for comparison with other studies.

RESULTS AND DISCUSSION

From 1988 through 2000, 2727 loggerheads were captured at the St. Lucie Power Plant intake canal. Of these, 246 were recaptures (9.0%). We used 64 recapture intervals comprising 44 turtles to calculate growth rates. There were 12 turtles that contributed multiple times to the dataset and 75% of these contributed only twice. However, one loggerhead contributed eight growth intervals and has been captured 27 times over the last 11.5 years (see below). Overall, the growth intervals spanned an average of 2.1 ± 1.6 years.

The mean observer measurement error was 0.26 ± 0.22 cm for SCLmin and 0.24 ± 0.23 cm for SCL. Since error was not significantly different between SCLmin and SCL (Paired t -test, n = 25, P = 0.622) and most researchers have reported growth rates in SCL, we used the later measurement for our calculations. The mean growth rate for all loggerheads was 1.03 ± 1.4 cm/yr and the mean size was 66.6 ± 10.1 cm SCL. Individual growth was highly variable, especially in the 50 - 60 cm size class (Figure 1). Natural variation may have been due to food availability, nutrient uptake, intrinsic factors, and/or sex (Bjorndal and Bolten, 1988; Klinger and Musick, 1995).

Mean growth decreased with increasing size class (Table 1). Growth slows considerably in larger turtles and with the onset of sexual maturity (Mendonca, 1981; Bjorndal and Bolten, 1988). However, our sample of mostly subadult animals appeared to be growing much slower in comparison with other growth studies (Table 1). Besides sampling error, one reason could be that most of the earlier studies were conducted in bays, lagoons or sounds, where turtle capture is easiest, but food availability may be higher. Loggerhead growth in nearshore Florida waters has been reported before, but the results were limited by small sample sizes and large measurement errors (Schmid, 1995). There is some evidence that a proportion of our loggerheads annually migrate northward in the summer (Ernest et al., 1989; Schmid, 1995). If so, these migrating turtles may not grow as fast as their more local counterparts due to high energetic demands (Klinger and Musick, 1995).

An interesting example of growth variability over time can be seen in turtle AAJ723 (Figure 2). This male loggerhead has been caught repeatedly since 1989. In 11.5 years, AAJ723 grew from 64.7 cm to 71.0 cm, yet growth was not constant (Figure 2). The growth spurt of AAJ723 and the large variability in our other multiple recaptures suggests that loggerhead growth in this population may be polyphasic. Polyphasic growth has been shown for pelagic loggerheads in the pacific (Chaloupka, 1998) and Kemp's ridleys (*Lepidochelys kempii*) in the Atlantic (Chaloupka and Zug, 1997). In the near future, one of our goals is to provide an appropriate growth model for our loggerheads so we can describe growth rates over time.

Table 1. Comparison of *C. caretta* growth rates by size class in four mark-recapture studies. a this study; b Mendonca, 1981; c Bjorndal and Bolten, 1988; d Klinger and Musick, 1995.

15.7 ± 1.32 3 ± 2.27 4 ± 1.43.0 ± 0.10 9 ± 1.06.0 ± 2.31.5 ± 1.20.1 ± 0.45.0 ± 3.55.2 ± 0.80.3 ± 0.11.2 ± 0.80.2 ± C

Size class	Hutchinson Island		Mosquito Lagoon		Great Inagua		Chesapeake Bay	
	n	GR	n	GR	n	GR	n	GR
40-50	-	-	-	-	3		-	-
50-60	12		2		-	-	2	
60-70	42		7		-	-	9	
70-80	4		4		2		-	-
80-90	3		-	-	-	-	6	
>90	3		-	-	-	-	-	-

Figure 1. Individual growth rates as a function of the mean SCL between initial and recapture sizes.

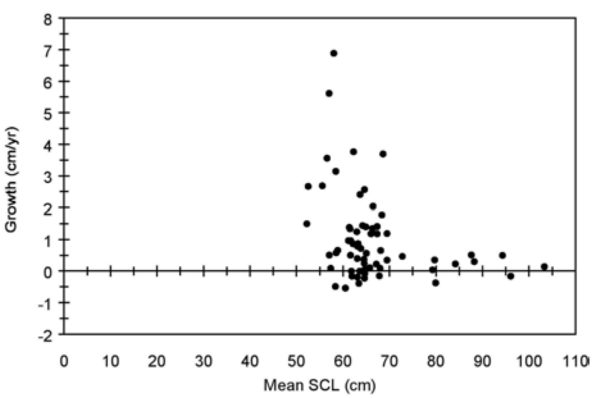

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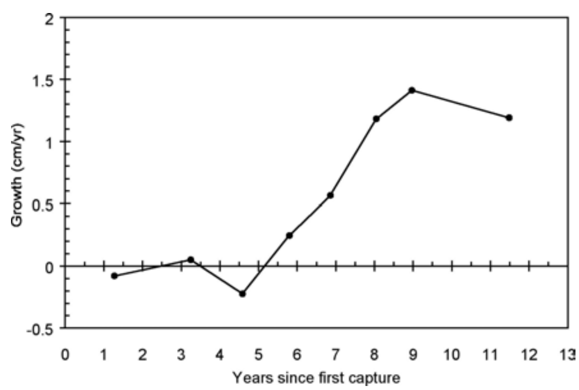
Figure 2. Growth rates over time in loggerhead AAJ723. Note the sharp increase in growth in the last six years.



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APOPTOTIC (TUNEL-POSITIVE) CELLS DIFFERENTIAL DENSITY ON LEATHERBACK TURTLE *DERMOCHELYS CORIACEA* HATCHLINGS GONADS

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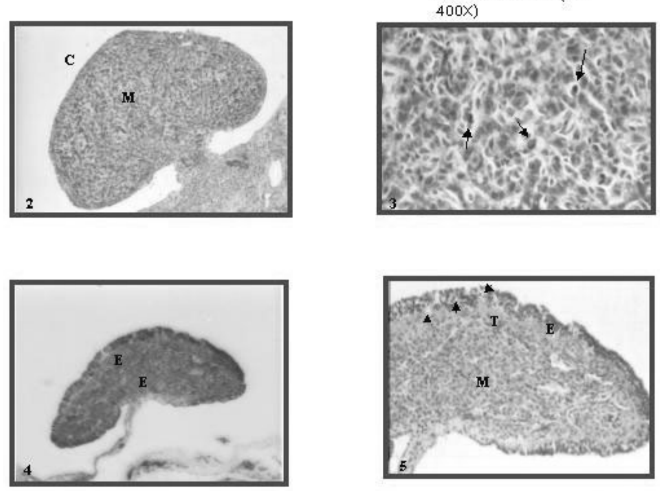
INTRODUCTION

Although numerous and intensive studies on the sexual differentiation issue have been carried out during last two decades on several reptiles families and specifically on sea turtles, there is not sufficient information about which one is the factor that trigger the gonadal differentiation process.

Recent studies performed on fresh water turtles suggest that incubation temperature can drive the production of one or more differentiations involving factors such as estrogens, estrogen related compounds, non aromatizable androgens, aromatase enzyme activity, steroidogenic factor-1 (SF-1), Muller inhibitor substance and genic expression of SOX-9 and DAX-1 genes, both involved in ovarian development. All these works emphasize a correlation between high incubation temperatures with female factors over-expression. On the other hand, on embryonic development during organogenesis, most cells have a fast cell cycle, where G1 and G2 phases are brief, occurring only DNA duplication and minimum growth for a cellular division. However at the same time, cellular replacement and elimination occur by apoptosis.

Taking into account the concepts mentioned above, we can suppose that a possible pathway of lower threshold incubation temperature action is to induce that female factor productor cells get undergo apoptosis and therefore permit testicular development. The aim of this work was to explore the presence and density of apoptotic cells on different histological defined gonads (pseudo-testis, pseudo-ovaries and intersexes).

1. Dissection of leatherback hatchling gonads. G.- Gonada; Ms.- mesonephrous
2. Microphotography of male gonad C.- Cortex; M.-Medulla H-E 100X
3. Apoptotic-like cells at the medulla of a male gonad (arrows) 400X
4. Microphotography of female gonad. C cortex; M medulla 100X
5. Microphotography of female gonad E.- high epithelia; Germ cells (arrows); M.- medulla T.- tunica (H-E 400X)



METHODS

Animals. 10 newly dead (not more than 5 minutes) leatherback turtle hatchlings incubated on hatchery were collected during 1995-1996 nesting season in the "Campamento Tortugero El Farito" on Mexiquillo beach, Mich., Mex. Immediately both gonads were dissected and immersed in a Zamboni fixer solution, until use in the laboratory.

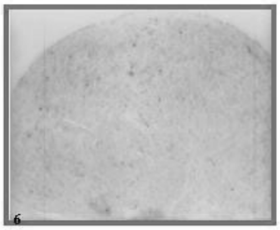
Tissue process. Fixed gonads were washed several times on phosphates buffer until the Zamboni solution was completely removed, then were routinely processed for paraffin histological technique. From each gonad 7mm serial slices were obtained and stained as follows, one with H-E and the other one with PAS, both for morphological sex identification.

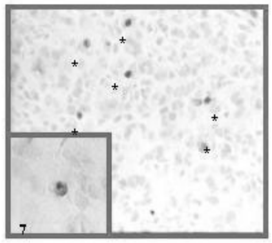
Apoptosis determination. Another slice from each gonad was tested by TUNEL assay, and then the apoptotic cells were numbered by square millimeter, and compared on different sexes.

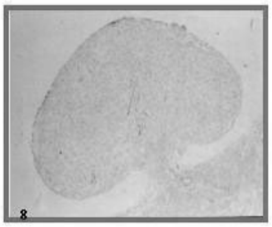
RESULTS

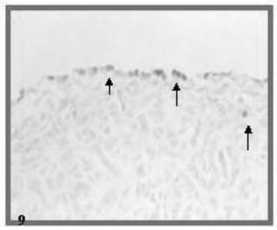
After microscopic observation of H-E and PAS stained sections, gonads that shown a high epithelia, a well developed albugyne tunic, a cortex with germ cells and follicle formation, were classified as female gonads; whereas male gonads shown a low epithelia, a thin albugyne tunic and a very dense medulla with tubules formation. Sex proportion was 3:1 (female:male), today this characteristics are accepted as features of newborne leatherback turtle gonads.

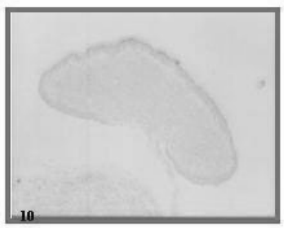
On male gonads we found a great number of apoptotic cells (TUNEL+) both cortex and medullar localization, whereas on female gonads we did not observe apoptotic cells, with exception of one gonad that possibly represents an ovotestis.











6. Male gonad. Apoptotic cells in medulla (brown). 160X
7. Medula male gonad. Apoptotic cells * 400X; frame: Cell with apoptotic bodies 1000X
8. Intersex gonad tunel positive mark only at epithelia 100X
9. Epithelial apoptotic cell (arrows) 400X
10. Female gonad TUNEL negative 100X

DISCUSSION

Some authors have been studying the estrogenic and anti-estrogenic agents action on the gonadal differentiation process, Dorizzi, 1991 & 1994 proved that gonadal sex can be modified on embryos at male incubation temperature with an estrogen treatment. Desvages & Pieau (1992) have shown that aromatase levels on male-temperature incubated embryos are basal during all termo sensible period, whereas female-temperature incubated embryos aromatase levels grow up exponentially reaching the highest at the termo sensible period ending. Richard-Mercier (1995) proved that aromatase inhibition induces sex reversal on female-temperature incubated embryos. Pieau, (1998) proposed that ovotestis development is due to a low elevation on aromatase activity during termo sensible period sufficient to induce the formation of an ovary cortex, but not enough to inhibit testicular cords formation.

The fact that apoptotic cells can be observed only on testis and ovotestis, strongly suggests that temperature indeed may be induced to get under apoptosis those cells committed to estrogenic activity, such as granular and thecal cells, and permitting male cells to appear, sertoli and leidyg, however, at this moment our work only left open this means, therefore the next step is to corroborate that these apoptotic cells correspond to the female cells mentioned above, as well as to verify if this apoptotic pattern occurs on hypothalamus, and finally determine which one is the apoptotic induction pathway that is activated and how temperature acts on it.

Leatherback turtle populations remain reduced and hardly endangered, therefore we don't want to sacrifice hatchlings of this specie, for this reason in our work we use only newly death hatchlings to avoid possibly tissue damage by autolytic processes, however we can not disclaim that a possible tissue damage alter our results until we can perform this kind of studies with normal individuals and a larger sample.

DIET COMPOSITION OF EAST PACIFIC GREEN TURTLES (*CHELONIA MYDAS*) IN BAHIA MAGDALENA, BAJA CALIFORNIA SUR, MEXICO

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INTRODUCTION

The coast of the Baja California Peninsula, Mexico, plays an important role for many species of sea turtles (Clifton et al., 1982). Bahía Magdalena, a 1390 km^2 bay located on the Pacific coast of the peninsula, is thought to provide valuable feeding and developmental grounds for Pacific green turtles (*Chelonia mydas*), locally known as black turtles. Green turtle feeding habits are perhaps the best documented of the world's sea turtles, and in some parts of its range the stomach contents of many individuals have been analyzed (Mortimer, 1985). However, knowledge of black turtle ecology along the Pacific coast of the Baja California Peninsula, in regions such as Bahía Magdalena, is limited. An understanding of the biology of sea turtles is essential to assessing and protecting the natural resources on which this species depends.

This study was conducted to answer the following questions: What food resources are sea turtles utilizing in the Bahía Magdalena region? Do feeding habits fluctuate with the seasons? Do feeding habits vary by geographic location? Providing data to answer these questions is essential in order to better understand which food resources are used by the turtles of this region and how these resources can be most effectively protected. One of the goals of this project is to provide information that can be used for determining the key areas within the bay that might be effective locations for the development of a turtle sanctuary.

METHODS

The study site, Bahía Magdalena, is made up of a chain of relatively shallow, narrow channels that run north and south, parallel to the coast. Bahía Magdalena forms the central part of a large lagoon system, the Magdalena-Almejas complex. The ocean connects to the bay through a channel between the barrier islands, Margarita Island and Magdalena Island. In the western part of the bay, coastal upwelling causes low temperatures and high nutrient concentrations, which contribute to a very productive ecosystem.

The feeding habits of black turtles living in the Bahía Magdalena region were assessed by analyzing sea turtle stomach contents. The research was conducted from the September 1999 through June 2000. The stomachs were collected from incidentally captured sea turtles and were frozen or preserved in alcohol until dissection. The stomachs were first weighed with the contents, and then re-weighed after the contents were removed. The contents were sorted into identifiable taxa and weighed. The red algae *Gracilaria pacifica*, *Gracilariopsis lemaneiformis*, and *Hypnea* johnstonii were grouped together throughout the analysis and labeled as *Gracilaria, Gracilariopsis*, and *Hypnea* due to the difficulty in separating the three algae. The relative abundance (by weight) of each taxon was determined by calculating the percentages of the taxa in each stomach. These percentages were then averaged to determine the relative abundance of each taxon for all stomachs. This method, as opposed to calculating a percentage based on total weight, was used so that larger stomachs would not disproportionately affect the relative abundance of each group. The stomachs from turtles captured in different seasons were compared to determine if there was a difference in seasonal feeding habits of the species. The stomachs were also divided by location, comparing turtles caught within the bay, and those from outside the bay. Due to the small sample size, no statistical tests were performed.

RESULTS AND DISCUSSION

ASSESSMENT OF DIET COMPOSITION BY SEASON

A total of sixteen black turtle stomachs were analyzed. Four stomachs were collected from sea turtles during the fall, 1999 and were predominantly composed of the red algae *Gracilaria, Gracilariopsis*, and *Hypnea* (about 64%) (Fig. 1). Sea grass, *Zostera marina*, was the second most abundant taxon comprising 17.7% of the total. Other taxa found in the stomachs during this season included invertebrates (10.6%), and the red alga *Gelidium robustum* (7.3%).

Two stomachs were analyzed from turtles captured in the winter and they contained 43% red algae *Gracilaria, Gracilariopsis*, and *Hypnea* and 45% of the green alga *Codium* (Fig. 2). Other taxa found in the stomachs included the red alga *Gracilaria textorii* and invertebrates, which comprised 2.5% and 6.1% of the total respectively.

The most abundant taxon in the group of six stomachs collected during the spring was the red alga *Gelidium robustum* (35.8%) (Fig. 3). These stomachs also contained large amounts of *Gracilaria, Gracilariopsis*,and *Hypnea* (22.0%) and *Zostera marina* (20.6%). Invertebrates made up 12.9% and the green alga, *Codium* was 1.8% of the total percent composition. The red alga, *Porphyra perforata*, comprised 3.1% of the total. Other contents included small amounts of animal matter (e.g. pelagic red crabs and hydrozoa), an unidentified red alga and the brown alga *Dictyota*.

The three stomachs collected in the summer contained a high abundance of *Zostera marina* (33.3%) and approximately 19% of the stomach contents were the red algae *Gracilaria, Gracilariopsis*, and *Hypnea* (Fig. 4). Both *Ulva lactuca*, sea lettuce, (19.9%) and invertebrates (19.7%) were also found in high abundances. The red alga *Gracilaria textorii* comprised about 5% of the stomach contents.

A comparison of the four seasons discussed above demonstrated that several taxa were common throughout the study period, the most notable being the red algae *Gracilaria, Gracilariopsis*, and *Hypnea*, which were relatively abundant in all seasons. Invertebrates were found in every season as well. The sea grass *Zostera marina* and the red alga *Gelidium robustum* were present in every season except winter. This may be due to the fact that the two stomachs from the winter season were from turtles that were located within the bay, whereas the other three seasons had stomachs from turtles captured in both the Pacific and the bay (see next section). This study indicates that there are several taxa that represent important diet components during the entire year, whereas other taxa are consumed only during specific seasons. Whether this finding is a result of the changes in abundance and availability of different food resources during different times of the year, or a change in feeding selectivity of the turtles remains to be determined and is currently the topic of a Masters thesis (M. López, CIBNOR, S.C., La Paz, Mexico).

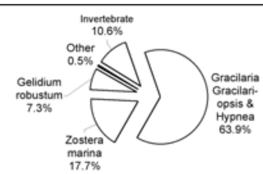

FIGURE 1. Stomach contents (as a percentage of total weight) of black turtles collected in the fall 1999

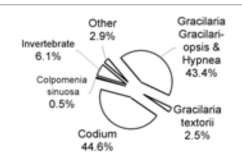

FIGURE 2. Stomach contents (as a percentage of total weight) of black turtles collected in the winter 1999-2000

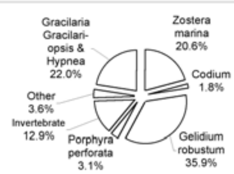

FIGURE 3. Stomach contents (as a percentage of total weight) of black turtles collected in the spring 2000

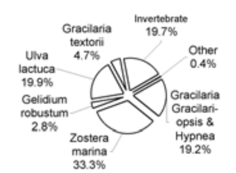

FIGURE 4. Stomach contents (as a percentage of total weight) of black turtles collected in the summer 2000

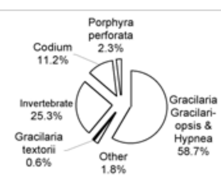

FIGURE 5. Stomach contents (as a percentage of total weight) of black turtles captured inside Bahía Magdalena, from the fall 1999 to summer 2000

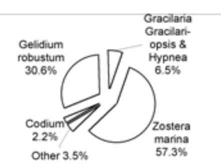

FIGURE 6. Stomach contents (as a percentage of total weight) of black turtles captured along the Pacific coast (outside of Bahía Magdalena), from the fall 1999 to summer 2000

ANALYSIS OF DIET COMPOSITION BY LOCATION

There was a considerable difference between the stomachs from turtles captured within the bay and those from the Pacific. The stomachs collected from turtles captured in the bay were dominated by the red algae *Gracilaria, Gracilariopsis*, and *Hypnea* (58.8%) (Fig. 5). Other abundant taxa include invertebrates and *Codium*, which represented 25.3% and 11.2% of the total percent composition. The red algae *Porphyra perforata* and *Gracilaria textorii* were also found in the stomach from turtles captured in the bay. These two algae comprised 2.3% and 0.6% of the total, respectively.

The contents of stomachs from turtles caught outside the bay, along the Pacific coast, contained approximately 57% *Zostera marina* sea grass (Fig. 6). The second most abundant taxon was the red alga *Gelidium robustum*, which made up about 30% of the total. *Gracilaria, Gracilariopsis*, and *Hypnea* (6.5%) and *Codium* (2.2%) were also found in the stomachs, but to a much lesser extent than in the bay-captured turtles. No invertebrates, *Porphyra perforata*, or *Gracilaria textorii* were present in the stomachs from the turtles captured in the Pacific.

The difference in diet composition between the two locations indicates that turtles in different geographic locations are capable of utilizing different resources. This information must be taken into consideration when identifying critical areas as turtle sanctuaries for the conservation of important food resources.

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The authors would like to acknowledge Whitman College, and the Parent's Council Internship, for funding this research during the summer, 2000 and providing the support for Sarah C. Hilbert to attend the Symposium. The School for Field Studies provided funding, housing and logistical support for the field work.

Appreciation is extended to the people of Puerto San Carlos for their cooperation in this project and to Professors Bob Carson and Charles Drabek who served as thesis advisors for Sarah C. Hilbert at Whitman College. This project was conducted as part of a Bachelor of Arts thesis, co-directed by faculty from Whitman College and the Centro de Investigaciones Biologicas del Noroeste, S.C.

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A PRELIMINARY STUDY ON GREEN TURTLE NESTING POPULATION IN DERAWAN ISLANDS, EAST KALIMANTAN, INDONESIA

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BACKGROUND

Derawan, a reef type archipelago, which comprises of 8 small islands, has been known as one of major green turtle rookeries as well as major feeding sites in Indonesia. In this region, turtle eggs have been known as a potential protein source as well as a trade commodity since the early time. Consequently, excessive harvests occurred that might lead (in the long run) to the declining of the nesting population.

If the viability of the turtle reproduction in these areas need to be sustained, then a well co-management of the nesting population and habitats, which involving the communities, local government, and private partners, should be promoted.

To meet the need of the mentioned goals, collection of database for defining the extent of the conservation challenge and evaluating effectiveness of a potential intervention or management responses needed to be conducted.

AIM OF THE STUDY

To provide a baseline data for commencing a well co-management turtle nesting beaches, which, ultimately sustaining the reproduction of turtle population in this region.

METHODOLOGY

Methodology used in this preliminary study are : Secondary data collection : Egg Yields Records, Interview and primary data collection (beach survey on Sangalaki Island)

RESULTS

General Description of the Islands
The turtle islands fall under the administrative jurisdiction of Berau District (sub district Derawan islands and Biduk-biduk, East Kalimantan Province).

Historical Information on Turtle Egg Harvest
In this region, the turtle eggs once used as a tribute (upeti) among royal families. This led to a commercialism and consequently massive harvest of the accessible and unregulated resource.

Existing Management Intervention
Restoring 10% of total harvest for conservation as an obligation for concessioner. The 10% (?) was managed through a 'head start' program promoted by Fisheries Department in Sangalaki and Derawan that involved relocation from other nesting islands, incubation in closed-shaded areas, rearing to 3-6 months. More 70,000 head-starters have been released since 1969. A nest adoption program has being promoted by dive operator where nests are incubated in situ and hatchlings are released naturally. Recent management progress is that more attention is being put on the the major rookery, Sangalaki island

Status of the Nesting Population
No reliable data available to assess the status of the nesting population to be able to draw an impact of excessive egg harvesting during the past period. The only available data in egg yield records which is defenitely based on the concessionair reports, therefor might be underestimated. The records show an increase trend in the 1980s. However, locals confirmed the present decline of the nesting population compared to decades before.

Assuming that strict protection on Sangalaki against egg harvesting has found effective, the increase of egg yield in 1980s might be due to the regeneration of adult females recruited during the period of 1934-1945. A high contribution of Sangalaki (appr. 40%) to total production were well recorded (only in 1985-2000) while other islands that have larger nesting areas have only minor contributions.

A distinct seasonal trend shown a probable seasonal breading peak in May except for the 1999 data which is in July-Sept. The concessioner confirmed that the year of 1999 has highest annual production during his concession period (since 1997). Can it be referred to the peak of breeding season or related to the El-Nino phenomenon ?

Preliminary Data on Sangalaki Nesting Turtles (survey period August-December 2000

During monitoring period, nesting green turtles were observed emerging during high tide. Mating activity takes place in the vicinity the island. Nesting attempts seemed to concentrate on particular side of the island that might be related to monsoon. In August-Sept, eastern monsoon, high density southern beach whereas in Nov-Dec, western monsoon, is on north-eastern. Ten to thirty nesting females, with an average size distribution of 100.1±6.81 cm of CCL and 89.5±7.7 cm of CCW attempted to nest each night.

A high percentage of nesting failures occurred in the period of August and September (43%) while less in November and October(29.7%). Possible causes were barriers on the beach (such as drift logs, fallen trees and the presence of people). Major cause that might be related to substrate suitability still in question. Several females tried several times to dig nests but ended up without laying eggs.

The average of clutch size is 94.8±9.2. Nest analysis that was done with adopted nests showed an average hatching success rate of 77.06±27.35% in the period of August-Sept and 69.07±34.16% in the period of Nov-Dec. Several nests demonstrated a very small hatching success (<5%) for unknown reasons. Eggs predation by monitor lizards, beach crabs, rats found occasionally. Incubation period for the two survey periods are 56±2.8 and 56.88±2.5 days respectively.

Follow up Activities

-Beach Survey on Sangalaki (tagging, counting, measuring, nest analysis)

-Preliminary population survey on other nesting islands

Table 1. General Description of the Derawan Turtle Islands

Islands	Area (Ha)	Predictive Nesting Density	Inhabitants	Tourist Activities	Conservation Status
Derawan	50	Moderate	present	present	none
Semama	50	Low	none	present	wildlife sanctuary
Sangalaki	23	High	none	present	marine tourism park
Bilang-bilangan	60	High	none	none	none
Mataha	30	High	none	none	none
Maratua	?	Low	present	present	none
Kakaban	?	Low	none	present	none
Balikukup	?	Moderate	none	none	none
Sampit	?	Moderate	none	none	none

Aknowledgment:

This preliminary work is done by Conservation Science Unit WWF-Indonesia (Wallacea Bioregion) in order to support Sea Turtle Campaign in the region and in Indonesia in close cooperation with District Government of Berau, NGO partners (Indonesian Biodiversity Foundation, Yayasan Kehati and German Turtle Foundation) and private sector (Sangalaki Dive Lodge, Borneo Divers). Supports from Packard Foundation and WWF-US Species Action Fund made this poster possible to be presented in the 21th Annual International Sea Turtle Symposium in Philadelphia, US.

Table 2. Periodical Information on Sea Turtle Management

Period	Harvest Method	Remarks
Prior to 1901	Open Access Resource	Cause high trade Demand/commersialism
1901 -1934	Colonial Regulation: No catch and slaughter of any marine turtles Licensed Harvests	Insufficient Enforcement for Derawan and Sangalaki were
1934 – 1945	Concession right was leased out to an individual business Closing Period (every alternate year)	Sangalaki was well safeguarded during the closing period
1945 – 1950s	Open Access	
late 1950s	Concession No close season	
After 1950s	Regulations regarding the management of sea turtles and eggs were issued: - Local Government Regulation (No. 30/ 1953) regarding sea turtles and their eggs. - Agriculture Minister Decree (no.604/KPAS/UM/8/1982) regarding the establishment of Semama and Sangalaki islands and adjacent waters as respectively Wildlife Sanctuary and Recreational Park - Local Government Regulation (No. 15/ 1983) regarding the use of sea turtles and their eggs in Berau Regency. - Decree of the head of Berau Regency (No. 69/ 1999), regarding the management of sea turtles and their eggs.	

Figure 1. Nesting Sites in Derawan Islands

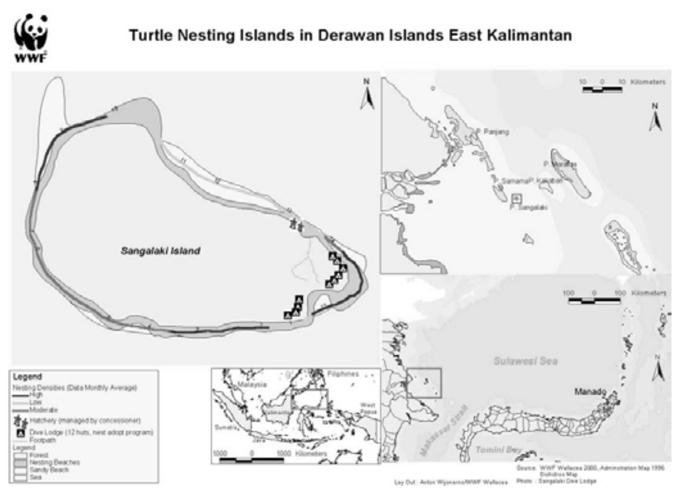
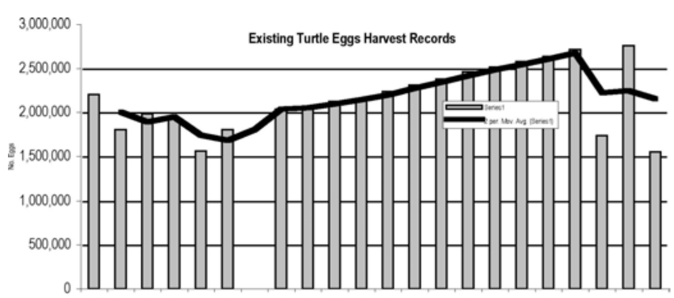


Figure 2. Egg Yield Records (sources; FAO, 1982; Schultz, 1994; Fisheries Dept. Berau).



SYSTEMATIC CHANGES IN DIVING BEHAVIOUR BY LOGGERHEAD TURTLES (CARETTA CARETTA) THROUGHOUT THE INTERNESTING PERIOD

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AIM

Time depth recorders were used to assess the patterns of depth utilisation by two loggerhead turtles (*Caretta caretta*) in Cyprus, eastern Mediterranean (35º21'N, 33º30'E) during the internesting period (INP).

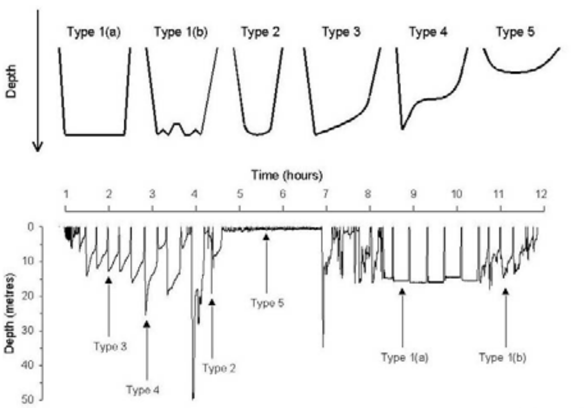
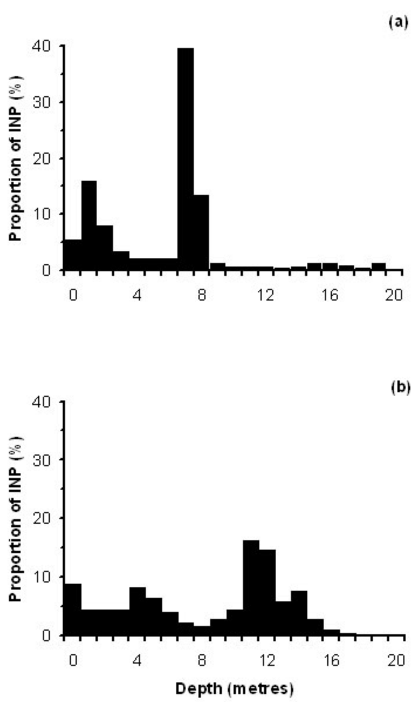
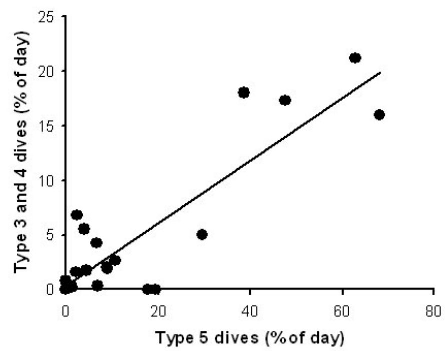


Figure 1



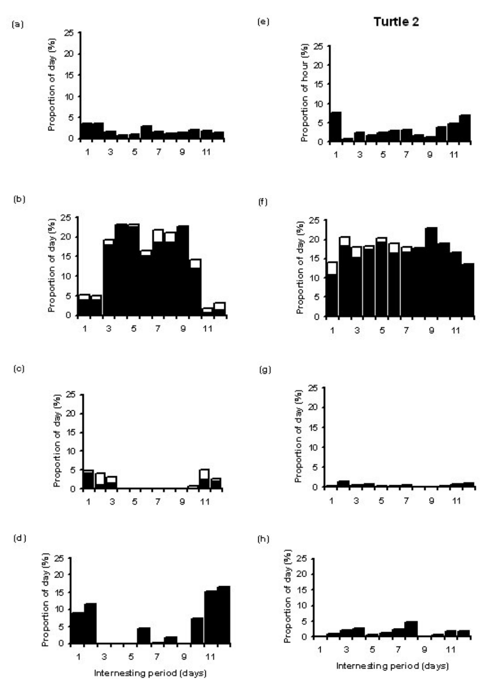
RESULTS

Six predominant dive types were identified (fig. 1). Dives to the seabed (Type 1(a) & (b)) accounted for 59% and 75% of the INP (fig. 2), respectively with most dives being < 20 m suggesting the turtles remained close to the shore (fig. 3). These benthic dives decreased markedly in the days following or prior to a nesting event further suggesting that the behaviours associated with nesting may be protracted (fig. 2).



DISCUSSION

This importance of the sea-bed for loggerhead turtles in Cyprus during the INP contrasts with the extensive use of mid-water resting dives (Type 3 and 4) recently reported for this species in Japan. This dichotomy may reflect differences in the amount of time spent travelling (i.e. type 5 dives), with mid-water resting occurring when turtles are travelling and, conversely, when little time is spent travelling turtles may opt to remain predominantly on the seabed (i.e. Type 1a and 1b dives) (fig. 4).



THE CONSERVATION AND MANAGEMENT OF THE OLIVE RIDLEY - *LEPIDOCHELYS OLIVACEA* (ESCHSCHOLTZ, 1829) IN ALAS PURWO NATIONAL PARK, EAST JAVA - INDONESIA

Herda Pamela Hutabarat

ALAMI Foundation

INTRODUCTION

The Alas Purwo National Park (APNP) is located in the extreme southeast of Java (8°26'46"– 8°47'00" S. lat., 114°20'16"– 114°36'00" E. long). It is app. 30-hour road travel from Jakarta --the capital of Indonesia-- to the east. The wildlife is extremely rich in this beautiful area. It is recognized as the only protected area in Java, where four species of marine turtle are still known to nest annually --the olive ridley, leatherback, hawksbill and green turtle. According to the local people, the turtle has been known to nest in the area since early 40's. "Alas" means "Hutan" or Forest, while "Purwo" means "Pertama" or First. (Possibly, represent the dominant lowland-primary-forest type).

There is extremely little publication on the Olive ridley in Indonesia., let alone APNP; since in the middle of the 90's a considerable number of researches have been taking place in the area. The result presented here is from a study conducted during the 1995's nesting season.

In 1983, a marine turtle hatchery program was established in Alas Purwo. Since then, the number of Olive's nest found has increased steadily, and the number of egg poaching decreased. Unfortunately, it is no guarantee that the threat stopped and that the continuation of the conservation effort is safe. Not to mention the contribution to the local community.

GOAL

Strategic approaches for balancing the need of marine turtle conservation and the need of the people in APNP.

OBJECTIVE

- to record the nesting of the Olive ridley during one nesting season;
- to assess the possibility for a long-term tagging program;
- to evaluate the conservation and management of the marine turtle and its habitat;

METHOD

- Total count of the nest and egg produced by conducting beach surveys (Pritchard et al., 1983);
- Secondary data collection from library, the local Forest Protection and Nature Conservation office;
- Interviewing local people.
- The nesting study was conducted along the 15.5-km long beach called Marengan beach. The area was known as the nesting site for the Olive ridley turtle. The basecamp was in the middle of the section of the beach called Ngagelan Post.

RESULT

- The average carapace length of the Olive ridley nested in APNP was 67.5 cm (SD = 3.2, range 62 - 75 cm CCL, n = 30);
- The average carapace width of the Olive ridley nested in APNP was 66.7 cm (SD = 3.9, range 59 - 74 cm CCL., n = 30);
- the nesting season in 1995 occurred from March through October;
- the total number of nest found was 162;
- the peak of nesting season was in July, when 51 nests (31.48%) were found;
- the number of eggs found was 15,000 - 16,000, with average 104 egg/nest (SD = 25.8, n = 152);
- the semi natural hatching rate was 83.7 % (12,467 hatchlings from 14,890 eggs) and the natural hatching rate was 90.5% (182 hatchlings from 201 eggs);
- the hatchling death rate in the hatchery tub was 27.4 %;
- the marine turtle in APNP (especially the Olive ridley) is potential for a tagging program due to the fact that it has been increasing steadily from 1984/1985 - 1995/1996.
- The hatchery staff has high commitment and awareness on the importance for conserving the marine turtle in the area. Unfortunately, there is a lack of insight on the biology and ecology of marine turtle among the hatchery staff;
- The APNP needed a well-prepared long-term monitoring and evaluation for the conservation and management of the marine turtle; especially in controlling the impact that would be caused by the unnecessary development that has been and would be done in the future.

CONCLUSIONS AND RECOMMENDATION

The Olive ridley in Alas Purwo National Park still faces threat from outside and inside the area. The 43.420 ha area is located in the densest island in Indonesia and 45-minute ferry-ride from Bali Island --one of the main tourist destination in Indonesia and the center for marine turtle trade in Indonesia; a road establishment inside the National Park (replacing the natural track) is being executed; the nesting beaches contain valuable source of income for local fishermen. These factors could become a potential support for developing a sustainable conservation and management program for the marine turtle in the area that gives an equal benefit to the local people. As a mobile species, the health existence of the Olive ridley in Indonesian waters contributes significantly to the conservation management of the world marine turtle.

Therefore, it is strongly recommended these next programs:

a. Conservation

1. To evaluate the last ten years data of marine turtle in the area;
2. To identify the main nesting sites of the species nest in Marengan Beach;
3. To conduct a socio-economic evaluation of the local community;
4. To produce an evaluation paper of what has been done on the marine turtle conservation program;
5. To develop a master plan for ecotourism on the area;

b. Training

1. To conduct a one-day GIS application training for the hatchery staff;
2. To train the hatchery staff for a tagging method for the nesting turtle and data collection;

c. Environmental Education

1. To embrace the local community in an innovative hatchery management;
2. To provide incentive to the community;
3. To establish an effective turtle education information centre for visitor on the hatchery;

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AN INTEGRATED APPROACH TO HATCHERY MANAGEMENT: DATA FROM PENINSULA MALAYSIA

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Hatcheries are an integral part of sea turtle conservation in Peninsula Malaysia. Currently close to 50% of clutches are under the protection of government managed hatcheries. Without adequate management and monitoring strategies these hatcheries face the risk of serving as little more than "feel good" exercises. We wish to develop an efficient and effective suite of nest and hatchling parameters that can be measured to form an integrated monitoring system. Using information collected over two seasons, we compare data on hatchling size (SCL), scale abnormality rates, and the effects of relocation, nest depth, and nest density on emergence and hatching success in four mainland hatcheries (Chendor, Geliga, Ma' Daerah) and one in-situ island beach (Mak Kepit). In addition, we used circle experiments to test for disorientation of hatchlings released at each beach.

Hatchery conditions between years were generally similar. However, after unsuitably high hatchery sand temperatures were discovered at Chendor in year one (1999). Chendor hatchery was shaded in year two (2000) which was, on average, effective in reducing temperatures by 20 C. Emergence and hatching success were lowest in nests relocated to hatcheries at Geliga and Ma Daerah, and highest in in-situ nests at Mak Kepit and hatchery nests at Chendor. Emergence success improved with nest depth, but we did not find a relationship between emergence success and nest density. All hatcheries were highly influenced by light pollution. At one hatchery (Geliga) hatchling orientation was found to be random. We suggest that in order to maximise the conservation benefit of hatcheries, responsible organisations must implement on-going integrated monitoring strategies for as many locations as possible. Data collected annually from the same locations will permit early identification of problems and allow for early initiation of solutions and/or research.

MICROSATELLITE MARKERS AND MULTIPLE PATERNITY IN GREEN TURTLES *CHELONIA MYDAS* OF ASCENSION ISLAND, SOUTH ATLANTIC

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Observations of the green turtle *Chelonia mydas* mating behaviour suggests that females may mate with multiple males (Booth and Peters, 1972). It is therefore assumed that the offspring in each clutch laid by such females are likely to have been sired by several fathers. Surprisingly, the first assessment of green turtle clutches using molecular markers found little evidence of multiple paternity in an Australian population (FitzSimmons, 1998). However, mating patterns may differ between populations, particularly if density-dependent factors play a role (FitzSimmons, 1998). We are therefore beginning to examine a different breeding population, that of Ascension Island. Here we present preliminary results based on an investigation of microsatellite markers detected with 32p radiolabelled primers. Such preliminary results indicate that multiple paternity exists in this population.

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EFFECTS OF INCUBATION TEMPERATURE ON THE HATCHING SUCCESS OF LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) NESTS ON SIESTA KEY, FLORIDA

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ABSTRACT

This study focuses on nests of Siesta Key, near Sarasota County, Florida: an area with unusually low hatching success. While nests found on Siesta Beach at the north end of Siesta Key have historically low rates of hatching success (25.0%), nests found in the Sanderling Area, ca. 1.5 km to the south, have high rates of hatching success (88.0%). There are clear differences between these two locations (i.e. sand color and grain size), no scientific studies have attempted to explain the differences. During the 1999 and 2000 nesting seasons temperatures adjacent to nests in both areas were recorded using Hobo Temp data loggers. A significant difference was seen in mean, maximum, and minimum temperatures between Siesta Beach and the Sanderling Area. There was also substantial evidence for a correlation between hatching success and mean nest temperature. This investigation was undertaken to increase scientific knowledge of how abiotic conditions affect hatching success of loggerhead sea turtle (*Caretta caretta*) nests and to contribute to conservation efforts in Sarasota County, Florida. Results will be further examined for possible contributions to low hatching success.

INTRODUCTION

The nesting beaches along the southern coast of Florida are part of one of the largest nesting aggregates in the world for the loggerhead sea turtle, *Caretta caretta* (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1991). Ninety percent of the Western Atlantic loggerhead population nest in the state of Florida (Cornelisen et al. 1998). However, some areas, such as Siesta Beach in Sarasota county, suffer low survivorship (Foote pers. comm.). Several studies in this region have investigated nest conditions and hatching development (e.g., Blair et al. 1998, Cheeks et al. 1998, Foley 1998, Wood and Bjorndal 2000).

The effects that different abiotic factors (i.e. nest temperature, sand type, nest moisture content, sand compaction, dissolved oxygen content, etc.) have on the survivorship of eggs in the nest environment is not fully understood. Comparing the hatchling survivorship in various areas and the abiotic conditions in these microsites can determine what nest conditions have an impact on the health of the developing embryos (Ackerman 1997). Numerous investigations have helped determine the effects that abiotic factors play in embryonic development (e.g., Ackerman 1981, 1980; Miller 1985; Mrosovsky and Provancha 1989; Mortimer 1990). However, data are lacking from areas with critically low survivorship.

This study focuses on nests of Siesta Key, near Sarasota County, Florida: an area with unusually low survivorship. While nests found on Siesta Beach at the north end of Siesta Key, have very low rates of hatching success (25 %), nests found in the Sanderling Area to the south have high rates of hatching success (88%). Hatching success on Siesta Beach is lower than any other beach in Sarasota County. Visual observations of the two sites show apparent physical differences of sand. Siesta Beach has extremely fine, white, compact sand. The Sanderling Area's beaches however are made up of shelly, loosely packed sand (pers. obs.). This study was designed to increase scientific knowledge of how abiotic conditions affect survivorship of loggerhead sea turtle (*Caretta caretta*) nests and to contribute to conservation efforts in Sarasota County, Florida.

METHODS

Optic Stowaway data loggers (manufactured by Onset Computer Corporation, Pocasset, MA) were used to monitor the temperature of *Caretta caretta* nests in the two sample areas. By programming these loggers to record temperature at thirty minute intervals, the total data collection interval was 1650 d. This insured that all loggers could be started at the beginning of the season and run throughout the duration of the study. Each logger was calibrated according to techniques shown effective by Maglothin and Carthy (pers. comm.).

Each logger was placed at a distance of 0.5 m from the south side of the nest cavity as mandated in the 2000 Special Conditions Attachment of Marine Turtle Permit #126. Logger placement took place when nests were first observed, usually the morning after they were laid. All loggers were placed at a depth of 25 cm below beach surface.

RESULTS

Nest temperature was assessed for 16 nests deposited during the 1999 and 2000 nesting seasons. The mean nest temperature for the Sanderling Area was 29.65 C ($SE = 0.24$, $n = 6$). The mean nest temperature for Siesta Beach was 27.54 C ($SE = 0.18$, $n = 10$). There was a significant difference between the mean temperatures of the two sites ($t = 7.0$, $P < 0.0001$, 15 d.f.). The maximum nest temperature for the Sanderling Area was 32.33 C ($SE = 0.47$, $n = 6$). The maximum nest temperature for Siesta Beach was 30.30 C ($SE = 0.34$, $n = 10$). There was a difference in the max temperatures between the two sites ($t = 3.5$, $P = 0.0032$, 15 d.f.). The minimum nest temperature for the Sanderling Area was 26.66 C ($SE = 0.34$, $n = 6$). The minimum nest temperature for Siesta Beach was 25.02 C ($SE = 0.18$, $n = 10$). A difference was found in the minimum temperatures between the two sites (t = 3.9, P = 0.0016, 15 d.f.). Hatching success was assessed for 14 of the nests. The mean hatching success in the Sanderling Area was found to be 87.76% (SE = 11.73, n = 7). The mean hatching success for Siesta Beach was found to be 25.01% (SE = 11.73, n = 7). There was a difference between the mean hatching success for the two sites (t = 3.78, P = 0.0026, 12 d.f.).

There was substantial evidence for a correlation between hatching success and mean nest temperature (F = 6.88, P = 0.024, 1 d.f.). A correlation was not found between hatching success and maximum nest temperature (F = 1.71, P = 0.22, 1 d.f.) or between hatching success and minimum temperature (F = 3.0, P = 0.11, 1 d.f.).

DISCUSSION

A significant difference was seen in mean, maximum, and minimum temperatures between Siesta Beach and the Sanderling Area (Table 1). This can be attributed to the obvious difference in sand color found at the two sites. As Mrosovsky (1980) reported, the rate of development of sea turtle eggs is positively correlated with increased temperature.

The normal incubation time for *Caretta caretta* embryos is 55 d. (Miller 1997). It was found that this time holds true in the Sanderling area, but deviates for Siesta Beach. The few nests that do hatch on Siesta Beach take ca. 65 d. The low temperatures measured on Siesta Beach may be contributing to long incubation duration.

Although neither is at a statistically significant level, it is interesting to note that the correlation between minimum temperature and decreased hatching success is stronger than that between maximum temperature and decreased hatching success. This may suggest that a nest can withstand longer durations at high temps than it can at low temps. If true, this shows that temperature does play a small role in the low rates of hatching success observed on Siesta Beach. The temperatures found in this study were within the normal limits of embryonic tolerance as shown by Maloney et al. (1990), suggesting that temperature alone is not the cause of decreased hatching success on Siesta Beach.

The present study has helped to elucidate the role of temperature; questions remain as to what other factors may play a role in limiting hatching success in the area of interest. Reduced gas exchange, as may be characteristic of certain sand types, slows embryonic growth and increases mortality (Ackerman 1980). Sand grain size and granulometry parameters influence hatching success (Mortimer 1990). Water table depth should also be considered. Analysis of these factors may prove to contribute significantly to the current work.

At a depth of 25 cm (chosen based on Foote and Mueller unpubl. Data) the logger was likely to be impacted more by solar heat than the clutch may have been at a deeper depth. One important consideration in the interpretation of the temperatures measured in this study is that there may be a substantial difference in temperature between the center of the clutch and the surrounding sand (Maloney et al 1990).

Using TSD standards set by Standora (1985) and mean daily temperatures recorded, it is hypothesized that Siesta Beach is producing mainly male hatchlings and that hatchlings originating from the Sanderling Area are primarily female. However, according to Miller (1997) the daily temperature fluctuations in natural nests cause mean temperature to be poor predictor of the hatchling sex.

The importance of the hypothesized male-biased population produced by the northern portion of Siesta Key to the total South Florida population of loggerhead sea turtles is unknown. As noted by Foley (1998) it is important to realize that even if a nest has extremely low survivorship the few hatchlings that it does produce may be of vital significance to the population. Low hatching success may not signal reproductive failure but may be a substantial component of reproductive success based on the adaptive nesting patterns of females.

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BARNACLES ASSOCIATED TO MARINE VERTEBRATES IN FLORIDA AND PUERTO RICO

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Systematic studies of the presence of cirripeds on marine mammals and sea turtles have been carried out in Florida but not in Puerto Rico. Specimens were collected from stranded whales, manatees and sea turtles in both geographic areas. Barnacles obtained using forceps and blade or by hand and preserved in 70% ethanol. They were dissected with forceps and pliers and the large individuals were cut using a geology saw. Each barnacle was measured and observed with a stereoscope. The measures taken were the diameter, height and the length of its operculum. These morphometric measures were used to establish a better description of each barnacle species found in our samples. In humpback whales, the barnacles species found were *Coronula diadema*, *Coronula reginae* and the pedunculate barnacle *Conchoderma auritum*. On the sea turtles, the species found were *Platylepas hexastylos*, *Platylepas decorata* and *Stomatolepas dermochelys* and over the manatees the species were *Platylepas hexastylos*, *Platylepas decorata*, *Balanus eburneus*, *Balanus amphitrite* and a possible *Chelonibia manati* subspecies in different stages of development. It is necessary to expand our knowledge doing a first description and identification of the cirripeds that can be found in the marine mammals and sea turtles in the island of Puerto Rico and compare these with the species found in Florida.

ENERGETICS OF THE EAST PACIFIC GREEN TURTLE AT A GULF OF CALIFORNIA FORAGING HABITAT

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RESUMEN

Se estudiaron los requerimientos energeticos de tortuga marina prieta en el area de pastoreo o forrageo de Bahía de los Angeles, en la provincia central del Golfo de California, México. Tasas metabolicas en reposo y de actividad fueron medidas en 15 diferentes tortugas marinas con rangos en biomass de 12.73 a 119.09 kg y 47.4 a 96.7 cm de carapacho largo recto. Los animales fueron colocados en una sistema cerrado con un respirometro de flujo para ensayos experimentales. La desviación de oxigeno de aire ambiental (20.94%) para el seguimiento posterior en porcentaje de oxigeno. El reposo y actividad de tasas metabolicas tuvieron un rango de 0.7 ml O^2 min-1kg-1 a 1.9 ml O2 min-1 kg-1 y 1.2 ml O2 min-1kg-1 a 3.3 ml O^2 min-1kg-1, respectivamente. Tortugas activas tienen cerca de dos incrementos de tasa metabolica. En base del modelo del 24-h actividad para este poblacion y conversion de consumo de oxigeno a gasto energetico, una tortuga de 50 kg requeria 2682 kJ d-1 de energia alimenticia. Usando las tasas de asimilación publicadas estimamos que una tortuga prieta requerira un consumo diario de algas marinas de 3.3 % de su biomasa total. Esta información sera de gran utilidad para determinar la capacidad de carga en mantos de algas marinas para pastoreo o forrageo y los requerimientos energeticos de estas amenazadas poblaciones de tortugas marinas.

INTRODUCTION

Juvenile and adult East Pacific green turtles (a.k.a. black turtles, *Chelonia mydas agassizii*) can be found year round in the Bahía de Los Angeles foraging grounds of the Gulf of California (Caldwell 1963, Seminoff 2000). Most of the resident turtles originate from nesting colonies in Michoacán, México, some 2000 km to the south (Nichols et al. in press). The productive waters of this bay have been reported as one of the most important foraging grounds for the green turtle in the Gulf (Caldwell 1963, Cliffton et al. 1982). The turtles' main forage is the red alga, Gracilariopsis lemaneiformis (Seminoff 2000); however, green turtles in this feeding habitat also consume a considerable amount of animal matter (Márquez 1990, Seminoff et al. 1998). Nesting, foraging ecology and movements of this animal have been studied extensively; however, little is known of the daily energetic expenditure and/or food energy requirements within Gulf foraging habitats.

The purpose of this study was to 1) quantify the resting and active metabolic rate of *C. m. agassizii* 2) apply these findings to daily energetic expenditures and 3) quantify daily food-energy requirements.

METHODS

Animals: We measured the resting and active metabolic rates of 15

C. m. agassizii captured near Bahía de Los Angeles, Baja California, México. Animals were housed at the Centro Regiónal de Investigaciónes Pesquera Sea Turtle Research Station. Seven turtles were long-term captives and eight were wild turtles recently captured in the study area. The turtles ranged in mass from 12.73 kg to 119.09 kg and in straight carapace length from 47.4 cm to 96.7 cm.

Oxygen consumption: Metabolic trials were carried out from June to August 2000. Animals were placed inside a closed flow respirometer for experimental trials. Turtles were termed resting if they spent the trial time on the bottom of tank, only lifting head to breath. They were termed active if the trial time was spent in voluntary routine activity. The oxygen deviation from ambient air (20.94%) was used to determine mass specific oxygen consumption. Ambient air was sealed in the respirometer and pumped through CO^2 (soda lime) and water (Drierite) absorbers, and then into an oxygen analyzer (Applied Electrochemistry Model S–3A Oxygen Analyzer). The volume of air inside respirometer was recorded. To determine oxygen consumption in individual animals we used the following equation:

$VO^2 = (\% O^2A - \% O^2P)\ VR$

O^2A = Oxygen in Ambient Air; O^2P = Oxygen in Respirometer - Post Trial;
VR = Volume of Air in Respirometer; VO^2 = Oxygen consumption.

RESULTS

We performed a total of 50 metabolic trials comprising 155 hours of experimental data. Our evaluations presented here are based on only those trials during which turtles exhibited consistent behavior (i.e., resting/active) for the full duration of the trial (n=27) The resting metabolic rate ranged from 0.7 ml O^2 min-1 kg-1 to 1.9 ml O^2 min-1 kg –1 while the active metabolic rate ranged from 1.2 ml O^2 min-1 kg-1 to 3.3 ml O^2 min-1 kg-1. Mean resting and active metabolic rates were 1.10 ml O^2 min-1 kg-1 (SE = 0.10) and 2.24 ml O^2 min-1 kg-1 (SE = 0.14), respectively.

Resting mass-specific oxygen consumption and mass where significantly correlated ($r = -0.72$, $P < 0.005$). Active mass-specific oxygen consumption remained constant with respect to mass and was not significantly correlated ($r = -0.09$). The mean active mass-specific oxygen consumption was more than 2 times greater than the mean resting mass-specific oxygen consumption (Wilcoxon Z = 3.87, $P < 0.0001$).

DISCUSSION

Active turtles had over a two-fold increase in metabolic rate; however, do to the constraints of the respirometer turtles constantly bumped the sidewalls and top of chamber. Turtles in a flow through tank or tethered in a larger tank might be more likely to show the 3 to 10-fold increase as reported by Prange and Jackson (1976) and Butler et al. (1984). There was a significant negative correlation between mass-specific oxygen consumption and mass as expected (Schmidt-Nielsen 1997) The established trend for the decrease in oxygen consumption vs. mass can be depicted by the equation VO^2 = aMb0.75 (Scmidt-Nielsen 1997), our trend was very similar at VO^2 = aMb0.70. Active metabolic rates remained constant with respect to mass as found by Jackson and Prange (1979). Thus, the larger adults are capable of greater relative increases in activity possibly aiding in long distance migrations (Wyneken 1996).

We calculated our daily energetic budgets based on a 36/64 resting vs. active diel activity model (Seminoff et al. this symposium). Based on this model and conversions of oxygen consumption to energy expenditure (Kleiber 1975), a 50-kg turtle would require 2682 kJ d-1 of food energy. Using Bjorndal's (1985) published digestibility estimates this would be equivalent to consuming 304 g d-1 (dry weight) or 1520 g d-1 (wet weight) of seagrass. Thus, a 50-kg black turtle would need to consume 3.3% of its body weight in seagrass daily. Our estimates coincide with those found by other investigators. Fenchel (1979) found that a 170-kg turtle consumed 0.6% of its body mass daily, while Bjorndal (1980) found that a 66-kg sea turtle consumed 218 g d-1 (dry mass), equivalent to 1.6% of its body mass. Thayer (1982) reported that a 64-kg green consumed 280 g d-1 equaling 2.2% of its body mass.

Such information is useful for determining carrying capacity of the local marine alga pastures and establishing energetic requirements for this endangered population. However, caution must be used in our comparisons. Not only do turtles at this site primarily consume a red alga (Gracilariopsis lemaneiformis), they consume a considerable amount of animal matter (Seminoff 2000) and the differing energetic profits of such omnivory are not fully established. To further quantify the relationship between food resources and energy expenditures in *C. m. agassizii*, we plan to perform bomb calorimetry and assimilation rates with G. lemaneiformis and other diet constituents.

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STUDIES ON THE POPULATION GENETICS OF HAWKSBILL TURTLES (*ERETMOCHELYS IMBRICATA*) IN MALAYSIA USING DNA MICROSATELLITES

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Genetic diversity of four populations of hawksbill turtle (*Eretmochelys imbricata*) from Malaysia were analysed using 14 microsatellite markers. High levels of polymorphism were observed with up to 8 alleles per locus and expected heterozygosity of 0.2 to 0.6. Genetic distance between populations ranged from 0.06 to 0.09 and cluster analysis using populations as node showed a clustering of populations according to geographical separations. This indicated that the genetic relationship was associated with the geographical distances. Therefore, these local populations should be recognised, monitored and conserved as separate management units. The results obtained revealed the evidence of 3 genetically differentiated stocks in Malaysian waters; the eastern part of Peninsular Malaysia represented by the Terengganu and Johor populations, Melaka population and Sabah population. This study also showed the potential usefulness of microsatellite DNAs in addressing evolutionary and conservation issues in endangered populations of marine turtles.

THE NEED FOR SEA TURTLE RESCUE CENTER IN TURKEY; A PRELIMINARY WORK

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The incresed number of injured sea turtles in Turkey and the growing public demand for treatment and rehabilitation of injured or sick turtles dictated the need for a Sea Turtle Rescue Center. During the treatment of an injured female in Fethiye (Mugla-Turkey), this idea was initialized and an application is made to the local Manicupiality and the Minister of Environment. This Center will also serve as a sea turtle public awarness facility near the main nesting beaches in Turkey. In the summer of 2000, our camping site for research was served as the place for Rescue Center. This paper will serve as contact information to the both local and international researchers.

INTRODUCTION

Five of the world's seven species of marine turtle occur in the Mediterranean sea, but only two of them nest regularly on the beaches along the Mediterranean beaches: the loggerhead turtle *Caretta caretta* and the green turtle *Chelonia mydas*. Non-nesting leatherback turtle *Dermochelys coriacea*, hawksbill turtle *Eretmochelys imbricata*, and olive ridley turtle *Lepidochelys olivacea* occur, reported by fishermans and found the dead ones, irregularly (Groombridge, 1990). All five are recognised as globally threatened species, the loggerhead is ranked "Vulnerable", the remainder "Endangered" (IUCN, 1988). Hathaway (1972) stated that there are more turtles in the Mediterranean than in any other sea, but Groombridge (1990) noted that no nesting population of marine turtles in the Mediterranean is large by world standards. According to investigations made so far, there may be on average some 2000 female *Caretta caretta* and 300-500 *Chelonia mydas* nesting annually in the Mediterranean (Groombridge, 1990).

On the Turkish coast, using unpublished data (1988-1993) and published sources (Geldiay et al., 1982; Baran & Kasparek, 1989; Canbolat, 1991; Baran et al., 1992, 1994, 1996; Erk'akan,1993; Kaska, 1993; van-Piggelen and Strijbosch, 1993; Yerli and Demirayak, 1996), there are 1000-2400 *Caretta caretta* nests and 600-1000 *Chelonia mydas* nests on 17 different beaches (Fig.1) (with a total length of 140 km.) in Turkey annually. It is estimated that each female lays an average of 3 nests in any season with each female nesting every 2-3 years (Groombridge, 1990).From these figures it can be estimated that approximately 450-900 *Caretta caretta* and 230-400 *Chelonia mydas* females nesting annually on the beaches of Turkey. In addition to these nesting females, the bays near by the beaches represents feeding grounds for both juvenile loggerhead and green turtles (Türkozan and Durmus, 2000). Nearly 2500 km stretch of south-west coastline of Turkey may hold large numbers juvenile turtles. In the Mediterranean, an estimated 50,000-100,000 mature and young turtles are cought each year on longline hooks and in nets destined for fish (Groombridge,1990). It seens to me that offshore mortality is a big problem and precautions should be taken immediately.

Fishing nets, speed boats and lines cause trouble to adult turtles in the sea as they may become entangled and drown, since I have observed only four dead turtles (one *Caretta* in Kizilot, one *Caretta* in Calis, Fethiye, one *Caretta* in Goksu Delta and a juvenile *Chelonia* in Dalyan and 10 (2 *Caretta*, 8 *Chelonia*) in Goksu (reported by Peters and Verhoven, 1992)) stranded up on the beaches all along the beaches of Turkey in different seasons. In general, 50 dead and 100 injured turtles reported to be stranded up to the beaches in every season.

Among the newer threats to turtles is the increasing incidence of fibropapilloma disease. Affected turtles exhibit large external tumours which may impair movement or grow across the eyes or mouth inhibiting feeding, breathing and vision. This disease is documented mainly in the green turtle in which it is common and is thus commonly known as "green turtle fibropapilloma disease" (GTFP). Such disease were not reported so far in the Mediterranean.

RESULTS AND SUGGESTIONS

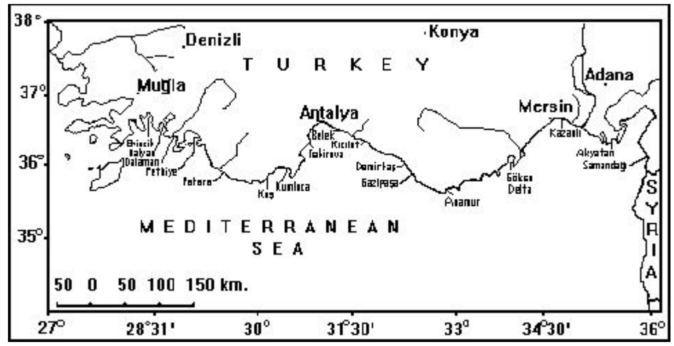
During the nesting season of 2000 on Fethiye Beach, an injured female adult loggerhead turtle were reported us that went to the lagoon of Fethiye. She was hit by a boat from her head. Her skull was seriously injured. We kept her for two weeks in a water tank and made the treatment with collaboration of local veterians. During the treatment, a public awarness were made and an application is also made to the Manucipiality of Çiftlik, near Fethiye for an establishment of Turtle Rescue Center for the future.

This center will serve as rehabilitation to injured and sick sea turtles and an efficient environmental education programme. Transport of turtles to the Centre would be easy since this place is just by the sea and hourbour. There is also an airport just 45 minutes drive-away in Dalaman.

We used tube feeding for that female, since she was very weak. Vitamin tablets, Shrimps and small fishes (sometimes blended) were given to the turtle. Once she started searching for food after 10 days, we released her with an organised ceremony, as an informal treatment of first injured turtle at the Rescue Center.

For the future, we should establish a public awareness against to the turtles and anyone see an injured turtle let us know or bring to the Center. After medical examination and surgery and rehabilitation, we hope to release more turtles in the following years.

Fig. 1. The nesting grounds of the sea turtles in Turkey.



Acknowledgements:

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NEST TEMPERATURES OF LOGGERHEAD TURTLE AT SOUTH WEST BEACHES OF TURKEY

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Temperatures of loggerhead turtle nests on Dalyan, Fethiye, and Patara beaches were examined. Electronic temperature recorders programmed by a computer were placed in the nests. The mean temperatures, incubation periods, the temperature during the middle third of the incubation and percentage of the sexes of hatchling were evaluated. There was considerable interbeach thermal variation. Over all nests, the temperatures recorded, were well-above the pivotal temperature and therefore they produced a female biased sex ratio on Dalyan and Patara beaches, the nests on Fethiye beach produced nearly equal sex ratio.

INTRODUCTION

Sexual differentiation of sea turtle hatchlings is determined by egg incubation temperature, usually during the middle third of development (Yntema, 1979; Yntema and Mrosovsky, 1980; Janzen and Paukstis, 1991; Mrosovsky, 1994; Kaska et al., 1998). Few studies have monitored incubation temperatures in the field, but experiments using artificial nests, or incubators with cyclic temperature fluctuations, suggest that sex is determined as though eggs were incubated constantly at the mean temperature. When eggs are incubated at constant temperatures, there is a narrow range of temperatures over which around 50% of each sex will be produced (pivotal temperature or threshold temperature), and wider ranges above this temperatures produce females and below this threshold produce males (Bull, 1980). For sea turtles, population survival is dependent on the occurrence of a sufficient range of incubation temperatures to produce offspring of both sexes. If the temperature of a nest during the middle third of development is known, then the sex ratio of hatchlings from that nest can be predicted. If in turn this information is known for all parts of a beach throughout a nesting season, then the overall primary sex ratio can be predicted for all hatchlings produced from that beach (Standora and Spotila, 1985). Estimates of the sex ratio have also been obtained by combining the nesting distribution with the sexing of samples of hatchlings from different times during the season by Mrosovsky (1994) or from pivotal incubation durations (Marcovaldi et al., 1997). In this study, only the temperatures were used to predict the sex ratio of a nest, as a continuation of the study (Kaska et al., 1998) about intra-clutch temperature differences of two species of turtles nesting in the Mediterranean, and their sex ratio of these nests by sexing a sample of hatchlings where temperatures were recorded.

MATERIALS AND METHODS

Temperatures of loggerhead turtle nests on the South west beaches of Turkey (Fig.1) were examined. Electronic continuous temperature recorders, launched and offloaded via computer, were placed into the middle of the nests. The mean temperature during the middle third of the incubation period was closely correlated with the percent sex ratio. Temperature was measured using "Tiny talk" temperature recorders (Orion Components (Chichester) Ltd., UK). The device fits within a 35 mm film case. The accuracy of the device was tested under laboratory conditions against a standard mercury thermometer, and they were found to have have a mean resolution of 0.35 ^{o}C (min. 0.3 ^{o}C, max. 0.4 ^{o}C) for temperatures between 4 ^{o}C and 50 ^{o}C. We launched the tiny talk by computer for a recording period of 60 days(Reported incubation period is between 47-60 days for sea turtle nests in the Eastern Mediterranean; Kaska 1993; Broderick and Godley 1996) with readings taken at 90 min. interval. They were placed during the oviposition. The nest was then covered, and protected with wire mesh against dog and fox predation. Temperature data were offloaded to a computer and the middle third of the incubation period was calculated from the total incubation period, from the night of laying to the day of first hatching.

RESULTS

Temperatures of 21 loggerhead nests were recorded on three close Eastern Mediterranean beaches (Dalyan, Fethiye and Patara beaches) during the nesting season of 2000 (Fig.1). The nesting season started at almost the end of May and continued until mid August on all beaches. The majority of the nests were recorded during June and July, since the peak nesting season was during that time. The distances of nest from sea varied between from 15 meters to 40 meters. The depths of top and bottom level of a loggerhead turtle nests were 30-50 cm. The clutch size varied from 65 to 108. The mean temperature of the whole incubation period for all loggerhead turtle nests ranged from 26.1 to 32.9 ^{o}C. Maximum temperature increase during the incubation period for loggerhead turtle nests was 4.6 ^{o}C (min. 26.5 oC , max. 31.1 ^{o}C). Temperature of the middle third of the incubation ranged from 26.8 to 32.3 ^{o}C. All the nests on Dalyan and patara beaches during the middle third of the incubation period experienced above the pivotal temperature. The sex ratio of hatchlings for all nests was also estimated. In the previous study (Kaska et al., 1998) temperatures were recorded and 10-18 hatchlings per nest were sexed, from these results there was a positive correlation between the mean temperature of the middle third of the incubation period (r^2= 0.96) and sex ratio (percent female (Figure 2). From this figure, we estimated the sex ratio that we recorded the temperature of the nests and it can be figure out that the pivotal temperature is for loggerhead turtles in the eastern Mediterranean is about 28.8 °C and 32.4 °C produce all females. Table 1 shows that one nest from Patara beach produced all females, the nests on dalyan beach produced 74.2 % female, the nests of Fethiye beach produced 54.6 %females.

DISCUSSION

Reported sex ratio for sea turtles is generally female dominated (Mrosovsky, 1994; Kaska et al., 1998). There was a female biased sex ratio on Dalyan and Patara beaches, but nearly equal sex ratio on fethiye beach. This may be because of the stones on Fethiye beach, since these may cause some coolness on the nests. Mean incubation temperatures may be adequate to predict sex ratios only in sea turtles that have deep nests which experience little temperature fluctuation (Bull, 1980; Morreale et al., 1982). The results of this work show that mean temperatures during the middle third of incubation period can be used for predicting the of sex ratio. The variety of relationship between pivotal and beach temperatures suggested that diversity of sex ratios in different populations should be expected. Pivotal temperatures for all sea turtle species are reported to lie within a 1 °C range (28.6-29.7 °C), and the variety of relationship between pivotal and beach temperatures suggests that diversity of sex ratios in different populations should be expected (Mrosovsky, 1994). From our results it can be said that the pivotal temperatures for sea turtles in the Mediterranean is 28.8 °C.

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Figure 1. The study beaches.

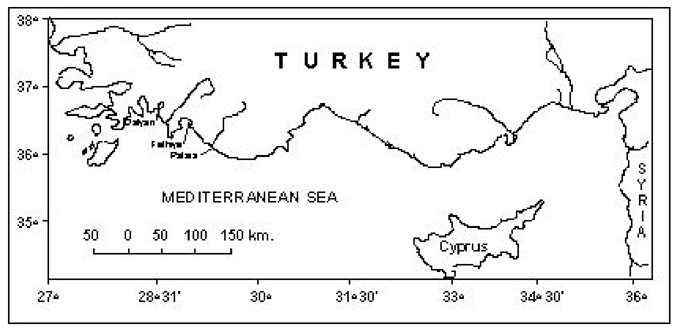
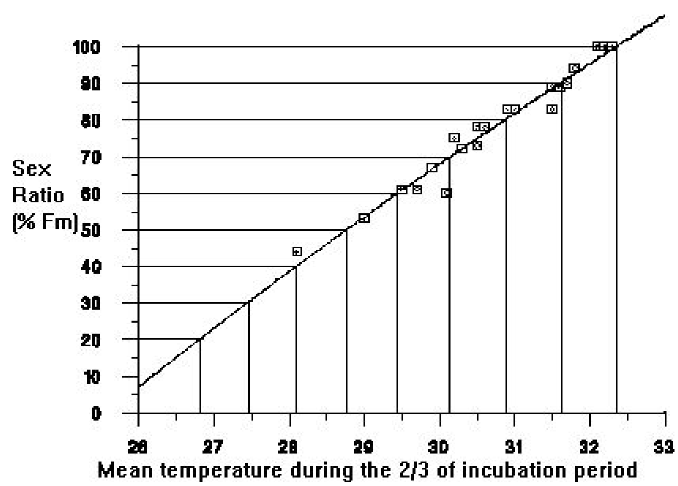


Figure 2. The relationship between the mean incubation temperature and sex ratio.



AN ESTIMATION OF THE TOTAL NESTING ACTIVITY OF SEA TURTLES IN TURKEY

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The loggerhead and green turtles are the only sea turtle species nesting along the shoreline of Turkey. For several years (since 1988) major nesting sites (17 nesting beaches) have been closely monitored and precise nesting data have been collected by mainly researchers from universities. All the information about the nesting data on beaches in different seasons were combined and an estimation of the total number of loggerhead and green turtle nests deposited in a typical season is attempted.

INTRODUCTION

Two species of marine turtle have been recorded as nesting in the Mediterranean; the loggerhead *Caretta caretta* and the green turtle *Chelonia mydas* (Groombridge, 1990). All five are recognised as globally threatened species: the loggerhead is ranked "Vulnerable", the remainder "Endangered" (IUCN, 1988). Hathaway (1972) stated that there are more turtles in the Mediterranean than in any other sea, but Groombridge (1990) noted that no nesting population of marine turtles in the Mediterranean is large by world standards. According to previous investigations, it is estimated that on average some 2000 female *Caretta caretta* and 300-400 *Chelonia mydas* nest annually in the Mediterranean (Groombridge, 1990). Genetic studies have shown that loggerhead turtles originating, most probably, from Florida colonized the Mediterranean Sea about 12,000 years ago (Bowen et al., 1993). According to present knowledge the coasts of Cyprus, Greece, Israel, Italy, Libya and Turkey have nesting populations of both species.

A survey commissioned by the WWF in 1988 studied marine turtles nesting grounds and found 17 sites were determined to be important nesting grounds (Baran & Kasparek, 1989). Since then, researchers from universities and people from NGOs trying to protect turtles on these beaches and counting the emergences and other recording any other nest papametres. The present paper is an attempt to produce an estimate of the overall nesting activity of loggerhead and green turtles nesting along the beaches of Turkey.

METHODS

Collection of the data were almost same on different seasons on different beaches. Students (5-6 on each beach) from Universities were patrolled the beaches during the night and early mornings from the end of May to end of September every season. If there is an incomplate information for the whole season for that beach, that data was omitted or an additonal nesting data were added to total number according to the complete nesting data from entire nesting period for that season. The nesting grounds of the sea turtles in Turkey is shown in figure 1.

RESULTS AND DISCUSSION

There were some differences reported data on the same beach on different seasons. This may be because of the nesting fluctuations between 'good' and 'bad' seasons. The data were present for Dalyan, Fethiye and Patara beaches nearly for every nesting seasons (1988-2000). The data on other beaches were present for 1-3 different seasons. Therefore the data reported in the below table may change slightly if more data collected. Based on project reports and mainly other unpublished data (1988-2000) and published sources (Geldiay et al., 1982; Baran & Kasparek, 1989; Canbolat, 1991; Baran et al., 1992; Erk'akan, 1993; Kaska, 1993; van Piggelen & Strijbosch, 1993; Baran et al., 1994; Brown & Macdonald, 1995; Baran & Turkozan, 1996; Yerli & Demirayak, 1996) it is estimated that there are 1360-2710 *Caretta caretta* nests and 700-1150 *Chelonia mydas* nests on Turkish beaches (with a total length of 178.4 km.) in annually. Using the assumption that each female nests an average of 3 times in a season every 2-3 years (Groombridge, 1990), this means that approximately 453-903 *Caretta caretta* and 233-383 *Chelonia mydas* nest annually on the beaches of Turkey. According to Groombridge's 1990 estimate, at least 25-50 % of the loggerhead and up to 70 % of the green turtles in the Mediterranean could nest on the beaches of Turkey. The protection of these beaches is critical to survival of these species in the Mediterranean.

Acknowledgements:

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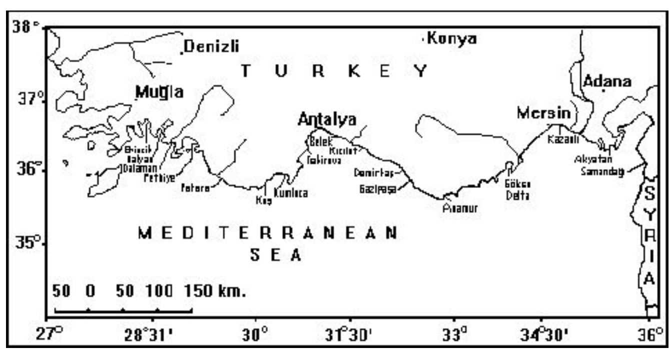
Fig. 1. The nesting grounds of the sea turtles in Turkey



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TEMPERATURE DETERMINED PATTERN OF LOGGERHEAD HATCHLING EMERGENCES IN FETHIYE BEACH, TURKEY

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The sand temperatures were examined in relation to the remergence of loggerhead hatchlings at Fethiye beach, Turkey. Data are presented on the duration of the period over which nests hatched and the preferred time of emergence in reletion to sand temperature profile. Emergence took place for 6 nights (2-9) from 21 pm to 6 am in the morning. Majority of hatchlings emerged between 22 pm and 3 am. Sand temperatures above the clutch at 10, 20 and 30 cm depts were recorded using electronic temperature recorders. In general, decreases in the sand temperatures, during the night, above the clutch were the stimulative factor for emergence of hatchlings.

INTRODUCTION

Emergence of marine turtle hatchlings from their nests during the evening, shortly after sunset, and thermal cues are believed to be important in controlling emergence (Hendrickson, 1958; Bustard, 1967; Witherington et al., 1990). Hatchlings may dig upwards from their nest chamber at any time during the 24 hour period (Bustard, 1972), previous studies have related emergence of hatchling to temperature through the sand column, proposing that emergence of hatchlings is triggered by a negative temperature gradient occuring at sand depths shallower than 15 cm (Hays et al., 1992). However, when approaching the surface during daylight, the hatchlings generally stop digging, presumably in response to high sand temperatures (Bustard, 1967, 1972; Mrosovsky, 1980). Nocturnal emergence among sea turtle hatchlings presumably evolved as a means to reduce mortality due to physiological stress and possibly diurnal predation (Hendrickson, 1958; Bustard, 1972).

Temperature has often been suggested as the main mechanism for controlling emergence, inhibition of the activity by temperatures above 28.5 ^{o}C (Mrosovsky, 1980), 30 ^{o}C (Bustard, 1967), 33 ^{o}C (Hendrickson, 1958) and 30-33 ^{o}C (Bustard, 1972) has been shown in both hatchling and posthatchling sea turtles. The possibility that hatchlings respond to negative thermotaxis has been raised (Mrosovsky, 1980) and temperature gradient in the top 10 cm of the sand column is the main factor controlling the emergence pattern of hatchlings (Gyuris, 1993).The aim of this work was to study the temporal emergence pattern of loggerhead hatchlings on Fethiye beach and compare the the patterns observed to relevant temperature cues.

MATERIALS AND METHODS

We patrolled the Fethiye beach during the night and early in the morning during the nesting season of 2000. Sand temperatures were also recorded just above the clutch (30, 20, 10 cm.) during the hatching period in order to understand emergence pattern of the hatchlings. Temperature was measured using "Tiny talk" temperature recorders (Orion Components (Chichester) Ltd., UK). The device fits within a 35 mm film case. The accuracy of the device was tested under laboratory conditions against a standard mercury thermometer, and they were found to have have a mean resolution of 0.35 ^{o}C (min. 0.3 ^{o}C, max. 0.4 ^{o}C) for temperatures between 4 ^{o}C and 50 ^{o}C. A few days before anticipated date of hatching these temperature recorders were placed just near by the sand column and the number of hatchling emerged from that nest were recorded by two students.

Emerged nests were excavated approximately 1 week after the last emergence, thus allowing completion of the natural emergence process. We determined hatching success by counting empty eggshells and unhatched eggs left in the nest cavity, and we recorded number of dead hatchlings left in the nest column. Unhatched eggs were brought to camp-site, opened and examined for signs of development.

RESULTS AND DISCUSSION

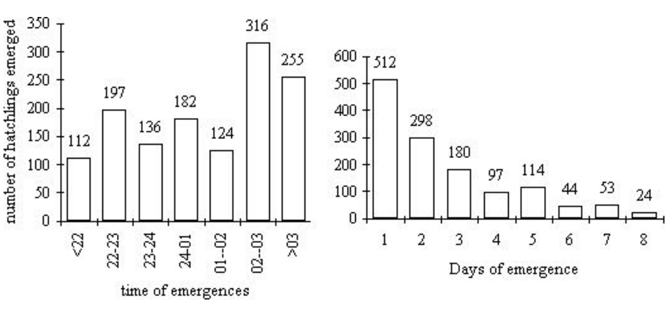
We monitored the times of emergence of loggerhead hatchlings from 22 nests. The mean hatching success of these nests was 75.1%. Hatching times varied between 2100 and 0530 h. But was higher during the 02-03 hours (Fig.1). Hatchlings from these nests always emerged on more than one night. The mean nightly number of hatchlings that emerged from loggerhead turtle nests was higher in the first three hatchings (75%) and then showed a decrease. The data presented in the following graphs. The temperature of 10 cm depth was the coolest during the emergence and the temperature of 20 and 30 cm depths were almost the same. This might be the stimulative factor for emergence of hatchlings.

Sea turtle hatchlings mostly emerge from their nests during the evening and thermal cues are believed to be important in controlling the emergence (Hendrickson, 1958; Bustard, 1967, 1972; Witherington et al., 1990; Gyuris, 1993). It has also been suggested that hatchling sea turtles remain in the eggchamber until their siblings hatch, so that individuals emerge as part of a group and not singly (Carr and Hirth, 1961). We found that hatchlings indeed hatched during the 24 h period, but emerged from the nests only during the night.

Emergence asynchrony for sea turtles was reported previously (Hendrickson, 1958; Witherington et al., 1990; Hays et al., 1992; Gyuris, 1993; Kaska, 1993; Peters et al., 1994). The number of emergences per nest was reported as 1-3 by Witherington et al. (1990), 1.6±0.9 by Peters et al. (1994) and the average emergence span was reported as 8.3 days by Hays et al. (1992) and 2.3±1.9 days by Peters et al. (1994) for *Caretta caretta* hatchlings. Emergence took place for 6 nights (2-9) from 21 pm to 6 am in the morning, but mainly during the first three nights.

Cooling of sand temperatures at 15 cm. was suggested as a cue for the emergence of hatchlings (Hays et al., 1992; Gyuris, 1993). We found that the time of emergence was not correlated with any fixed absolute temperature, and hatchlings emerged during the cooling period of the sand above the nest at 10 cm depth. The temperature of 30 and 20 cm depths were quite close during the emergence. Therefore our results are agree with previous studies.

Fig.1 The time and days of loggerhead turtle hatching emergences on Fethiye Beach.



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NESTING BIOLOGY OF LOGGERHEAD TURTLE ON FETHIYE BEACH, TURKEY

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The nesting biology of loggerhead turtle were investigated on Fethiye Beach during a single nesting season. This beach is about 8 km in length and have been used for tourism. Major problems for turtles on the beach were tourism development, sand extraction, photo-illumination. As a total 348 loggerhead turtle emergences were recorded. Only 110 of these emergences resulted in successful nesting. 17 adult female were tagged. The mean SCL of these females was 69.12±4.62, and SCW was 49.68±4.46. The mean number of eggs per nest was 78 and the mean incubation period for these nests was 52.3 days. The hatchling success was 90 %.

INTRODUCTION

Two species of marine turtle have been recorded as nesting in the Mediterranean; the loggerhead *Caretta caretta* and the green turtle *Chelonia mydas* (Groombridge, 1990). All five are recognised as globally threatened species: the loggerhead is ranked "Vulnerable", the remainder "Endangered" (IUCN, 1988). Hathaway (1972) stated that there are more turtles in the Mediterranean than in any other sea, but Groombridge (1990) noted that no nesting population of marine turtles in the Mediterranean is large by world standards. According to previous investigations, it is estimated that on average some 2000 female *Caretta caretta* and 300-400 *Chelonia mydas* nest annually in the Mediterranean (Groombridge, 1990).

Previous published sources (Geldiay et al., 1982; Baran & Kasparek, 1989; Baran et al., 1992, 1994, 1996; Baran & Turkozan, 1996) showed that Fethiye beach is an important beach for loggerhead turtles holding 100-200 nests annually. The protection of this beach is critical to survival of loggerhead turtles as well as the juvenile green turtles (Turkozan and Durmus, 2000) in the Mediterranean. We investigated the turtle population on Fethiye beach during the nesting season of 2000, and collected the information about nesting females and nests.

MATERIALS AND METHODS

Fethiye Beach has a total length of 8 km on the south-west coast of Turkey (Fig.1). Beach was patrolled continuously by groups of 2-3 people between 2100 at night and 800 in the morning. The use of lights was avoided unless it was absolutely necessary, in order to minimize disturbance to the animals. During the night patrols, after sea turtles had completed their nesting process, body measurements were taken and turtles tagged with metal tags on the right front flipper. Carapace lengths and widths (curved and straight) were measured using tape and wooden calipers. During the morning patrols, the emergensec were recorded and tracks that resulted in nests were marked. Tracks with no nest were counted as non-nesting emergences. The sites of nests and tracks were determined with reference to their distance from numbered poles set at intervals on the beach.

Eggs were counted whenever turtles were found during egg laying or 7-10 days after the first emergence occured. The nests were protected from predators (foxes, dogs) by wire screens buried in the sand 20-30 cm deep above the nest. The number of retained hatchling, empty eggshells, unfertilized eggs, dead-in-shell embryos were counted and the total number of eggs in the clutch determined exactly. Some nests at risk of inundation or nests constructed on the beach vehicle path were relocated to a safer place on same night or the morning of laying.

RESULTS AND DISCUSSION

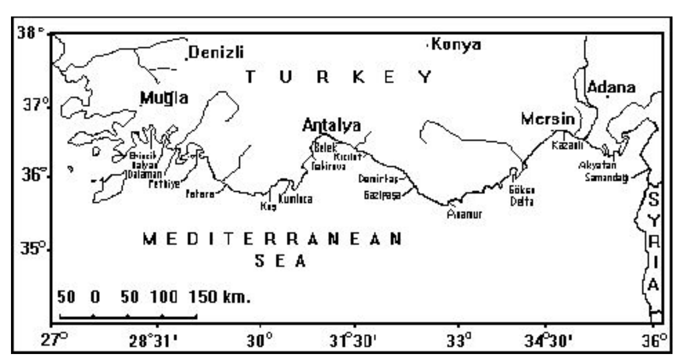
The nesting season of *Caretta caretta* started at the middle of May and continued till the middle of August on the beach. A total of 348 nesting activities were recorded on Fethiye beach, with 110 of these being nests in 2000. From these nests, 10 occurred in May, 64 were in June, 35 occurred in July, and only one of them were laid in August. The number of nests is quite low compare to the number of emergences. One of the reasons for this that the beach consists of large pebbles (stones) in some areas, making it very difficult to record all of tracks and sometimes difficult to record that nest during the hatching period. The actual number of nests on this beach may be higher than we recorded.

A total of 17 adult females were tagged and measured, 13 for the first time, 4 recaptures from previous years. The mean straight carapace length of these females was 69.12±4.62 cm, straight carapace width was 49.68±4.46 and the mean curved carapace length was 75.03±4.77 cm.

The hatching season on the beach began in July and ended in September. After hatching, empty egg shells were counted and the average number of eggs per nest was 78.5*2.9. As a total of 298 eggs were recorded as demolished and no sign of development, 2060 dead in shell embryos, 6200 alive hatchlings. The average incubation period was 52.3.0 *1.0 days. These values lie between the range that reported previously (i.e., Baran et al., 1996).

Five of the nests were relocated. In these nests there were 409 eggs and 343 (83.6%) produced hatchling. As a total of 27 nests screened against predation. Only 354 eggs were predated by dogs and foxes on 6 nests, but 150 eggs were also destroyed by Coleoptera larvae (*Pimelia* sp.) as previously reported (Baran and Turkozan, 1996).

Fig. 1. The nesting grounds of the sea turtles in Turkey.



Using the published data (Geldiay et al., 1982; Baran & Kasparek, 1989; Baran et al., 1992, 1994, 1996; Baran and Turkozan, 1996; Yerli and Demirayak, 1996) and ours, there may be 100-200 nests annually, in other words around 33-70 *Caretta caretta* nest annually on Fethiye Beach, since it is estimated that one in three emergences results in nest and each female lays an average of 3 nests in any season with each female nesting every 2-3 years (Groombridge, 1990).

Acknowledgements:

A.K. would like to thank the David and Lucile Packard Foundation and the Sea Turtle Symposium for travel support and providing the accommodation.

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HATCHING FAILURE OF SEA TURTLE NESTS AT PATARA BEACH, TURKEY

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As a total of 165 adult emergences have been observed during the breeding season of 2000 at Patara Beach, 87 of (52%) these emergences were resulted in nests of which only two of them were belong to green turtle. None of the green turtle nests were hatched. Only 19 loggerhead turtle nests were hatched, majority of them did not hatch mainly due to inundation. Factors negatively affecting the eggs and hatchlings were foxes, dogs, crabs beach erasion and inundation. We suggest that nest relocation against inundation and screening against predation would be very useful in order to increase hatching success.

INTRODUCTION

Two species of marine turtle have been recorded as nesting in the Mediterranean; the loggerhead *Caretta caretta* and the green turtle *Chelonia mydas* (Groombridge, 1990). All five are recognised as globally threatened species: the loggerhead is ranked "Vulnerable", the remainder "Endangered" (IUCN, 1988). Hathaway (1972) stated that there are more turtles in the Mediterranean than in any other sea, but Groombridge (1990) noted that no nesting population of marine turtles in the Mediterranean is large by world standards. According to previous investigations, it is estimated that on average some 2000 female *Caretta caretta* and 300-400 *Chelonia mydas* nest annually in the Mediterranean (Groombridge, 1990). We investigated the turtle population of Patara beach during a single season.

MATERIALS AND METHODS

Patara Beach has a total length of 11.8 km on the western border of Antalya, and is bisected by Esen Çay. Beach was patrolled continuously by groups of 2-3 people between 2100 at night and 800 in the morning. The use of lights was avoided unless it was absolutely necessary, in order to minimize disturbance to the animals. The sites of nests and tracks were determined with GPS (Global Positioning System).

Eggs were counted whenever turtles were found during egg laying or 7-10 days after the first emergence occured. Beaches were inspected before sunrise every morning to determine nests with hatchlings, following the trails that were left on the sand. The number of hatchlings disorientated by the lights and/or eaten by predators, was determined by following and counting, when it is possible, their tracks. Hatching usually took place over a few day but the incubation period was defined as being the time elapsed from oviposition to first emergence of the hatchlings. The nests were protected from predators (foxes, dogs) by wire screens buried in the sand 20-30 cm deep above the nest.

RESULTS

The nesting season of *Caretta caretta* started at the middle of May and continued till the middle of August on the beach. A total of 165 nesting activities were recorded on Patara beach, with 87 of these being nests. Only 2 of these were green turtle nests, 85 were loggerhead nests.

Only 19 nest produced hatchlings, 24 nests were predated primarly by foxes and ghost crabs. The locations of 2 nests were lost, these were either false crawls or we could not find the egg chamber. The remaining 42 nests were inundated. Because of the sand erosion on Patara beach, the overall hatching success was very low . During the investigation season, 42 (48%) nests on Patara were inundated by the high spring tides. The reason for 48% of the nests exposed to wet area is the wind erosion on Patara Beach.

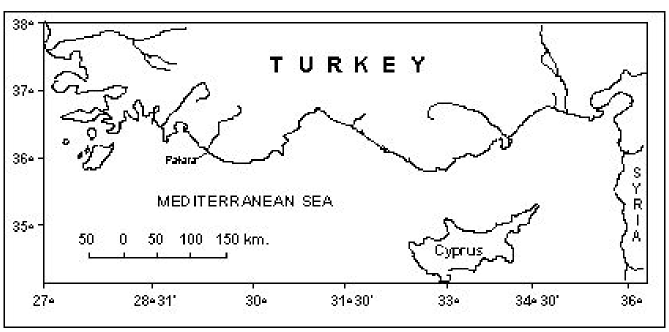
The hatching season on the beach began in July and ended in September. After hatching, empty egg shells were counted and the average number of eggs per nest was 69.5[S.E.=*2.9] (n=25) on Patara Beach. The average hatching success was 22.35% [S.E.=*4.0] was on Patara Beach. The average incubation period was 60.0 [S.E.=*1.0] days for 19 hatched nests on Patara Beach.

DISCUSSION

Using the published data (Geldiay et al., 1982; Baran & Kasparek, 1989; Baran et al., 1992, 1994, 1996; Kaska, 1993; Yerli and Demirayak, 1996) and ours, there may be 70-150 nests annually, in other words around 25-50 *Caretta caretta* nest annually on Patara Beach, since it is estimated that one in three emergences results in nest and each female lays an average of 3 nests in any season with each female nesting every 2-3 years (Groombridge, 1990).

Foxes, dogs and ghost crabs were common predators to nests and hatchlings on beaches. Human activities (sticking the umbrella poles into the nesting beach, digging in the nest, sand extraction, vehicular pressure, building fire...etc.) and natural dangers (beach erosion, high tides, rainfalls) can damage eggs in nests. The main nest predators were dogs and foxes which excavate the nests while ghost crabs have a minimal impact as they tend to predate single hatchlings after they have emerged from the nest or scavenge remaining from nests predated by dogs and foxes.

Figure 1. The location of Patara Beach.



During the investigation season, high number of nests were inundated by the high spring tides. The reason for 48% of the nests exposed to wet area is the wind erosion on Patara Beach. Behind the beach a fence is erected for forestation purposes. In summer, off shore winds blow sand up the beach piling it against the fence and eroding the sand depth close to the sea. In winter, on shore winds would normally blow sand back, restoring the depth at the shore, but the fence reduces this effect with the overall result being that sand depth close to the sea has been reduced. The fences on Patara may help the hatchlings to orientate correctly but there is a side affect because of the wind erosion.

If a turtle lays a clutch of eggs at an unsuitable site, consideration may be given to relocating the eggs to an artificial nest constructed at a more suitable location. Therefore, we suggest that relocation of the nests on Patara beach should be done in order to increase hatching success.

Acknowledgements:

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COMMUNITY-BASED CONSERVATION IN GUATEMALA

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BACKGROUND AND RATIONALE

Sea turtle nesting occurs on both coasts of Guatemala [Baillie and Groombridge, 1996]. Laws meant to protect sea turtles and eggs are not enforced, and egg poaching is widespread [Muccio, 1998]. On the Caribbean coast, nesting occurs on the Manabique Peninsula [Rosales-Loessener, 1987], much of it in the area of Jaloa, a tiny community mid-way along the outer shore, two hours from the nearest city by boat. A small population of "Critically Endangered" [cf. Baillie and Groombridge, 1996] hawksbill turtles (*Eretmochelys imbricata*) appears to be the predominant nester. Precise data on the distribution and abundance of annual nesting are lacking.

PROJECT DESCRIPTION

Proyecto Tortugas Mar Caribe, a community-based sea turtle research and conservation project in Jaloa, has been working to respond to community desires to be involved in the monitoring and management of the local sea turtle resource. The Project is sponsored by the Rotary Club of Puerto Barrios, in collaboration with the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) and the Caribbean Conservation Corporation (CCC), both international nonprofit organizations working to protect sea turtles and their habitats in the Caribbean region.

In a 2000 pilot project, a team of experienced egg collectors from the coastal community of Jaloa was hired by the Project to monitor a 10-kilometer (6-mile) section of beach adjacent to their homes. They patrolled nightly for 3 months and relocated 34 sea turtle nests to a protected area within the community. Each of the 13 members of the team - representing 85% of Jaloa families - was paid a weekly salary of Q100 (US$ 13.30), funded by a private donation through CCC and administered by the Rotary Club of Puerto Barrios. Bi-weekly Project meetings open to all members of the community provided a discussion forum for sea turtle issues, as well as for general community concerns.

Children also become involved. They participated in documenting dead turtles and in nest excavation; they created sea turtles (among other things) in art projects and presented a sea turtle story for visitors; and they recycled aluminum cans, which were sold in Puerto Barrios. With a view to participate in larger environmental issues that were of concern to them, the entire community set aside used batteries to be removed from the peninsula. These results were inspiring, even though (because there was no teacher at the Jaloa school with whom to collaborate during the Project), our educational, artistic, and related activities were less extensive than planned.

RESULTS AND ACHIEVEMENTS

The pilot project enjoyed the endorsement of CONAP ([Guatemala] National Council on Protected Areas). CONAP Region III/Northeast and RECOSMO staff in the Puerto Barrios office (CONAP/RECOSMO) were particularly helpful in providing advice and office support throughout the Project. As a result of the support we had locally, nationally, and internationally, we are proud of a number of achievements in 2000, including:

* Monitoring of the 10-km study site every night for 12 weeks (June 19 - September 10);
* Construction of a hatchery within the community where egg clutches found on patrol were reburied and protected throughout the study period;
* Documentation of three species nesting – hawksbill, green turtle (*Chelonia mydas*), and leatherback turtle (*Dermochelys coriacea*) [leatherback nesting was only reported north of the patrolled study site];
* Documentation of international movement by green turtles, in that a female originally tagged in Mexico nested north of the patrolled study site;
* Valuable lessons learned about suitable (and unsuitable) hatchery locations;
* Data compilation, including nesting and non-nesting emergences, dead [stranded] turtles, and preliminary information on nest fate;
* Collection of tissue samples for genetic analysis;
* Compilation and evaluation of anecdotal information on nesting and dead turtles reported outside the study area; and
* Establishment of a foundation of teamwork and advance planning as the basis for further study and conservation activities.

Incomplete hatch information is available for 2000. In future years, hatch data will be included in reports. In fact, most Proyecto Tortugas nests did not hatch. There are two likely reasons for this: (i) nests became overgrown with vegetation (the hatchery was in a low grassy area, chosen because it was farther from the water's edge and presumably safer than in a higher, sandy spot) and (ii) ground water in the hatchery was too high (meaning that eggs were reburied at depths more shallow than at their original sites, with sand piled on the surface to compensate). Both factors influence nest temperature, moisture level, and gas exchange, which in turn negatively affected the hatch rate. In 2001 the hatchery will be located away from thick vegetation (in habitat more closely resembling natural nesting habitat) and moisture and temperature will be monitored.

Egg rotation is another possible factor in the low hatch rate. Initially the patrol carried eggs in plastic bags where the eggs were exposed to considerable jostling and movement. Later, knapsacks containing (stiff) plastic wastepaper baskets kept the eggs stationary during transport. Rotation poses a threat to sea turtle eggs that are not exhumed and relocated in a timely way [Eckert et al. 1999]. The time between a nest's being found and the eggs' being reburied in the hatchery averaged 5 hours. In most cases the turtle was not seen; therefore, the time between egg deposition and reburial was even more.

After the first nests failed to hatch, the community made the decision that a higher and drier location was worth the risk of erosion and built a second hatchery closer to the water's edge. Nests 22-34 were reburied there. In September the first nine nests were excavated (with a lot of help from the children) and no visible signs of development were found. Samples were taken from each of these nests for genetic analysis.

The low hatch rate was discouraging to all involved with Proyecto Tortugas and especially so for the community. However, the hatchlings the project did produce represent an enormous increase over the hatch rate for eggs going to market, which, in the absence of the Project, would have been the fate of all eggs laid that year. Important too is the experience gained by the patrol team and by the community. The lessons - in the complexities of hatchery management, for example - will be invaluable in future seasons. Hands-on experience is especially important in this isolated community which is resistant to information from outsiders and is without access to print resources, given the low rate of literacy and the scarcity of materials.

FUTURE PLANS

I. 10-KILOMETER STUDY AREA (JUNE 19 - SEPTEMBER 10, 2000)

Nests	
Total nests relocated:	34
Nests poached:	1
Total nests:	35
Tags	
Nesting females observed - tagged:	1
Nesting females observed - not tagged:	5
Total turtles observed:	6
Strandings	
Dead turtles reported:	3
Of these, documented by photo:	2
Non-nesting emergences	
Non-nesting emergences or "false crawls":	37

Species

With the exception of one nest of a green sea turtle (Chelonia mydas), all nests were reported by the patrol to be those of hawksbills (Eretmochelys imbricata).

Eggs

For the 33 nests reported to be those of hawksbills, original egg clutches ranged from 48 to 188 eggs per nest, the average being 143 eggs.

The nest of the green turtle contained 109 eggs.

Approximately 4570 eggs were relocated to the Jaloa hatchery. This number excludes eggs broken - at the original nest sites (8 eggs) or in transit (1 egg)

The tagged female observed was a hawksbill tagged during a 10-year Guatemalan project, discontinued in the late 1990's, for which data were not maintained and, therefore, are not available.

II. OUTSIDE OF THE STUDY AREA

According to anecdotal information, the majority of Year 2000 nesting activity on the Manabique Peninsula outside the study area (57 nests) occurred in the 10 to 15 kilometers north of Jaloa. Reports included nests of a leatherback and of a tagged green sea turtle. Unfortunately, the tag number reported was short a digit, so biologists contacted in Mexico, where the tag originated, could identify the turtle only as a green tagged in Quintana Roo in the mied-1990's.

In 2001, the project will:

* Increase data collection by extending the study period to 6 months (May - October) and the study site (beach length) to 12 kilometers;
* Improve nest relocation techniques, especially toward reducing egg rotation;
* Improve hatchery management, including the addition of moisture and temperature studies;
* Provide a series of environmental education lessons in regularly scheduled visits over 4 months to 18 village schools (including the Jaloa school and six others on the Manabique Peninsula) and to three city schools in Puerto Barrios/Santo Tomas and in Livingston; and
* Establish a media campaign to promote sea turtle conservation, particularly in the coastal cities of Puerto Barrios/Santo Tomas and Livingston.

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ASSESSMENT OF IMMUNE FUNCTION AND PRESENCE OF CONTAMINANTS IN THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*)

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Environmental contaminants such as polychlorinated biphenyls (PCBs) and organochlorine (OC) pesticides suppress the immune system of a wide variety of species (Faisal et al., 1991; Grasman et al., 1996; Ross et al., 1996). This study examined the relationship between the presence of these contaminants in fat tissue and measurements of the immune system in the loggerhead sea turtle (*Caretta caretta*).

Thirty-eight PCBs and ten OC pesticides were detected in fat biopsies taken from 21 live, juvenile loggerhead turtles from Core Sound, North Carolina. The total PCB concentrations ranged from 61.3 to 4550 ng/g lipid (or 7.99 to 1080 ng/g wet weight) with a mean and standard deviation of 1300 ± 1100 ng/g lipid (or 247 ± 249 ng/g wet weight). The total DDT (sum of 2,4'-DDE, 4,4'-DDE, 2,4'-DDD, 4,4'-DDD, 2,4'-DDT and 4,4'-DDT) concentrations ranged from non-detectable to 1950 ng/g lipid (or non-detectable to 287 ng/g wet weight) with a mean and standard deviation of 403 ± 425 ng/g lipid (or 81.7 ± 80.2 ng/g wet weight).

Using the Spearman Rank Correlation Test, we compared the contaminant concentrations to the differential white blood cell (WBC) counts from a subsample of 13 turtles. The composition of the WBCs significantly correlated to pollutant concentrations in these animals. Turtles having higher concentrations of PCBs and pesticides exhibited a lower percentage of circulating lymphocytes and a higher percentage of eosinophils. For example, total PCBs correlated to decreased lymphocytes ($R_s = -0.569$; $p < 0.05$) and to increased eosinophils ($R_s = 0.643$; $p < 0.05$).

Eosinophils, as well as heterophils and basophils are categorized as granulocytes or cells that perform non-specific immune functions, while lymphocytes perform specific immune functions. The ratio of granulocyte concentration to lymphocyte concentration is elevated during a response to stress (Gross and Siegel, 1983). This ratio was significantly and positively correlated ($p < 0.05$) to concentrations of penta-chlorinated PCBs ($R_s = 0.643$), hexa-chlorinated PCBs ($R_s =$

0.582), di-ortho chlorinated PCBs (Rs = 0.566) and total PCBs (Rs = 0.582), as well as to oxychlordane (Rs = 0.680) and mirex (Rs = 0.674).

The results presented in this study imply that current levels of contamination found in juvenile loggerhead sea turtles may affect their immune system. Therefore, future studies should be conducted to determine whether a cause and effect relationship actually exists. Studies should not only focus on counting white blood cells, but also on assessing the functional role that those cells play in the immune system.

Acknowledgements:

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MARINE TURTLES IN THE WILD. 2000 – A WWF SPECIES STATUS REPORT

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What WWF has Done

Since it was founded in 1961, WWF has supported numerous sea turtle conservation efforts worldwide. Much of the early work involved mapping the distribution of nesting beaches, with surveys in more than 40 countries. Other projects focused on survival of eggs and hatchlings, establishment of protected areas, research into sea turtle biology, ecology and behaviour, monitoring the trade in turtle products, investigating the threats from fisheries, and sponsoring international conferences and workshops on sea turtle conservation. WWF assisted in the creation of what was to become the IUCN/SSC Marine Turtle Specialist Group (MTSG). "The present world situation for the great marine turtles is tragic," said a Statement issued after the First Working Meeting of Marine Turtle Specialists organized by IUCN in 1969. Describing 20th-century population declines as "cata-strophic", biologists called for a variety of conservation mea-sures, more public awareness campaigns, and international cooperation for turtle protection. WWF swung into action immediately, funding surveys throughout the 1970s along the coasts of southern Africa, Australia and Latin America. In 1979, WWF supported the first World Conference on the Conservation of Sea Turtles, and helped set in motion an Action Plan of 137 urgent projects. For WWF 1980 was the "Year of the Turtle".

In the past 30 years, biologists have started to explore the mysteries of turtle migrations by tagging adult and immature turtles and more recently by using satellite technology. From these studies, it has become apparent that regional approaches to turtle conservation are needed. Because of the great mobility of these animals, vast numbers of turtles are vulnerable throughout their ranges to a myriad of threats, including intentional hunting/trapping and incidental capture in fishing nets. While WWF continues to support national efforts to conserve sea turtles, it is increasingly focusing on regional approaches to conservation in the Mediterranean, Indo-Pacific, eastern Pacific and Caribbean. In 1999, WWF co-funded production of a state-of-the-art publication, Research and Management Techniques for the Conservation of Sea Turtles, prepared by the IUCN/SSC Marine Turtle Specialist Group.

What Needs to be Done

Six of the world's seven species of marine turtles are threatened with extinction. Many populations which were abundant 100 to 200 years ago are now depleted, declining or remnants of their former size. Local extinctions have occurred in all ocean basins, and no population, not even those that are stable as a result of long-term conservation and management, is completely safe. Marine turtles present enormous conservation challenges because they grow slowly and require numerous and diverse habitats as they mature. They also move great distances in their lifetimes, frequenting the waters of many nations and must come ashore to lay their eggs. Although marine turtles are ancient creatures, the science of marine turtle biology is relatively new. Scientists have amassed a great deal of data about the amazing life history of these animals, but as one set of questions is answered, new ones emerge. In recent years powerful new tools, such as genetic analysis and satellite telemetry, have been developed to answer the riddles surrounding marine turtles, but much remains to be discovered, and much needs to be done.

The following activities need to be undertaken:

Carry out long-term conservation action

Clear and comprehensive conservation programmes are needed everywhere if marine turtles are to survive well into the future. Ensuring many populations recover to abundance (so that turtles can fulfill their ecological roles in the marine environment) is a necessary goal. Recognizing that regional cooperation and collaboration are essential to marine turtle conservation and management, resource managers have started international initiatives, collaborating with near and distant neighbour nations. More is needed. Long-term commitments to conservation are essential. Those started long ago are reaping rewards. Some depleted nesting populations, such as green turtles in Malaysia, loggerheads and leatherbacks in South Africa, and hawksbills and Kemp's ridleys in Mexico, have stabilized and increased in recent years. But this is after more than two decades of protection and management. While the future of these populations remains tenuous, their improved status demonstrates the value of focused conservation efforts.

Develop regional conservation and management programmes

Marine turtle conservation and management need to be addressed regionally so that activities in one area do not undermine (but complement) programmes in others. Breeding and feeding areas are often widely separated, and within each region, critical nesting, foraging, resting and migration areas for each species must be identified and formally protected. Conservation hotspots in each region should also be identified so that attention can be focused on resolving problems, such as overexploitation of feeding grounds in one country where turtles from other nations may congregate. Regional agreements that provide legal frameworks, such as the Inter American Convention for the Protection and Conservation of Sea Turtles and an initiative in the Indian Ocean to negotiate a treaty for marine turtles, need to be sup-ported. Successful regional programmes must involve the participation of numerous sectors and include participants from the local to national to international level. To date, regional networks of biologists, conservationists, and resource managers have evolved in Southeast Asia, the South Pacific, the Mediterranean, Latin American, and the wider Caribbean, while new groups are emerging in the northern and western Indian Ocean, Arabian Gulf and Eastern Atlantic. These networks need to be strengthened, thus ensuring that cooperation, collaboration and the sharing of information, such as through regional databanks, should be promoted on all levels. Financial support from governments and donor organizations is also needed.

Reduce accidental capture in fisheries

After the shrimp trawl fishery was identified as a major source of mortality in the early 1980s, net inserts or Turtle Excluder Devices (TEDs) were developed to allow entrapped turtles (and other bycatch) to escape. Although TEDs are used widely in the western hemisphere, they are not employed extensively in shrimp and other trawl fisheries around the world. Mortality in longline fisheries for pelagic species such as swordfish and tuna is a grave and increasing threat, as these fisheries, which set billions of hooks each year, continue to expand. Marine turtles swallow longline hooks or become entangled in lines and drown. Many animals that are released alive but with hooks embedded in their gastro-intestinal tracts subsequently succumb to their injuries. Modifications to hooks and bait, as well as area and seasonal closures, will be needed to address this problem satisfactorily. Marine turtles are also captured and drowned in various gill net fisheries and in the lines of fish traps. Programmes to reduce mortality through modified gear and fishing techniques, or closing particular areas at particular times, are needed. Fishermen should be encouraged to assist in these efforts.

Enforce CITES, laws and agreements

Most species of marine turtles have been prohibited from international trade since 1975 when CITES came into force. By 1981, all marine turtle species were listed on Appendix I of CITES. This list prohibits trade by all CITES member nations. However, Japan continued to import large quantities of green, olive ridley and hawksbill products until the early 1990s under "reservations" or exceptions to the CITES listing. In 1992, Japan agreed to comply with CITES and stop marine turtle trade and retrain the bekko or tortoise-shell artisans. Today, more than 140 countries have acceded to CITES, but tortoiseshell jewellry, turtle oil and stuffed turtle curios are still entering international trade. Marine turtles and their parts are sold in tourist markets and inter-national airports in many areas of the western hemisphere and Asia. WWF encourages CITES member nations to stop illicit international trade and urges all countries to pass and implement national laws and regional agreements to conserve marine turtles.

Protect marine turtle habitat

Marine turtles move in and out of ocean and coastal habitats as they grow and mature. Although crucial nesting and for-aging habitats can be conserved within national parks and marine protected areas, other areas utilized exceed the capacity of any government to provide full protection. Marine turtle conservation requirements should be included in coastal zone management plans as well as ecosystem conservation programmes. Regulations for maintaining water quality and contingency plans for oil and chemical spills are critical to maintain the health and productivity of the ecosys-tems on which marine turtle depend. The threats posed by dynamite fishing, marine debris, and oil pollution should be eliminated. Where necessary, legislation must be encouraged, such as lighting restrictions on nesting beaches. Erosion, accretion, sand mining, and foot and vehicular traffic on nesting beaches also need to be addressed to ensure that nesting females, eggs and hatchlings are protected. Long-term monitoring programmes are also critical to assessing the impact on these habitats.

Support development of sound ecotourism based on marine turtles

Sound ecotourism not only benefits local guides, food vendors, and small hotel operators, but, as shown by the cooperatives run by Projecto TAMAR in Brazil, can also help support entire communities. In Tortuguero, Costa Rica, the village's major source of income is generated by tourists who visit the area to see its famous green turtles: in recent years the influx of visitors has enabled the community to install electricity and other modern amenities. These programmes demonstrate that living marine turtles can be more beneficial to coastal communities as "renewable" resources rather than harvested resources which are only used once.

Develop guidelines for use

Recognizing that some communities are dependent on marine turtles and their eggs, WWF supports the need to develop guidelines for use, with the goal of ensuring use is sustainable and these programmes benefit local coastal people. Opinions vary about what constitutes sustainable use of marine turtles. Thus, in developing guidelines, resource managers and biologists have to address the status of the population within its full range. Various approaches will need to be explored, such as weighing the value of an adult female for her production of eggs versus meat or harvesting nesting turtles that come ashore after a number of breeding seasons. In many countries harvest regulations focus on the wrong part of the population because they protect sub-adult turtles at the expense of adult breeders. Although egg collection is less controversial, these programmes are not without problems, as in the case of an authorized egg collection for one species that jeopardizes the eggs of other species needing full protection. Egg collection programmes need to be flexible enough to ensure that a sufficient proportion of eggs successfully hatch each year.

Support sea turtle research

Many gaps in our knowledge of marine turtle biology still exist, such as how many hatchlings survive to reach maturity or how long marine turtles live. While "full knowledge" is not necessary to make many informed decisions about conservation and management, additional research is needed about factors that affect health, reduce reproductive output, or address the ecological roles of marine turtles in their environment. For example, in the last ten years, scientists have become increasingly concerned about the impact of fibro-papillomas, debilitating and life-threatening tumour-like growths found in all species, but especially in green turtles. The effects of pathogens, pollutants and climate changes on sea turtles also need to be determined. While it is impossible to determine how depleted populations may have functioned when they were more abundant, studies demonstrate that nutrients from turtle eggs and egg shells play a critical role in maintaining the roots of beach grass and the stability of the associated dune ecosystem while offshore seagrasses regularly grazed by green turtles are more productive.

Promote public awareness and education

For many populations of marine turtles around the world, the day-to-day support of local coastal communities is crucial to their survival. Public awareness and educational programmes to instill understanding and appreciation are the cornerstones of local and national initiatives to conserve marine turtles. In Greece, for example, programmes developed by Archelon – the Sea Turtle Protection Society, reach thousands of school children and visitors to turtle beaches each year. This growing public awareness has enabled the government to establish the National Marine Park of Zakyanthos, a major loggerhead nesting area in Greece. Other sectors of society that need to be targeted include developers, industrialists, and the media. Only by understanding the needs of marine turtles will they be encouraged to address the threats these species face.

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ETHOGRAM OF THE NESTING FEMALE OLIVE RIDLEY

Dianna Kibler and Duane McPherson

SUNY Geneseo

The nesting behavior of the olive ridley (*Lepidochelys olivacea*) was studied and filmed on a beach in Ostional, Costa Rica in January 1999. The nesting process was identified as having ten phases, each involving many different behavior patterns. Individual turtles varied slightly in their behaviors performed in each phase. Some phases involved highly predictable patterns in which the sequence of movements and actions were the same for all turtles studied. Two such predictable (and innate) behaviors include excavation of the egg chamber and laying of the eggs. Some transitions between phases were easy to delineate, such as the transition from egg laying to filling-in the egg chamber. This transition appears to result from not having any more eggs to lay, or alternatively from the sensation that the egg chamber is full. Terminations of other phases were more difficult to delineate, such as completion of the body pit or packing of the nest site, since they are likely to be influenced by the environmental surroundings, and by individual female selection. In almost all phases of the nesting process all four limbs are utilized. In some phase all limbs are used to move sand. In other phases, such as egg chamber excavation, only the hind fins move sand while the front fins support and rotate the body.

NESTING ACTIVITY AND THE MORTALITY OF NESTS ON TWO LEATHERBACK NESTING BEACHES IN GRENADA, WEST INDIES.

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Ocean Spirits Inc. , Ocean Spirits P. O. Box 1373, Grand Anse, St. Georges, GRENADA, West Indies

Two leatherback (*Dermochelys coriacea*) nesting beaches were monitored during the year 2000 nesting season in Grenada, West Indies. Both Levera and Bathway beaches were surveyed every morning for nesting activity. 66 Nests were identified on Levera beach and 45 on Bathway, a total of 111 nests. Concurrent surveys of poaching activity showed that a total of 81 nests (73%) were harvested during the nesting season (March to July).

Observations made of egg poaching activities concluded that less than 10 individuals were responsible for the majority of the take. Personal communication with local people and a number of turtle egg consumers indicated that their motivation was habitual rather than for financial gain. Legislation in Grenada prohibits the harvest of eggs from 1st May until 31st August. No action was taken against violators during 2000.

Activities planned for the 2001 nesting season include continued monitoring of leatherback nesting beaches, the introduction of community forums, turtle watching trips, a hatchery and the disemination of educational materials. Through these activities we hope to illustrate to the local community the value of sea turtles as a resource for use in ecotourism.

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TEMPORAL TRENDS IN TWELVE YEARS OF SEA TURTLE NESTING AT INDEX NESTING BEACHES IN FLORIDA, USA

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Daily surveys of sea turtle crawls (track evidence from nesting attempts) on nesting beaches are one of the most widely used indicators of sea turtle abundance. In Florida, USA, this evidence of sea turtle nesting activity is recorded within the Index Nesting Beach Survey (INBS) program. Consistent, standardized methods of the program allow accurate expressions of sea turtle nesting trends that are not biased by changes in monitoring effort. Here, we outline temporal and spatial trends in the nesting of three species using Florida beaches, loggerheads (*Caretta caretta*), green turtles (*Chelonia mydas*), and leatherbacks (*Dermochelys coriacea*).

STUDY LOCATIONS AND METHODS

The Index Nesting Beach program comprises 32 beach sites that represent the sea turtle nesting beaches of Florida. Each beach is divided into zones approximately 0.8 km in length. The season that INBS surveys take place also is representative and is standardized among beaches to begin 15 May and end 31 August each year. Index Nesting Beach Surveys represent approximately 67%, 74%, and 34% of loggerhead, green turtle, and leatherback nesting, respectively. To examine temporal nesting trends, we used a core set of index beaches totaling 316 km in length where surveys were conducted 1989-2000. Florida index beaches are monitored each nesting season by a network of trained surveyors who follow a standardized protocol for crawl identification, survey methods, and data reporting. Surveyors conduct daily appraisals of tracks that have resulted from nightly nesting attempts by female turtles. The accuracy of morning track surveys was tested during several seasons by observing nesting turtles at night on a sample of beach sites and by comparing these verified nest/species identifications to the crawl observations made by surveyors the following morning. The error rate in nest identification is 7.5% for loggerhead tracks (n = 451) and 12% for green turtle tracks (n = 41). The error in species identification is 1.5% (n = 139).

RESULTS

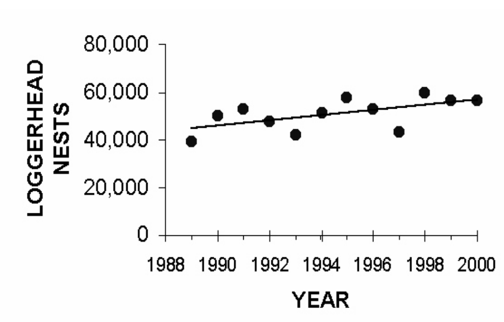
The spatial distribution of loggerhead and green turtle nesting was similar, each having multiple peaks in nesting on the Atlantic coast between latitudes 27° and 29° N. Leatherback nesting was largely restricted to the Atlantic coast between latitudes 27° and 28° N. The annual number of loggerhead nests at the core set of index beaches ranged 39,091-59,918 nests (mean = 50,762), green turtle nests ranged 267-6240 (mean = 1759), and leatherback nests ranged 30-230 (mean = 89) for the period 1989-2000. Annual nesting for each of the three species increased significantly during the 12-year period (Figs. 1-3). Nesting numbers for green turtles showed a clear biennial periodicity, with odd years having low nesting and even years having high nesting, during the 12-year period. To reduce variation for linear regression, we grouped green turtle nesting into two-year (high-nesting/low-nesting) blocks (Fig. 2). To examine spatial trends, we combined INBS zones into 10 beach groups and plotted nesting trends for each group (Figs. 4 and 5). Correlation coefficients describing twelve-year slopes at each surveyed beach show considerable variation in temporal trends among beaches for both loggerhead and green turtle nesting.

DISCUSSION

Annual nesting of loggerheads, green turtles, and leatherbacks in Florida all increased during the period 1989-2000. However, these increases are not observed in every region of the state. Although significant nesting increases for loggerheads were seen in the southwest and central east-coast, regions of Florida, southeast Florida did not show this trend. Green turtle nesting seemed to have increased significantly at beaches where there were sufficient data, with the most prominent increases on southeast and central east-coast beaches. Leatherback nests were too few to divide this way among beach groups.

It is important to understand the limitations of our assessment of nesting trends in helping to determine the status of sea turtles in Florida. The sea turtle nesting trends we portray are a retrospective look at the previous 12 years and do not forecast future nesting. Moreover, these trends describe only the segment of each turtle population that comprises adult females visiting nesting beaches. Because these trends are an index of the oldest members of the population, they lag decades behind events that affect their numbers.

Figure 1. Loggerhead nests counted at index beaches in Florida, USA, during the period 1989-2000 (r^2=0.35, p=0.044). Survey effort did not vary among years. Nesting on index beaches represents approximately 67% of loggerhead nesting in the state of Florida.



Acknowledgements:

The Index Nesting Beach Survey program was conceived Barbara Schroeder, Alan Huff, Earl Possardt, Lew Ehrhart, Anne Meylan, Erik Martin, and Blair Witherington. Data were entered by Carrie Crady, Carolyn Farmer, Layne Bolen, Chris Koeppel, and Barbara Courtney. The INBS data collection comes from the valiant effort of people from many diverse groups. Contributors include Mary Duffy, Russ Ferris, Bob Joseph, Chad Loch, Clif Maxwell, Robert Rahberg, Mort Hanson, Jan Hanson, Randy Hester, Bert Charest, J.B. Miller, David Parker, Andrew Rich, Mike Evans, Kevin Marczak, Wendell Simpson, John Stiner, Ron Hight, Mark Epstein, Don George, Terry O'Toole, Paul Tritaik, Karen Frutchey, Dan Griffin, Diane Oliver, Jonathan Gorham, Mike Bressette, Rick Herren, Erik Martin, Bob Ernest, Mark Mercadante, Jane Provancha, Angy Chambers, Olin Miller, Lew Ehrhart, Dean Bagley, Ron Johns, Gerry Heyes, Pete Schutte, Chris Perretta, John Griner, Ryan Noel, Peter Quincy, Larry Wood, Kirt Rusenko, Joe Smyth, Sid Leve, Brian Christ, Jim Hoover, Bill Ahern, Beverly Ball, Robert Steiger, David Addison, Bob Baker, Betsy Baker, Bruce Hagedorn, Dennis Teague, Bob Miller, Kennard Watson, Joe Mitchell, Meg Lamont, Steve Shea, and Bonnie Mowery. Support for the INBS program came from the Florida FWCC Marine Turtle Protection Trust Fund, the U. S. Fish and Wildlife Service, and the in-kind service of data collectors.

Figure 2. Green turtle nests counted at index beaches in Florida, USA, during the period 1989-2000. Connected open circles represent annual nests and closed circles represent combined nests from biennial groups (combined consecutive high- and low-nesting years). The trend line is fit to the biennial data (r^2=0.76, p=0.023). Survey effort did not vary among years. Nesting on index beaches represents approximately 74% of green turtle nesting in the state of Florida.

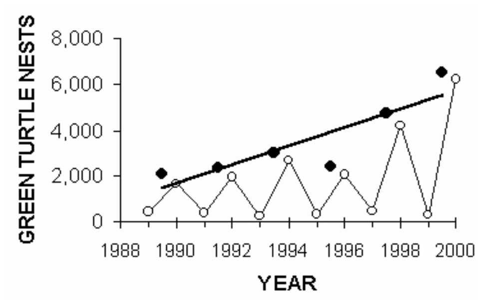


Figure 3. Leatherback nests counted at index beaches in Florida, USA, during the period 1989-2000. (r^2=0.71, p<0.001). Survey effort did not vary among years. Nesting on index beaches represents approximately 34% of leatherback nesting in the state of Florida.

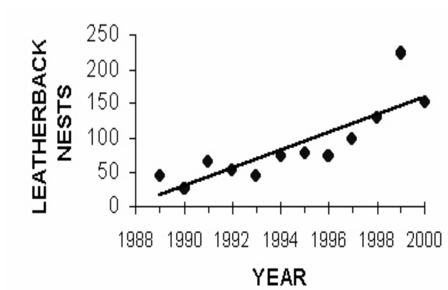
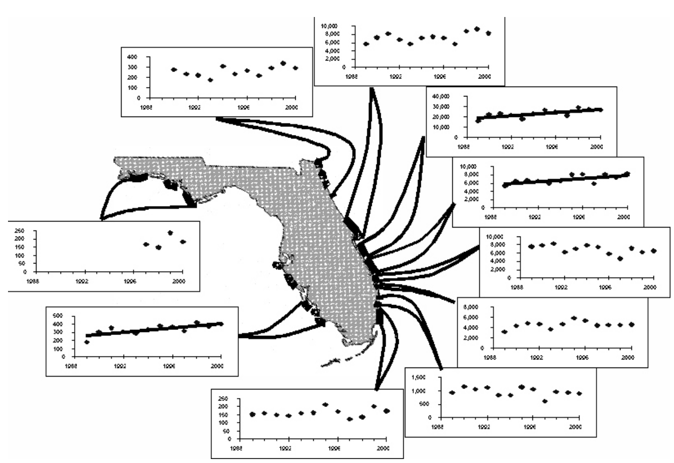


Figure 4. Green turtle nesting, summed for two-year periods, versus year, at grouped index nesting beach sites in Florida during the period 1989-2000. Summing consecutive even and odd years of nest numbers dampens a pronounced biennial nesting periodicity at each location. Plots with trend lines have a significant slope (alpha=0.05). Plots without lines have no significant trend. Coastal index beach locations are represented by bold lines. Some locations show missing data for periods when complete and consistent nesting surveys did not take place.



ASPECTS OF OLIVE RIDLEY FEEDING ECOLOGY IN THE EASTERN TROPICAL PACIFIC

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While participating in a biological research cruise in the eastern tropical Pacific from July - December 2000, we opportunistically captured over 200 olive ridley turtles throughout the region as part of an on-going study. In order to investigate food preferences of this species we stomach lavaged 36 individuals captured 14 to 788 km offshore of the mainland. We obtained identifiable food samples from 20 individuals, including 4 males, 5 females and 11 juveniles (SCL < 46.9 cm). Prey was found to consist almost entirely of gelatinous organisms (mainly jellyfish and ctenophores), and a small number of associated commensals. One individual too small to lavage (SCL 11.4 cm) had been feeding on Portuguese man-of-war (*Physalia*). Many of the delicate gelatinous organisms that we obtained were intact which suggests to us that pelagic olive ridleys take their prey by suction feeding. The throat distention that this species shows during respiration should provide an easy mechanism for sucking up their small, gelatinous prey. Olive ridleys have been classified as benthic feeders based on previous studies that have been confined to nearshore areas. Our observations suggest a more flexible feeding ecology and show that ridleys are active pelagic feeders in the open ocean. Furthermore, we found adults and juvenile olive ridleys occupying the same oceanic habitat and apparently feeding on the same kind of prey, suggesting that the traditional concept of a distinct juvenile developmental habitat may not apply for this species.

AN ANALYSIS OF A 415% INCREASE OF SEA TURTLE STRANDINGS IN COLLIER COUNTY, FL, USA

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INTRODUCTION

The Collier County Natural Resources Department (NRD) has been actively involved in assisting the Florida Fish and Wildlife Conservation Commission (FWC) with data collection for the "Sea Turtle Stranding and Salvage Network" (STSSN) since 1994. Prior to 1994, not all strandings were reported and many were disposed of without notification to the NRD or the FWC.

Sources of sea turtle mortality include, but are not limited to: incidental catch by commercial fisheries (trawling gear, gill nets, drift nets, and long lines), entanglement and ingestion of marine debris, boat strikes, poaching, injury from shark attack, disease, and other natural causes (National Research Council, 1990). The cause of mortality is determined when possible and used to identify possible ways of reducing future mortality. The STSSN program is critical to the future of sea turtle conservation and recovery efforts.

RESULTS

In 2000, 108 sea turtles were reported stranded along the Collier County coastline, representing a 415% increase over the past 5 year average of 26 per year (Table 1). Most Florida Counties, with the exception of Monroe County, did not experience the same magnitude of strandings in 2000 (Foley, Pers. Comm.). Strandings occurred during most months with peaks in March and May (Figure 1).

Species Composition

Strandings in 2000 involved primarily loggerheads (*Caretta caretta*, N=74), followed by Kemp's ridleys (*Lepidochelys kempii*, N=29), green turtles (N= 3), hawksbills (*Eretmochelys imbricata*, N=1) and unidentified species (N=1) (figure 2).

Indications as to Cause of Death

Strandings were broken down into the following categories: strandings which occurred during elevated red tide counts (42), no obvious cause (37), deliberate human mutilation or shark bites (17 including 3 which occurred during red tide), boat strikes including obvious damage from propeller, skeg, or hull (12 including 5 which occurred during red tide), and too decomposed to assess (8) (Figure 3). In most cases it is not known whether the boat damage or shark bites was the cause of death or inflicted post-mortem.

Six sea turtles were live strandings, including four that occurred during elevated red tide counts, and two that had no obvious cause of injury. All were taken to Clearwater Marine Aquarium for rehabilitation. The live red tide related turtles made a full recovery during rehabilitation and were released, the remaining two died of unknown causes.

First Stranding Peak

From January through late April a widespread bloom of red tide coincided with 43 sea turtle strandings (Figure 4). During this time NRD staff performed one field necropsy, and 10 turtles were frozen and later taken to the FWC Florida Marine Research Institute for necropsy. Tissue and organ samples were taken for analysis and results are pending.

Toxic dinoflagellates responsible for red tide (such as *Gymnodinium breve*) produce a nerve toxin that can be fatal to fish and causes respiratory irritation in humans. These toxins are capable of accumulating in high concentrations in shellfish. It may take up to 2-4 weeks for the toxin to be completely purged from shellfish depending on the length of exposure and flushing of the water body (FDEP, 1999). At this time the harmful effects of red tide on sea turtles is poorly understood. There is only circumstantial evidence that the exposure of sea turtles to red tide through respiration and ingestion of filter feeding organisms such as shellfish can be linked to a possible cause of death.

Second Stranding Peak

The second peak of strandings occurred during the period of May through July, with 50 strandings. Although this time corresponds to sea turtle nesting season, 25 of the 50 strandings were fresh to moderately decomposed large male loggerheads, compared to 12 of the 45 during the previous three months (February through April). Most of the males necropsied appeared to be healthy at the time of death. Biologists at FWC Florida Marine Research Institute indicated that fisheries interaction might have played a role in the strandings (Foley, Pers. Comm.).

Shrimp Trawlers

Federal regulations require the use of a Turtle Excluder Device (TED) on shrimp trawls to reduce sea turtle mortalities. Dimensions of the Gulf of Mexico TED's are currently a minimum of 81.28 cm (32 inches) width and 25.4 cm (10 in) height/depth (Federal Register, 1999). The body depth of many of the Collier County strandings were measured in the field and others were calculated by a morphometric analysis described by Epperly, 1999. It was determined that at least 92 % (68 of the 74) of loggerheads that stranded in 2000 had body depth measurements that exceeded the height requirements of Gulf of Mexico TED's (Figure 5). It was also determined that at least 80% (59 of the 74) of this species that stranded had body depth measurements that exceeded the height requirements of Atlantic TEDs (30.5 cm or 12 inches). One loggerhead measured had a body depth less than the Gulf TED minimum height requirements, and five were too damaged or deteriorated to measure. In addition, one green turtle would not have been able to escape the Gulf TED under current Federal regulations. The hawksbill stranding could not be calculated using the morphometric analysis described by Epperly, 1999. Correlations between the strandings and shrimping effort in this area will be examined when shrimping data becomes available. The data will also assist in determining if Texas shrimping ground closures will impact the eastern Gulf of Mexico shrimping grounds and local sea turtle populations.

DISCUSSION

There is no direct evidence as to the cause of the 415% increase in strandings in Collier County, 2000. A red tide bloom may have influenced many of the 43 strandings that occurred during the first peak. Four of the live strandings occurred during the red tide bloom. The turtles exhibited a loss of motor skills and recovered rather quickly when placed into the rehabilitation facility (Harmon, Pers. Comm.). These symptoms seem to indicate possible algal toxicosus ((red tide poisoning) Jacobson, Pers. Comm.). Tissue samples taken during necropsies were sent to various agencies for red tide analysis, and results are pending.

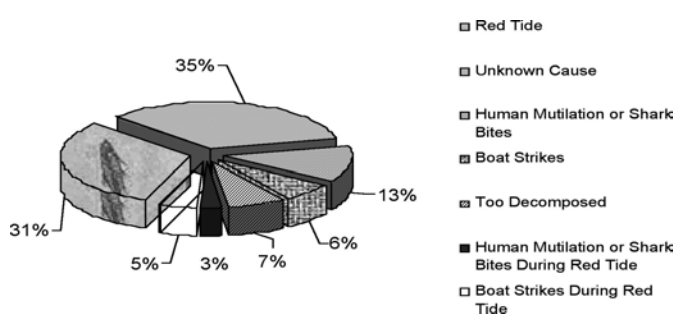
The second peak of strandings is equally inconclusive, but presents some interesting trends. Since the majority of the 50 strandings were large, healthy male loggerheads with body depths greater than the minimum height/depth requirement for TED's in the area, it appears that shrimp trawler interaction may have been the possible cause. Stranding data indicates the need for a reevaluation of regulations concerning Gulf of Mexico TED dimensions; a height/depth of 50.3 cm or larger would have been required to exclude the largest turtle stranded.

The NRD continues to gather as much data from each stranding as possible. We continue to investigate more thorough ways of documenting, examining, and sampling stranded sea turtles in the hopes of bridging the gap between possible causes and a conclusion.

Acknowledgements:

We would like to thank Thomas Herbert of the NMFS Fort Myers Field Station and Steve Brown of the FWC Florida Marine Research Institute (FMRI), for providing shrimp trawler effort data; Lisa Vanderbloemen, FWC FMRI, and NOAA CoastWatch for their chlorophyll a satellite image.

We would also like to thank the following people and agencies for their help with strandings: NRD staff; David Addison and the turtle interns, Conservancy of Southwest Florida; Steve Bertone, Karyn Tremper, and Jill Ryder, Rookery Bay National Estuary Research Reserve; Terry Doyle of the United States Fish and Wildlife Service; staff at Delnor Wiggins Pass State Recreation Area; Collier County Parks and Recreation Department; and the many concerned citizens of Collier County who reported strandings either to us or the FWC. We would like to express our extreme appreciation to Glen Harmon of the Clearwater Marine Aquarium, for picking up and rehabilitating our live strandings.



SPORADIC NESTING OF OLIVE RIDLEY TURTLES (*LEPIDOCHELYS OLIVACEA*) AND EFFORTS TO CONSERVE THEM ALONG THE COAST OF KARNATAKA (SOUTH WEST INDIA)

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A drastic decline in the nesting of olive ridley's turtle has been observed in the coast of Karnataka. The incident of ridley's eggs being sold in open market has reduced presumably due to lower nesting. But for a few incidents of conservation efforts by the

Karnataka Forest Department there is no conservation activity or any such activity to create awareness among the fisher folk.

I studied a stretch of 12-km shoreline from Mangalore to Mukka in Karnataka during the period from October of 1985 to March of 1986. The study area is dotted with fishermen communities and the region is known for its fishing activity. Three major fishing communities live in the area. Their attitude towards turtle meat and eggs are varied. While some worship the turtles others eat them, some eat only the egg.

The study was a beach survey, collection of eggs and hatching them in a fenced location on the beach. Early morning walks along the beach from 2 am to 6 am was conducted to look for nesting. Some nests were opened and eggs collected. Market visit looking for eggs were organized. All the eggs in the market were purchased and were shifted to the hatcheries and were hatched successfully.

Sporadic nesting of the olive ridley's turtles along the West Coast of Karnataka has been reported as early as 1985 (Sharath, et al., 1986). In the study area, I have observed the nesting frequency to be as low as frequency = 0.25/km (Table 1). Each nest had around 80 eggs and an incubation period of 60 days (Table 2). During the same period, the sale of eggs in the local fish market was also rampant. I observed more than 600 eggs being sold during the period from Nov. 1985 to Feb. 1986 in just one market in Mangalore.

The Mangalore University carried out a semi captive breeding and release of 2560 hatchlings in 1985. Later in 1986 the Karnataka forest department carried out semi captive breeding in three different locations, leading to the release of more than 15000 hatchlings (Appayya, 1984). The unique conservation activity carried out by the department was in the northern district of Uttara Kannada (Karwar) where in situ conservation was tried. Metal cages were distributed to activists among the fisher folks who placed them over the nests and guarded them daily until the eggs were hatched (Table 4).

Preliminary survey of the study area done during Nov. 2000 and Feb. 2001 reviled that the nesting frequency has reduced to 0.05. however, this data needs further confirmation.

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Table 1. Nesting frequency along the Bengre shore.

	Total dist. of the shore walked (in km)	Number of nesting observed.
1st week of Nov. 1985	28	5
2nd week of Nov. 1985	32	9
1st week of Dec. 1985	12	2
2nd week of Dec. 1985	42	12
	Frequency (number of nests per km)	0.25

Table 2. Turtle egg collection at Bengre (Mangalore coast)

Cluster ID	Date of Nesting	Date of hatching	Number of eggs
C_{1a}	9 Nov. 1985	3 Jan. 1986	75
C_{1b}	9 Nov. 1985	3 Jan. 1986	75
C_2	7 Dec. 1985	4 Feb. 1986	70
C_3	10 Dec. 1985	8 Feb. 1986	164
C_4	18 Dec. 1985	11 Feb. 1986	95
C_5	1 Jan. 1986	18 Feb. 1986	126

Table 3. Morphometric details of the hatchlings emerged during early 1986 at Begre (Mangalore coast).

Carapace length (Avg.) in mm (SD, N= 605)	Carapace (Avg.) width in mm (SD, N= 605)	Weight (Avg.) in g. (SD. N= 605)
427	366	18.7
(0.1)	(0.09)	(1.15)

Table 4. Conservation activity in the Karnataka coast during 1985-86.

Place of activity	Method of conservation	Success
Bengre (Mangalore)	Semi captive breeding in wired cages and release within a week of hatching	1250 Hatchlings released
Maravanthe (Coondapur)	Semi captive breeding and some raised for a couple of years before release.	10 raised for 6 months, 2 raised for 2 years and one for 3 years.
Bhatkal (Karwar)	In situ conservation with metal cages.	2500 hatchlings released.

ELASMOBRANCH ASSOCIATES OF MARINE TURTLES ON THE EAST COAST OF FLORIDA

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Background

The inshore and nearshore waters of the east central coast of Florida are prime developmental habitats for juvenile green turtles (*Chelonia mydas*) and subadult loggerheads (*Caretta caretta*). The UCF Marine Turtle Research group has been involved in long-term population studies of juvenile marine turtles in three study areas from Cape Canaveral, FL to Sebastian Inlet, FL since 1982. Turtles are captured by large-mesh tangle net, and are tagged, measured, and photographed. In addition, blood and lavage samples are obtained.

Netting for marine turtles by the UCF group began in the Indian River Lagoon system 3 km south of Sebastian Inlet in Indian River County, FL in 1982. Since that time there have been 1660 captures of juvenile green turtles (mean SCL = 42.3 cm) and 741 captures of subadult loggerheads (mean SCL = 62.6 cm). Catch per unit effort (CPUE) for these two species at this site can be found in Figure 1. In addition, three Kemp's ridleys and one hawksbill have been captured.

A second netting project was begun in 1989 over nearshore Sabellariid worm rock reefs, just across the barrier island from the lagoon site. This is the ultimate in juvenile green turtle developmental habitat and has impressed us with the numbers of green turtles living in this finite system. The extraordinary CPUE is shown in Figure 2 and was presented in more detail at the 20th Annual Symposium (Holloway- Adkins et al. 2000). Since 1989 there have been 644 captures of juvenile green turtles (mean SCL = 42.1 cm) and 6 captures of subadult loggerheads (mean SCL = 58.3 cm).

In 1993 a third study began in the Trident Submarine Turning Basin at Port Canaveral, FL. To date 790 captures of juvenile green turtles have been recorded. The algae covered rock liner supports an aggregation of juvenile green turtles that exhibits an extremely small size-class distribution (mean SCL = 32.5 cm). We cannot provide a relevant CPUE for this site because significantly more animals are captured by long-handle dip nets than in large mesh tangle nets.

Numerous species of elasmobranchs also inhabit these waters and comprise the majority of incidental captures. Whereas encounters with five species of stingrays (*Dasyatis americana*, *Dasyatis sayi*, *Gymnura micrura*, *Rhinoptera bonasus*, *Aetobatus narinari*) are relatively common (Schmidt et al. 1988), encounters with shark species were infrequent until 1998. Within the last three years we have seen a marked increase in the number of individual sharks and the diversity of species in the central region of the Indian River Lagoon. Recent encounters with rare elasmobranch species such as the smalltooth sawfish (*Pristis pectinata*), the manta ray (*Manta birostris*), the finetooth shark (*Carcharinus isodon*) and tiger shark (*Galeocerdo cuvier*) are of scientific importance. Six species of sharks have been identified as predators of marine turtles, but only tiger sharks (*Galeocerdo cuvier*) prey extensively on them (Witzell 1987). Shark species caught in turtle nets over the years include bulls (*Carcharinus leucas*), blacktips (*Carcharinus limbatus*), bonnetheads (*Sphyrna tiburo*), lemons (*Negaprion brevirostris*) and nurse sharks (*Ginglymostoma cirratum*). Tiger sharks were caught for the first time in the Indian River Lagoon in May 2000. The presence of these species in marine turtle developmental habitats is not unusual, but they seem to be increasingly more common on the east central coast of Florida.

Tiger Shark – *Galeocerdo cuvier*

Fishermen in Melbourne Beach, FL occasionally land tiger sharks ranging in size from small juveniles to large adults. On 4 May, 2000 between 1400 and 1500 hours, a female tiger shark estimated to be 6 feet in length became entangled in our nets. It was photographed and released unharmed. On 19 May, 2000 a second tiger shark was caught. This animal was also female, but appeared to be larger (8 feet). These two captures are the first records of tiger sharks in the Indian River Lagoon system (F. Snelson pers. com.; D. Adams pers. com.; SMS 2000). Later that summer, a member of our crew came upon a fisherman who caught three tiger sharks while fishing on the nearby ocean beach. Three flippers from an adult loggerhead were found in the stomach of one of the sharks (A. Maharaj pers. com.). The presence of turtle remains in tiger shark stomachs is well documented in the literature (Coles 1919; Dodrill 1977; Gudger 1948a, 1948b, 1949; Lowe et al. 1996; Simpfendorfer 1992). A survey of the sharks found within 500 meters of shore at Melbourne Beach, FL between 1974 and 1977 found 4 of 16 tiger sharks with turtle remains in the stomach contents. The two largest sharks, 3.136 m and 3.64 m, contained pieces of large loggerhead turtles. The stomach contents of the two smaller sharks, 1.818 m and 1.828 m, included a small piece of a turtle and 10 fresh loggerhead hatchlings (Dodrill 1977). Encountering turtles with shark-related injuries is relatively infrequent, however when they occur the tiger shark is the primary suspect.

Smalltooth Sawfish – *Pristis pectinata*

The smalltooth sawfish (*Pristis pectinata*) was common in the Indian River Lagoon in the 1800s but is believed to have been extirpated early in the 20th century (Snelson 1981; Schmid et al. 1988) due to commercial and recreational netting. Historically, commercial turtle fisherman working in the Indian River Lagoon in the late 1800s refused to set their nets from March through October due to the arrival of large sawfish and sharks that damaged their nets (Wilcox 1898). One fisherman estimated that 300 sawfishes were captured in his nets during a one year period (Evermann and Bean 1896). Accounts like these suggest that most of the sawfishes encountered during that time were killed. In over 25 years of netting in the lagoon system the UCF group never encountered this species. As a result, it was completely unexpected when we captured a 13' male smalltooth sawfish in nets set over nearshore worm rock reefs in approximately 3 meters of water. The individual was carefully untangled and released unharmed. Photos were taken for documentation and have been catalogued into the Florida Museum of Natural History in Gainesville under record #UF-110738.

The last documented lagoon record was from 1935, although one animal was apparently seen in the early 1990s just south of Ft. Pierce Inlet (Gilmore pers. com.). The last record from the east central Atlantic coast of Florida of which we are aware was from Ft. Pierce in 1979 (Gilmore 1995).

Finetooth Shark – *Carcharinus isodon*

The finetooth shark (*Carcharinus isodon*) lives in shallow inshore waters off the eastern coast of the Americas in the Atlantic Ocean. They appear in the nursery and mating areas of South Carolina when water temperature rises above 20°C in May. This species migrates south as water temperature drops below 20°C, and winters off southern Florida (Castro 1991). Until our capture on 17 March, 1999, it was unknown from the Indian River Lagoon system.

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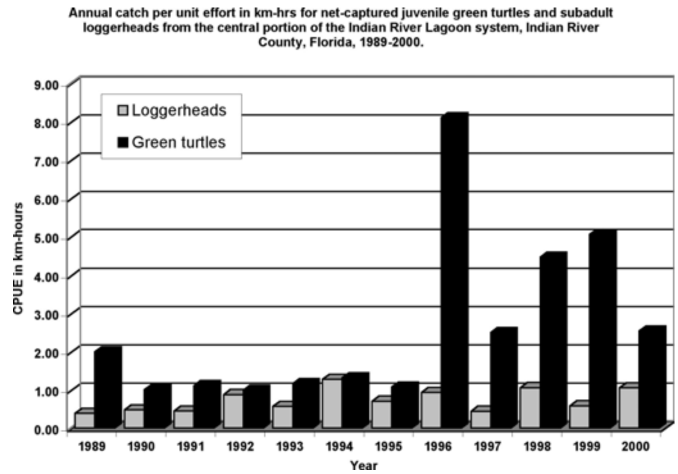

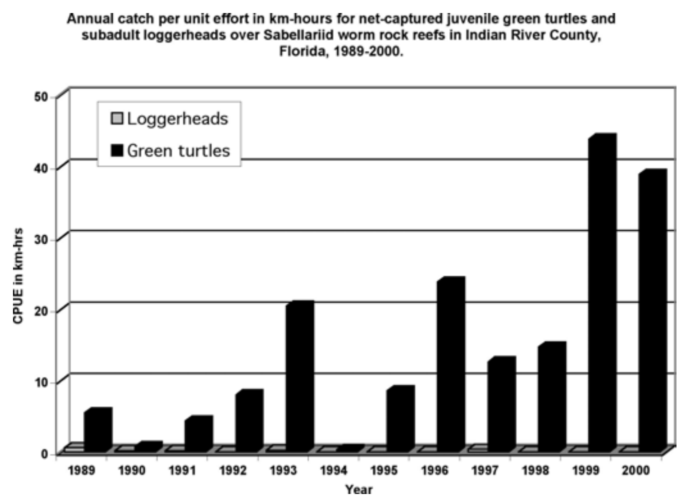

RESPONSE OF NESTING SEA TURTLES TO BARRIER ISLAND DYNAMICS

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Barrier island beaches constantly move in response to changing wind, tidal, and current patterns. Species such as sea turtles must cope with these changes to survive. One area that may provide significant challenges for nesting sea turtles is Cape San Blas, Florida. The West Beach of Cape San Blas experiences one of the greatest erosional rates in Florida, whereas the East Beach gains sand (Lamont et al. 1997). Although this region is extremely dynamic, it supports the greatest density of nesting loggerhead turtles in Northwest Florida. In addition, Encalada et al. (1998) found that loggerhead turtles nesting in Northwest Florida are genetically distinct from those nesting throughout the Southeastern United States. Although the West Beach of Cape San Blas is extremely dynamic, the majority of turtles nest along the eroding beach (Lamont et al. 1997). Therefore, from 1998 through 2000 we researched the response of nesting turtles to the dynamics of this barrier island system. The objectives of this study were to assess:

1. sea turtle nesting patterns,
2. structure of the nesting sea turtle group,
3. tidal patterns,
4. current direction, and
5. changes in beach topography along Cape San Blas, Florida.

Night surveys for nesting turtles were conducted along five km of beach on Cape San Blas, from approximately 2130 to 0600 every night during peak nesting (May 15 to August 10). When a nesting turtle was located, the curved length and width of her carapace was measured, her location recorded, and a metal tag placed in both front flippers. Tidal patterns were recorded using a Hydrolab DataSonde 3 water monitor anchored offshore and programmed to record water level, salinity, and temperature. Oceanographic observations following those of Schneider and Weggel (1982) were gathered daily at two benchmarks to assess current direction. Wind data was gathered from a National Weather Service station located on West Beach. Wind direction was divided into 8 categories of 45 degrees each: North (N), Northeast (NE), East (E), Southeast (SE), South (S), Southwest (SW), West (W), and Northwest (NW). A logistic regression was used to assess the relationship between current direction and the number of turtles nesting along Cape San Blas. A Chi-Square goodness-of-fit was used to determine if the number of nests observed on East Beach differed significantly from the number expected under an even (50:50) distribution. Topographical measurements occurred biweekly throughout the summer. Transects originated at two benchmarks. Data was recorded using a laser transit every five meters along the transect, as far into the water as possible.

A mean of 65 nests were laid on Cape San Blas in 1998, 1999, and 2000, and of those, a mean of 78.1% were observed at oviposition. Of the 111 turtles that were tagged, 24.3% nested more than once, and 7.2% nested three or more times. The mean distance between successive nests was 1.14 km.

Of the 153 nests laid, 61.4% were laid on West Beach and 38.6% were laid in East Beach. Tidal information was gathered off West Beach for 54 days in 1998 and 9 days in 1999, and off East Beach for five days in 2000. Tidal patterns gathered from the water monitor off both beaches were nearly identical to those provided by the National Oceanographic and Atmospheric Administration. The diurnal tidal pattern observed off Cape San Blas was synchronous between West and East Beaches. Comparison of tidal patterns and timing of sea turtle nesting for all three years revealed 98% turtles nested on a rising tide and 2% on a falling tide. No turtles nested on a falling tide in 1998, one turtle did so in 1999, and two turtles nested while the tide was falling in 2000.

Oceanographic observations were collected for 57 days from May through August 2000. Along West Beach, the current traveled E more frequently (63.2%) than it traveled W (36.8%). When the current flow was W, the wind blew primarily from the E, and when it traveled east it blew most often from the W ($p = 0.0001$). Along East Beach, the current traveled E (74.6%) more often than W (25.4%). When the current flow was westerly, the wind blew from the E as often as when it blew from the W, however, when the current traveled E, the wind blew primarily from the W ($p = 0.013$). Along West Beach, turtles nested almost equally on E and W winds, however on East Beach, turtles nested more frequently during W winds than E winds ($p = 0.011$).

From July 1998 to August 2000, West Beach lost 8.6 m of sand along the entire profile. Individual points along the profile differed; the greatest loss occurred 30 meters from the benchmark whereas the first 15 m of the profile gained 0.67 m. During this time, East Beach gained 2.3 m of sand along the entire profile. The greatest gain occurred 35 m from the benchmark, while the greatest loss was documented 45 m from the benchmark.

One strategy for reproductive success adopted by species inhabiting harsh environments is to produce many, small offspring in several different clutches throughout the season, thereby increasing the probability that at least one offspring will survive to reproductive maturity. In addition, these species often exhibit site fidelity, which allows them to place their eggs in an area already proven successful.

Sea turtles on Cape San Blas lay an average 109 eggs in as many as four nests per season, with a mean inter-nesting interval of 14.5 days. The turtles nesting in this region, did not however, exhibit strong site fidelity. On Cape San Blas, the mean distance between successive nests was 1.12 km, however the study site encompassed only five km. It is likely that many of the turtles tagged on Cape San Blas nested in the region but outside the study boundaries. Species such as the green turtle (*Chelonia mydas*) that typically nest on more stable beaches exhibit high site fidelity and often re-nest within an average 0.6 k m of their original nesting site (Miller 1997). On a barrier island beach in South Carolina, loggerhead turtles also expressed low site fidelity, with a mean distance between successive nests of 3.2 km (Talbert et al. 1980). Possibly, strong site fidelity is not as important to sea turtles nesting along unpredictable coasts as it is to species nesting on more stable beaches.

Strong site fidelity may actually reduce the success of loggerhead turtles nesting on barrier island beaches. The barrier island of which Cape San Blas is a part was formed approximately 5,000 years ago, and although this area frequently changes, it has persisted (Campbell 1984). Individual areas along the barrier island may increase or decrease in size, however the system itself endures. On a barrier island, a female turtle may lose all of her nests in one season if she places them on one small section of beach that subsequently experiences severe erosion. If she places them throughout the system, she may increase the chances that one of her nests will incubate safely.

Exhibiting strong site fidelity on a barrier island beach may also require more energy than on a stable beach because turtles must overcome the dynamic forces acting on these systems. Because the water surrounding Cape San Blas is shallow, this system is wind driven. In this area, wind causes tidal ranges to average two feet higher than normal (four feet total; Stauble 1971). Turtles nesting along Cape San Blas may travel onshore with the rising tide, thereby reducing the distance they must crawl and saving energy. Wind driven tides may save energy, but most likely do not affect site fidelity. Wind driven currents may, however. On Cape San Blas, when the wind blew from the east (SE, E, NE) the current traveled most often towards the west, and a west (W, SW, NW) wind typically resulted in an eastward current ($p = 0.013$). If turtles approach Cape San Blas from the west, they could nest on West Beach with little energy expenditure. However, to nest on East Beach under an east wind would require swimming against the current and over the shoals, which may reduce the amount of energy available for nesting. Turtles nested on West Beach almost equally during an east wind (46.9%) and a west wind (53.1%), however on East Beach they nested less often on an east wind (17.5%) than they did on a west wind (82.5%). The wind conditions under which a turtle first emerged would influence her ability to nest again in that location. If she originally nested on East beach on a west wind, she would have to return to East Beach to re-nest. However, if the wind pattern shifted during the inter-nesting interval and blew from the east, she would have to spend the energy to travel against the current and across the shoals.

Results of this study indicate loggerhead turtles nesting along Cape San Blas may exhibit low site fidelity to increase chances of reproductive success and reduce energy expenditure. Increasing sample sizes, gathering information on the offshore topography along this region, and determining from which direction turtles are approaching the beach may provide further information about the response of nesting sea turtles to barrier island dynamics.

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WHAT DOES THE EAR TELL ABOUT TURTLE PHYLOGENETIC RELATIONSHIPS?

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Turtles are traditionally considered primitive reptiles sharing many characteristics with the stem reptiles from which birds and mammals evolved. Turtles are classified as anapsids, being a sister group to both diapsids and mammals. Turtles have what is considered a primitive inner ear condition, characterized by an oval basilar membrane and electrically tuned hair cells. While the inner ear may be typical of what is considered a primitive ear, the middle ear bone or columella, is not. This slim spring like and resonant structure is more bird-like than it is like that of a primitive reptile or mammal. Acoustic modeling of the turtle columella reveals a low pass frequency structure that will respond to sound in air, sound in water and substrate vibration. Such a tuned mechanism is in stark contrast to the massive middle ear bone in stem reptiles that likely acted only as inertial mass for detection of substrate vibration. For stem reptiles, hearing likely involved a process that is the reverse of airborne sound detection. Substrate vibration would enter the body and shake the skull. The massive columella would move after an inertial lag, thus differentially displacing the fluids in the inner ear. Turtles retain this primitive function of substrate vibration but the ear is also capable of efficiently detecting sound in air and water.

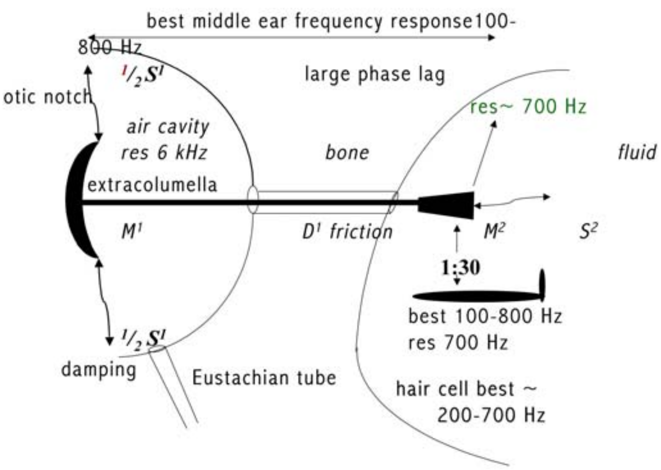
Inertial hearing alone would be inefficient in water. The middle ear contains an air filled middle ear space that does not directly communicate with the inner ear. The lack of communication allows the ear to operate under high external pressures. The middle ear air acts as a bubble and will resonate at a frequency higher than the columella. In adult fresh water species (*C. scripta*) the resonant frequency is about 6 kHz, when modeled as a resonant cylinder. If the cylinder is varied as in the case of marine turtles (*C. caretta*; *C. mydas*) diving. The reduced air volume will result in an increase in resonant frequency. The air bubble in a mature animal will vary more than 5000 Hz when the turtle dives 50 meters. Immature animal will have smaller middle ear volumes and higher resonate frequencies. These resonant frequencies too will increase with diving. The air bubble will respond to sound pressure at many meters from the source. The turtle middle ear also has a partial one way pressure valve or Eustachian tube. This tube connects the middle ear with the pharynx. Repeated intense sound pressure exposures would gradually force air out of the middle ear and reduce the ear's sensitivity to the sound by increasing the resonant frequency of the bubble and adding stiffness to the eardrum and columella. This is a very adaptive mechanism in an animal that has not evolved middle ear muscles and mammals.

The turtle ear is effective as an aerial receptor in the low frequencies. The eardrum or tympanum is undifferentiated skin under little tension. In marine forms there is also a layer of fat on the medial surface. This, modeled as a mass spring system, has resonate frequencies below 700 Hz. The inner ear too is a resonance structure. The basilar membrane resonates at 700 Hz with a frequency response from about 100-800 Hz. Sensory hair cells resting on this membrane also have resonant frequencies that range from 200-700 Hz. In frequency range of the middle and inner ear turtles can detect airborne energy. No airborne audiogram is available on a marine form but sensitivity is about 30-40 dB SPL in *S. scripta* (Patterson, 1966).

Stem reptile adapted well to substrate vibration, but turtles retain good substrate sensitivity and expanded their hearing capabilities to fluid (air and water). The turtle ear is tuned to low frequencies (mass dominated damping system) and the middle ear air acts as a spring for aerial hearing and a bubble for water hearing. The columella is an inertial mass spring damping system for substrate hearing.

Movement of the columella can effectively stimulate the basilar membrane upon which about half the hair cells lie. Turtles have almost half their hair cells resting on bone on either end of the oval shaped basilar membrane termed the limbus. Limbic hair cells would be stimulated by bulk vibration of the body, possibly very important in an animal almost encapsulated in bone. Crocodiles and birds share this feature of limbic hair cells but not lizards or snakes.

Figure 1. Model of a generalized turtle ear depicting the tympanum in the otic notch, the middle ear bone or columella and the fluid filled inner ear. The ear acts like a low pass filter but due to its mechanical properties is quite serviceable as a detector of substrate vibration and sound in air and water. Symbols: /S/ stiffness; /M/ mass; /~/ frequency; /res./ resonance.



Turtles have good hearing in air and underwater. Crocodiles have similar thresholds but with higher frequency sensitivity. In other words, crocodiles have expanded turtle hearing. There are other important similarities between turtles and crocodiles as the vascular tree but it is the mitrochondrial DNA data that build a compelling case that turtles are diapsids and only secondary anapsid. The turtle-crocodile clade has little superficial morphology to support the relationship but crocodiles do have dorsal and ventral body armor. Both share a thin rod columella and an otic notch with is interpreted an implying an aerial impedance matching middle ear (Gaffney and Meylan, 1988), but as discussed this middle ear provides excellent tuning for substrate and water hearing. Turtles are therefore unique reptiles but surely not primitive. It is the ear morphology that is used to define turtles and it is this morphology and function that is also supports the DNA evidence of a turtle-crocodile relationship, hidden in the dramatic postcranial development in these unique vertebrates. Auditory scientists have to reexamine their contention that the ears of the animals are that of “living fossils”.

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FIRST WORKSHOP ON BASIC NOTIONS FOR THE STUDY OF THE BIOLOGY AND CONSERVATION OF SEA TURTLES FROM THE GULF OF VENEZUELA, YEAR 2000

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ABSTRACT

In the month of June, the days 3, 10 and 11, the first workshop on basic notions for the study of biology and conservation of sea turtles from the Gulf of Venezuela, year 2000, was convened at the Biology Department from the Experimental Sciences Faculty, University of Zulia, Maracaibo, Venezuela. The time frame of the workshop was 23 hours, with 30 participants, mainly biology, veterinary medicine, social communication students from the University of Zulia (LUZ), education and law professionals, alumni from LUZ, and Electric engineering students from Rafael Belloso Chacín University (URBE). The principal instructors were Héctor Barrios G. and Tatiana León F., coordinators of the group Tortugueros del Golfo de Venezuela (TGV) - Proyecto Shäwa. General turtle biology aspects were informed, as well as threats for their survival and strategies to get financial support to develop research projects on this subject. The workshop also included a field activity, group work, visits to fishermen camps, direct observations in the beach and work with the Guajira community. The interdisciplinary participants, helped to emphasize on the implementation of environmental education programs, with the help of local and regional communities, as well as the consolidation of joint efforts for research, protection and conservation of marine turtles in this region.

INTRODUCTION

The “I Workshop on Basic Notions for the Study of the Biology and Conservation of Sea Turtles” was organized by the members of the “Tortugueros del Golfo de Venezuela (TGV)-Proyecto Shäwa” and by the coordinators Lic. Jim Hernandez and Mg. Sc. Rosanna Calchi, both belong to the Biology Department of La Universidad del Zulia. Tatiana Leon F., Hector Barrios G., Lenin Parra and Maria Rincon R. were in charge of the expositions.

The objective of this workshop was to form a working group that functions of the State Zulia for the development of extension, investigation and conservation activities about sea turtles. It was held on June 03, 10 and 11 of the last year, at the conference room of the Biology Department at LUZ, with an assistance of 30 people including Biologist, Veterinarian, Social Communication and Electronic Engineering student as well as professionals in Education, Lawyers.

CONTENTS OF THE WORKSHOP

The contents of the workshop was divided in eight (8) sessions; on June 3rd they talked about the General Aspects of the Biology of Sea Turtles, making references to the Taxonomical Classification, species identification, life cycle and world distribution, followed by a Video Session. Then, they exposed the General Topics on Environmental Education and the Implementation of Strategies to make this possible; finally, they talked about the role of Veterinary Medicine in sea turtles, which include Microbiology, Parasitology, Virology and Physiology.

On June 10th they talked about the threats to the survival of sea turtles, which include artisan or incidental fishing, loss of habitats due to the contamination, Laws and proposals like the use of TEDs, guarding, and the actions of the ONG's in diverse assignations. This was followed by a small lecture on Obtaining and Financing Strategies and to finish, a final evaluation of the participants took place.

On June 11th a field trip to the Guajira in the Gulf of Venezuela took place; fishing camps at Cazuzai were visited, the Neima beaches were directly observed and they worked as a group with the Paraguaipoa community. These locations can be observed in the Figure 1: Gulf of Venezuela and Zulia map. Highlighted zone: Beaches observed in the "I Workshop on Basic Notions for the Study of the Biology and Conservation of Sea Turtles" field trip.

RESULTS

Thanks to the "I Workshop on Basic Notions for the Study of the Biology and Conservation of Sea Turtles" a new group was formed that will work in the State of Zulia which will organize projects about the Education and Conservation of sea turtles, among all of the Gulf of Venezuela, emphasizing the Guajira zone, due to the fact that this is the zone were sea turtles are affected the most because they are being use as an economic and food resource. This is why we need to concentrate our efforts to make great journeys in the zone already mentioned, as well as informing the Authorities of Maracaibo that they must take care of sea turtles.

During this workshop, the "Turtle Camp Guajira 2000" also took place, an activity which pursuits the making of projects about environmental education and investigations with sea turtles in Porshoure, Parashiou and Castilletes, all belonging to the Gulf of Venezuela.

SPONSORS

The "I Workshop on Basic Notions for the Study of the Biology and Conservation of Sea Turtles" was held thanks to the following sponsors:

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ILLEGAL TRADE AND USE OF MARINE TURTLES IN URUGUAY

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INTRODUCTION

There are many types and levels of sea turtle utilization and commercialization. Sea turtle items for sale include whole turtles, meat, eggs, leather, shell products (e.g., jewelry), mounted parts, extracted products (e.g., lotions, soaps, oils) and prepared food (e.g., turtle soup). The consumers' reason for purchase include: ceremony /festivity, decoration (restaurant/ bar), food, home use, religious belief, resale and medicinal use.

Given the almost complete lack of studies on the trade of marine turtles in Uruguay, the Project Karumbé began in 1999 as an in depth study on this topic focusing on the following objectives:

1. Detect the sale of sea turtle products
2. Determine the types of sea turtle utilization in Uruguay

METHODS

Between May of 1999 and April of 2000 interviews were carried out of the owners and employees of different craft stores, markets and ports in order to detect the sale and use of sea turtle products along the Uruguayan coast (cities and resorts). Biometric data (CCL) as well as photographs of carapaces and products were taken whenever it was permitted. An identification guide of WIDECAST in Spanish and the law that protects the marine turtles in Uruguay were handed out to each interviewee or government authority.

RESULTS

COMMERCIALIZATION

The sale of thirteen carapaces (10 *Chelonia mydas* and 3 *Caretta caretta*) were detected at seven craft stores, a fishermen's club (Atlántida), a fish market (Piriápolis) and at La Paloma's port. Prices varied from $12 to 250 USD and showed a positive correlation with the size of the shells.

In December 1999, in "Punta del Este" the seaside resort with the highest tourism in Uruguay, a decor store belonging to the Copper & Bronze firm was selling an embalmed head of an adult loggerhead (*C. caretta*) that was offered at $1500 USD while another head of a leatherback (*D. coriacea*) was valued at $1700 USD. Members of "Proyecto Karumbé" denounce the selling of the sea turtle heads and in January 2000 the inspectors of the Fauna Direction from the Agriculture, Livestock and Fisheries Ministry confiscated the heads. However, the origin of these heads is still unknown, as Uruguayan laws forbid making this knowledge public while the case is still open, which might last for years (López & Fallabrino 2001).

SEA TURTLE UTILIZATION

There were two types of very defined uses by consumers: Decoration (Table 1) and Food.

Regarding turtle meat consumption, 50% of the interviewees declared to consume it in a number of occasions. The green turtle was considered the preferred species, followed by the leatherback. Most of this supply came from incidental catch in gill nets of artisanal fishermen and lines of recreational fishermen. Some fishermen admitted that even though the turtle was living when captured it, they killed it for consumption.

It can be seen that the juvenile green population is the most representative group (Fig. 1), which may indicate that this area might be important feeding and developmental habitats for the green turtle population.

DISCUSSION

Uruguay possesses very low consumption of marine turtles with regard to other countries such as Indonesia (Donnelly 1994), Costa Rica (Troëng 1997), Mexico (Steiner 1994) and Colombia (Rueda et al. 1992) among others. The high prices at which sea turtle products are sold, the demand that exists for these products (mostly used as decoration) and the current economical situation does not suggest that a decrease of this illegal trade will occur over next few years. Although in many of the cases the origin of the shells was from already dead individuals, this trade provides incentives to fishermen to sacrifice living individuals (e.g., fishermen of "La Coronilla").

The interaction between fisheries and marine turtles is very important and it is the cause of many deaths annually (Fallabrino et at. the 2000). Most of shells of *C. caretta* that were for sale or used as decoration item were detected at La Paloma's port and resort where an important incidental capture of this species occurs due to trawling activities (Fallabrino et al. the 1999). Therefore, it is necessary to quantify how many individuals die annually and thus be able to determine the magnitude of the impact on the populations of marine turtles that inhabit our waters.

With regard to the sale of the embalmed heads, this is the first time that we have observed sea turtle heads being sold in Uruguay, and it is extremely worrying, since it indicates that traders are trying to sell new types of sea turtle products, perhaps motivated by the high prices that characterize this type of illegal business.

"Proyecto Karumbé" intends to encourage consensus among the Uruguayan society by providing information through different mass media (e.g., radio, television, internet) about the importance of sea turtle conservation, in order to discourage people from buying sea turtle products and thus help to protect these ecologically valuable species.

Acknowledgments: We would like to thank Ana, Cecilia, Daniel (University of Buenos Aires), Ana Vasquez (University of Uruguay) and Alvaro Opazo for their participation as volunteers at the Santa Teresa 2000 camp, where we obtained much of the information here exposed. A special thank to Dr. Jorge Cravino (D.G.F.S.) for his quick performance in the confiscation of the heads; and The David and Lucile Packard Foundation for providing travel assistance to the Symposium. Milagros Lopez is currently a Masters of Science student at the Centro de Investigaciones del Noroeste, S.C. in La Paz, Mexico.

Figure 1. Length Frequency per species detected for sale and used as decoration in public places between May 1999 - April 2000.

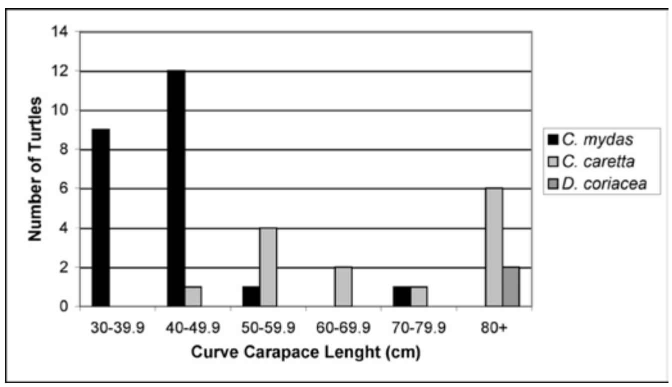

Table 1. Number of carapaces per species used as decoration items at different locations.

	C. mydas	C. caretta	D. coriacea	Total
Restaurants	5	5	0	10
Fishmarkets	6	4	1	**12**
Craft stores	0	1	0	1
Private homes	3	1	1	5
Total	**14**	11	2	**27**

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COZUMEL SEA TURTLE CONSERVATION PROGRAM - RESULTS OF THE *C. CARETTA* AND *C. MYDAS* 2000 NESTING SEASON

Gustavo Luna, Ma. Angelica Gonzalez Vera , and Gibran Tuxpan Torrijos

PARQUE NACIONAL ARRECIFES DE COZUMEL

Season 2000 of the Cozumel Sea Turtle Conservation Program produced the second highest number of collected nests since the conservation committee began the program in 1990. A total of 882 nests were collected. Of these, 177 were of *Caretta caretta* and 705 were *Chelonia mydas*. Average nest size was 116.72 eggs for *C. caretta* and 125.67 eggs per nest for *C. mydas*. There were a total of 109,386 eggs incubated in the corral which had a survival rate of 68.44 %. A total of 74,864 hatchlings were released into the Caribbean sea.

The Cozumel Sea Turtle Conservation Program is located in the Western Caribbean on the eastern shore of Isla Cozumel, Quintana Roo State, Mexico. It incorporates 18.7 km of mostly uninhabited coastline and protects about half of the known sea turtle nesting habitat on the island.

This year the Cozumel Reefs National Park, together with the Conservation Program, initiated scientific research on the nesting beach and wishes to expand this aspect of the program in future seasons.

EFFECT OF INCUBATION TEMPERATURE ON THE SURVIVAL , MORTALITY AND SEX RATIO OF TRANSPLANTED NESTS OF *C. CARETTA* AND *C. MYDAS* IN COZUMEL, Q. ROO, MEXICO

Gustavo Luna[1], Sheryl Shea[1], and Thane Wibbels[2]

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[2] UNIVERSITY OF ALABAMA

Data Loggers were placed into 26 nests, 22 in nests of *C. mydas* and 4 in nests of *C. caretta*, to determine average temperature for the critical period of sex determination, which is the second third of the incubation period. The 4 *C. caretta* nests registered temperatures above the pivotal temperature of 28.74° C. reported by Ackerman in 1999. During the critical period the nest temperatures registered from 29.65° C. to 30.39° C. , with a range of 1.65 °C. The 22 *C. mydas* nests registered temperatures of 29.30° C. to 31.02° C., with a range of 2.76° C. during the critical period, also the pivotal temperature of 28.26° C. for *C. mydas*. The sex ratio therefore had a female tendency and 9 nests produced 100% females. During the last third of the period of incubation the nests registered temperatures of up to 36.5° C., probably provoking the deaths of 11,391 hatchlings or 11.39% of total hatchling production.

EFFORTS TO MINIMIZE OFFSHORE PREDATION OF LEATHERBACK HATCHLINGS AT SANDY POINT NWR, USVI

Amy Mackay[1], Claudia Lombard[1], and Kirra Smith[2]

[1] U. S. Fish and Wildlife Service
[2] St. Croix Educational Complex

Due to a highly dynamic beach with consistent, annual erosion cycles, leatherback sea turtle nests are moved to a smaller, more stable relocation zone of Sandy Point NWR. A recent increase in the number of nesting females has subsequently saturated this relocation zone. The high concentration of nests is believed to support higher rates of offshore predation. During the peak of the 2000 hatchling season, the US Fish and Wildlife Service initiated a program to reduce offshore predation. Emerging hatchlings were moved from the relocation zone and released in other areas of the Refuge.

INTRODUCTION

Sandy Point National Wildlife Refuge (SPNWR) consists of a peninsula projecting off the southwest corner of the island of St. Croix in the U.S. Virgin Islands. The Refuge's 3.2 km of coastline serves as nesting beach for three species of marine turtles: the leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), and hawksbill (*Eretmochelys imbricata*). In 1981, the USVI Department of Planning and Natural Resources, Division of Fish and Wildlife initiated a research project to study the nesting biology of Sandy Point's leatherback population. The near shore waters and beach areas of Sandy Point had already been designated as Critical Habitat by the National Marine Fisheries Services and the U.S. Fish and Wildlife Service (USFWS) respectively. Subsequently, in 1984, Sandy Point became part of the USFW's Caribbean Islands National Wildlife Refuge System.

After twenty years (1981-2000) of uninterrupted data collection, it is recognized that Sandy Point NWR supports the largest concentration of nesting leatherbacks in the United States. Sandy Point NWR beaches are unique in St. Croix in that they are wide and sandy and lack fringe reefs and rock formations along the bottom of their near shore waters. These characteristics make for excellent nesting habitat for leatherbacks. However, Sandy Point is highly dynamic and characterized by consistent, annual erosion cycles. The "west beach" area of the Refuge is approximately 600 m in length and is annually eroded and redeposited by wave action. Each season, due to this pattern of erosion, a significant percentage of leatherback nests are moved to a smaller, more stable zone of shoreline. This area, on the leeward side of the Refuge, is approximately 500 m in length and is commonly referred to as the relocation zone. This zone supports most relocated nests as well as a number of in situ nests therefore making it an extremely important Refuge area. A recent, seasonal increase in the number of nesting leatherbacks has led to a similar increase in the number of nests moved to the relocation zone.

The near shore waters of the relocation zone are clear and relatively calm and water depth increases dramatically close to shore, supporting an abundance of large, predatory fish. The artificial concentration of nests in the relocation zone may support an artificial concentration of offshore predators. The relocation zone, like a beach hatchery, may be vulnerable to increased rates of offshore predation.

During the peak of the 2000 hatchling season, the USFWS initiated a pilot program to try to reduce offshore predation by dispersing hatchlings emerging in the relocation zone to beach areas throughout the Refuge.

The USFWS plans to look even more closely at this management concern in order to assess whether offshore predation rates in the near shore waters of the relocation zone are higher than in other Refuge areas and serving to reduce or negate the conservation value of relocating nests unless further measures are employed.

METHODS

The USFWS's hatchling dispersal program began on 30 June 2000 and ended on 1 August 2000. The following methods were carried out three to four evenings each week.

1. Each evening at 1730, USFWS personnel, assisted by local students, would begin foot patrols of the relocation zone.
2. If an emergence was encountered, time and location were noted and the nest was monitored. Nests due to hatch were observed for signs of emergence.
3. Hatchlings were collected after they emerged and began moving from the "hatchling puddle" towards the water.
4. Hatchlings were transported in styrofoam coolers with a layer of sand at the bottom to the windward side of the Refuge where there is a lower concentration of nests.
5. Vehicle access adjacent to both the relocation zone and release areas made it possible to minimize the time between collection and release of the hatchlings.
6. In the case of multiple emergences, groups of hatchlings were released at different locations on the windward side of the Refuge.
7. When released, hatchlings were allowed to crawl to the water on their own.
8. Most monitoring and release activities ended by 1930.

RESULTS AND DISCUSSION

During the four weeks of the hatchling dispersal program, hatchlings were collected and released from 23 different nests (both relocated and in situ) in the relocation zone. A total of 653 hatchlings were dispersed by USFWS personnel and local students.

Prior to the 2000 hatchling season, we tried to map nest locations for past seasons in order to quantify the concentration of nests in the relocation zone. However, we discovered that there are gaps in the data sheets provided by DPNR for the 1997, 1998, and 1999 nesting seasons.

The USFWS recognizes that there are many questions that need to be addressed before a long term management strategy can be implemented. It is imperative that we ensure that hatchling production is not compromised by lower rates of hatchling survival created by increased offshore predation.

"SEA TURTLE EDUCATION AT SANDY POINT NWR, USVI (1997 - 2000)"

Amy Mackay[1], Claudia Lombard[1], and Sera Harold[2]

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Sandy Point NWR is an important nesting site for leatherback sea turtles and it provides unique educational opportunities to the surrounding community. Every nesting season, hundreds of local students visit the Refuge to witness both leatherback nesting and hatchling emergence. This program, started in 1997 by the US Fish and Wildlife Service, has been evaluated for possible negative impacts on nest success.

INTRODUCTION

Since 1981, the United States Virgin Islands (USVI) Division of Fish and Wildlife (DPNR) has run a comprehensive study of the biology of leatherback sea turtles (*Dermochelys coriacea*) nesting on the beaches of Sandy Point National Wildlife Refuge (NWR) St. Croix, USVI. Education has been an important component of the study since its inception. Both past and present Field Directors have made significant contributions to the educational value of the study by increasing public awareness. Efforts were also made to bring information about all three of St. Croix's marine turtles (hawksbills, greens, and leatherbacks) to island classrooms.

As more people visited to project, public interest grew dramatically. It became difficult for the Field Directors to meet the increased demands on their already limited time. A reservation system was instituted in order to deal with larger numbers of nighttime visitors to the Refuge.

Throughout the history of the Leatherback Project, there has been a steady increase in the number of leatherbacks nesting each season. The combination of increases in both public awareness and nesting females made it necessary for the US Fish and Wildlife Service (USFWS) to become more involved in Refuge management. In 1981, the first Refuge Manager was hired in order to address public use and wildlife management issues. Efforts were made to limit the number of nighttime visitors while also providing daytime visitors with information about Refuge regulations. These regulations were instituted by USFWS to mitigate human impact on sea turtles and their nests. A gate was installed on the Refuge's main road in order to block vehicle access during nighttime hours. However, public use problems continued and Refuge hours were limited to weekend, daytime use.

In 1994, the USFWS decided to focus public education efforts on school and youth groups. Their decision was prompted by the need to limit visitors to the Refuge during nighttime hours. Additionally, they hoped to encourage new visitors, especially young people, to the Refuge. Previously, despite high visitor numbers, the program was only reaching a small number of the same people every season. USFWS recognized the need for a more structured and comprehensive education program which would complement the Leatherback Project.

From 1995-1998, two, local volunteers coordinated public education for the USFWS Sandy Point Sea Turtle Education Program. Beginning in 1999, USFWS added a seasonal employee to continue education and outreach in the Refuge.

GOALS

The overall objective of the USFWS Sandy Point Sea Turtle Education Program is to make the community an integral part of the conservation of sea turtles and their habitats. In doing so, we foster a conservation ethic which extends to all aspects of the natural community. An educated and concerned public is our greatest ally when it comes to the preservation of sites such as Sandy Point NWR. The leatherback sea turtles of Sandy Point allow us to show visitors a world they may never have seen before. This is especially true of our local, young people since St. Croix has no zoos or natural history museums. For many of these children, this is their first opportunity to interact with a wild animal. This objective is met by doing the following:

1. Developing advocates for the Refuge and its sea turtles.
2. Heightening awareness of sea turtle natural history.
3. Involving the community in management.
4. Promoting proper use of the Refuge.
5. Inspiring respect for natural communities.

RESULTS

Since 1997, over 2000 schoolchildren and local adults have visited Sandy Point, NWR in order to see leatherback sea turtles nesting. The USFWS, in order to address both the growing community interest in sea turtles as well as the needs of the resource, limits weekend, nighttime visitation to groups of schoolchildren. Local adults are allowed to visit during weeknights by special reservation. Individual reservations are not accepted from off-island visitors because the program is community based and not suited for tourism. We focus on local outreach in order to increase public awareness as to the importance of Sandy Point NWR.

In 1997, USFWS began to assess possible impacts education groups might have on nesting leatherbacks. Even though groups are closely monitored in order minimize stress to the nesting female, nest success of these females was compared to that of turtles not observed by groups. No significant difference was found in nesting success. Furthermore, observed turtles were timed during their different nesting stages and these results were compared to average times established by years of previous research done by DPNR researchers. Again, there was no significant difference between the two.

NESTING FREQUENCY AND HATCHING SUCCESS OF THE LEATHERBACK TURTLE (*DERMOCHELYS CORIACEA*) IN CENTRAL AND SOUTH BREVARD COUNTY, FLORIDA

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Prior to 1983, there was no recorded leatherback (*Dermochelys coriacea*) nesting in Central and South Brevard County, Florida. There were less than 3 leatherback nests per year in Central and South Brevard County, Florida between 1983 and 1993. However, in 1994 there were four nests and subsequent years have shown a dramatic increase, with a peak of 30 in 1999.

Hatching success has been studied at a number of leatherback sites in several different years. A study of hatching success on Playa Grande, Costa Rica from 1993-1994 showed a hatching success of 48.6% (Williams, 1996). During the 1990-1991 nesting season in Tortuguero, Costa Rica, hatching success was reported at 70% and in 1991-1992 hatching success was 53.1%. In St. Croix, hatching success for leatherbacks was 40.2% in 1982, 48.9% in 1983, 55.5% in 1984 and 53.2% in 1985 (Eckert, 1985). In Culebra, Puerto Rico, mean annual hatching success varied from 72.2%-76.8% for the 1984-1987 nesting season (Tucker, 1988). Hatching success rates in South and Central Brevard County, Florida for 1993-2000 has remained relatively constant at an average of 33% hatched.

The hatching success rates for leatherbacks on this study site are inconsistent with the hatching success rates of greens and loggerheads that nest in large numbers on the same beach. The hatching success is comparatively low with regard to loggerheads and green turtles on our study site. The cause for this comparatively low hatching success of leatherbacks is currently unexplained with the data available.

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BEHAVIOR AND DEVELOPMENT OF GREEN, LOGGERHEAD AND HAWKSBILL POST-HATCH: EIGHT YEARS LATER

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A comparative species analysis of green (*Chelonia mydas*), loggerhead (*Caretta caretta*), and hawksbill (*Eretmochelys imbricata*) hatchling sea turtles provides evidence that although the three species encounter similar ecological pressures, each species has a unique life history that is evident within weeks of their post-hatch development. The emergence of distinguishing life history characteristics may be related to the specific adaptations prepared for the utilization of diverse habitats (Musick and Limpus, 1997). Specifically, developmental characteristics of the three species may be primarily the outgrowth of evolved features for locomotion and migration (Wyneken, 1997).

That differences among the three species should be evident so early in their development attests to the precocial nature of the species; altricial species have relatively few distinguishing features. Table 1 compares the three species during the early post-hatch period (i.e., before one month of age) with respect to activity, orientation, reaction to weeds, reaction to simulated predation, learning, reaction to novelty, body size, coloration, and interspecific behavior. The table shows that there are multiple differences among species (although we have not had as much experience with hawksbill turtles) and large individual differences within a species.

Differences in behavioral and morphological characteristics among and within species over development call or further longitudinal analyses. (See Salmon and Horch in this volume.) To understand the development of individuals, one might correlate body size to size of the egg mass in a search for benchmarks that predict growth trajectories or patterns of maturation over time. Similarly, there are notable differences among individuals in response to the presentation of novel stimuli that may or may not be related functionally to some physical feature. For example, reactions among green hatchlings to novel stimuli ranged from calm inspection to frantic avoidance but the specific reactions of individuals have not been related to perceptual or locomotor abilities within the species. And while greens and loggerheads differed in their initial reactions to novel stimuli, both loggerheads and greens show a remarkable facility for learning simple relationships between events in their environments (Mellgren, Mann, and Arenas, 1998). Of course, even small initial differences can have large consequences if differences in learning accumulate over time. So, study of the traits and skills that influence learning and performance is essential to understanding other complex behavioral processes. Longitudinal analyses are essential for detecting continuities and discontinuities in development.

The large reaction range to novel stimuli observed among the species may be related in some systematic way to the omnivorous adaptation shown by the three species. It would be important to re-examine responses to novelty as dietary specializations emerge. Responsiveness to novelty at an early age may have predictive value for understanding the onset of exploratory behaviors in individuals including grooming and play as well as other interactions with inanimate and animate objects (Mann and Mellgren, 1998).

The range of individual differences is the raw material upon which natural selection works. While sea turtles are evolutionarily very old, substantial differences exist in their behavioral repertoires. Most observations have been made on nesting females and emerging hatchlings. If behavioral studies were limited to these developmental benchmarks, the data might lead one to believe that sea turtles are capable of only highly stereotyped responses. And if we were to generalize these observations to other behaviors and assume the fixity of responses, we would likely underestimate the variation between and within species. Finally, it is essential to understand and appreciate the sources of variation in their life history traits as well as the maintenance of that variance over generations. Future comparative work will include Kemp's ridley hatchlings.

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Table 1: COMPARATIVE HATCHLING CHARACTERISTICS

CHARACTERISTIC:	Green	Loggerhead	Hawksbill
Activity	Continuous swimming during daylight	Limited activity	Limited activity
Orientation	Swims toward brightest part of overhead sky	Floats without specific orientation	Floats without specific orientation
Reaction to weeds (real and artificial)	Avoids contact during day (except eating real weeds)	Rests in weeds both day and night	Rests in weeds both day and night
Reaction to simulated predation	Swims away when released	Immobile when released	Immobile when release
Learning	Readily associates stimuli that predict food; shows social learning	Readily associates stimuli that predict food; social learning understudied	Unstudied
Reaction to novelty	Rapid approach/contact with novel object; play	Moderate approach/contact with novel objects; more biting than play	Unstudied
Body size	Variable (150% difference) Large flippers relative to body size	Unstudied	Highly variable; over 300% difference
Coloration	Black carapace, white plastron; carapace changes to brown/yellow at 6-8 mos	Dark brown carapace; light brown plastron	Dark brown carapace; light brown plastron; mottled at 1 year
Intraspecific behavior	Calm, live easily together	Aggressive	Extremely aggressive

FORAGING BEHAVIOR AND INCIDENTAL CAPTURE OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) WITHIN THE CHESAPEAKE BAY, VIRGINIA, USA

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INTRODUCTION

The Chesapeake Bay and the coastal waters of Virginia serve as a principal developmental habitat for demersal juvenile loggerhead (*Caretta caretta*) and Kemp's ridley (*Lepidochelys kempii*) sea turtles (Musick and Limpus, 1997; Lutcavage and Musick, 1985). Sea turtles enter the Chesapeake Bay each spring/summer when the sea temperatures reach approximately 18° C (Bellmund et al., 1987; Byles, 1988; Keinath et al., 1987). Each year, between 200 and 300 sea turtle stranding deaths are recorded within Virginia's waters.

Some of the sea turtle mortalities may be attributed to entanglement in poundnet leaders (Bellmund et al., 1987): nets with large (>8 in/20 cm) mesh leaders set in the lower Chesapeake Bay where currents are strong and may entangle turtles when they first enter the Bay after the spring migration.

Poundnet stands are structures that consist of wooden poles driven into the sediment. These poles serve as a framework for mesh nets that are attached to the poles, typically forming three distinct segments: the leader, the heart and the pound. Poundnet surveys were conducted by VIMS in the 1980's and it was estimated that up to 33% of the sea turtle mortalities in Virginia were due to poundnet entanglement (Lutcavage and Musick, 1985). These entanglement events occurred beginning late May, slowly increasing through the first two weeks of June and peaking in late June (Bellmund et al., 1987). Very few entanglements were observed after June, indicating that turtles may be at risk of entanglement for only a fraction of their residence time in the Chesapeake Bay.

Another impact of poundnets on sea turtles is the incidental capture of live turtles within the pound. Questions that must be answered in order to fully understand the impact of the poundnet fishery on the Bay turtle foraging population include whether turtles are utilizing poundnets as a source of food and what the incidental capture rates are of live sea turtles.

METHODS

Since 1979, VIMS has conducted a sea turtle mark-recapture program in cooperation with local poundnet fishermen in the Bay. Turtles in our studies are taken by poundnets at the mouth of the Potomac River from May through November, coinciding with the season that turtles are present within the Chesapeake Bay. One fisherman based in the Potomac River has been supplying consistent data on incidental capture of sea turtles for the last 20 years. This fisherman has set between five and seven nets each season. All live turtles captured by him were reported to VIMS. All captured turtles that VIMS responded to were identified as to species and age class (adult or juvenile), flipper tagged with National inconel or monel tags, measured and weighed. Sick or injured turtles were rehabilitated by VIMS or cooperative rehabilitation agencies. All turtles were released unless illness, injury or death prevented re-release into the wild.

Telonics ST-14 and ST-6 satellite transmitters were used to track the at-sea movements of a sea turtle captured multiple times within poundnets in the mouth of the Potomac River since 1994. Data from the transmitter was archived and sorted based on accuracy of transmission. Location data were imported into ArcView 3.2 and a Kernel analysis for home range was performed using the Spatial Analyst and Animal Movement extentions. Only transmissions with high accuracy readings were used in these analyses. Kernel output contours were set at 95% and 50% confidence levels. The 95% contour is typically used to determine the area the animal actually inhabits or uses, and the 50% contour is used to determine the "core area of activity" (Hooge and Eichenlaub, 1997). Kernel analyses were performed for both seasons the turtle was observed as resident within the Chesapeake Bay, excluding the southern movements of the turtle's winter migration.

RESULTS

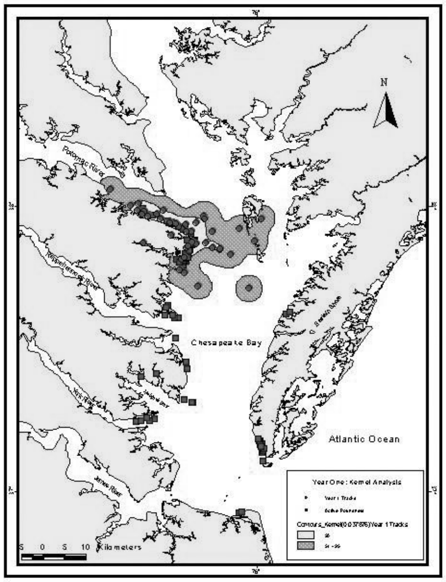
A total of 457 individual turtles were caught in the Potomac River fisherman's nets between 1980 and 1999. The majority (89.06%) of turtles were determined to be juvenile loggerhead sea turtles, with 7.62% adults and 3.32% that were undetermined. Of the 457 turtles caught, 363 turtles were originally captured and tagged from these nets. Fifty-four of these individual animals were caught subsequently by the same fisherman, representing a 14.8% return to the original site of capture. In addition to the initial tagging event, this fisherman has reported a total of 160 recaptures of these turtles, including multiple recaptures of the same turtles within a season and between seasons. Length frequency analysis indicates that most turtles (23.34%) were between 61 and 70 cm curved carapace length. Curved carapace lengths of all loggerheads captured ranged from 45.3 cm to 114.6 cm (n=406). Mean carapace length was 69.8 cm with a standard deviation of +/-13.16 cm. Weights ranged from 9.07 kg to 140 kg (n=400), with a mean weight of 42.23 kg (+/- 23.70 kg). Sex was determined in only 24 individuals based on tail size, laparoscopy, ultrasound or subsequent stranding and necropsy. Fifteen turtles were determined to be female and nine determined to be males.

The incidental capture of loggerhead sea turtles begins in May and increases within the first two weeks of June. Incidental captures peaked in the second half of June but then gradually tapers off until the fall when turtles begin their southern migration out of the Bay. This peak follows a peak in sea turtle strandings in the first two weeks of June within the Western Bay. The average number of loggerhead sea turtles that have stranded dead each year in the Chesapeake Bay since 1979 is 139.29 +/-59.98 (n=2925). Between 14 and 92 turtles have been captured incidentally in the Potomac River nets, with an average of 31.07 +/- 19.57 loggerheads caught per year (n=435). These data were compiled only for years in which turtles were reported to VIMS throughout the season.

The majority of turtles were seen only once and the ones that did return to the same nets did so over an average of three to four years. One turtle in particular was first captured in 1994 and was tagged (SSB-919), measured and released by VIMS personnel. At the time of first capture, the turtle was already close to adult-sized (97.8 cm CCL, 90.7 cm SCL). Measurements during the 1999 season (99.7 cm CCL, 91.2 SCL) indicate SSB-919 has had a slow growth rate in the past seven years. An ultrasound was performed and the presence of well formed eggs and egg follicles within the infundibulum and oviduct confirmed that this turtle was an adult female.

Satellite tracking data for SSB-919 illustrated that the she stayed within close proximity to the Potomac River nets during the time that she was resident in the Chesapeake Bay. This turtle was caught multiple times within a season both before and after being tagged with a satellite transmitter. She was tracked a second time the following year and exhibited a similar behavioral pattern. Kernel analysis of 'Year One' and 'Year Two' tracks indicate that this turtle exhibits a strong site fidelity to the mouth of the Potomac River and the area in which this study's poundnets are located. The area associated with SSB-919's home range (95% confidence contour) for Year One was 1261.5 square km, including a 50% confidence contour of 243.69 sq km (Figure 1). This includes two full months of tracking data before transmission failure while still in the Bay and within her home range. Year two, home range area was 1557.56 sq km with a 50% confidence contour of 305.86 sq km (Figure 2). This includes three months of resident tracking data before she began her southern winter migration. Between Year One and Year Two, the percentage of area overlap between the 95% confidence contours was 73.90%. Between the 50% contours of Year One and Year Two, there was 39.48% overlap. During Year Two, prior to her first movements south, she maintained residency in the Bay until the first week in November when sea surface temperatures, based on both VIMS pier data and satellite sensor data, were between 12° and 13° Celsius. Year Two tracks show that this turtle has established winter residency south of Cape Hatteras, North Carolina, mostly on the outer continental shelf at the edge of the gulf stream.

It is important to note that both loggerheads and Kemp's ridley sea turtles have been captured in the study's poundnets. However, the number of Kemp's ridleys captured (n=44) were much lower than the loggerheads (n=457). Kemp's ridleys also were not recaptured with the same frequency as the loggerheads. Of the 44 ridleys captured in our fisherman's nets since 1980, only two were recaptured in the same nets, and these turtles were recaptured only once.



DISCUSSION

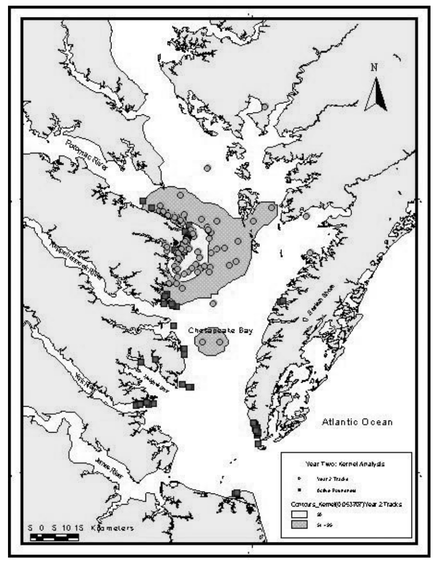
The poundnets used in the data analysis of VIMS mark-recapture data represent only a handful of poundnets that are present throughout the Chesapeake Bay. Many of the turtles captured within these nets were subsequently caught in other poundnets in the Bay. Our documentation of these recaptures is a conservative estimate at best since most fishermen have not regularly informed VIMS of incidental captures since the mid-1980's. Upwards of 250 to 300 poundnets set in the Bay in the 1980's and approximately 100 nets currently set in the Bay during the season when turtles are resident in Virginia's waters (Mansfield et al., 2001).
Few data are available on the frequency of incidental captures within other nets in the Bay over time. More data are needed regarding whether there is a higher concentration of foraging turtles near the mouth of the Potomac River, or whether the frequency of incidental capture is consistent throughout the Bay. Regardless, the high number of loggerhead turtles caught per year within the Potomac nets alone has strong management implications. The VIMS mark-recapture study illustrates that some turtles show fidelity to particular nets and will return to them year after year, indicating that turtles actively interact with poundnets. This behavior must be considered when developing management plans.

Home range analysis of SSB-919 for the two seasons she was tracked indicated that her concentrated home range (represented by the 50% confidence contour) was a bit larger than the area within which the Potomac River poundnets occupied. After satellite attachment, this turtle was also found in another fisherman's poundnet just south of the Potomac River mouth near Reedville, Virginia. The high percentage (73.90%) of home range overlap between Year One and Year Two further supports the hypothesis of foraging site fidelity for this turtle. In determining home ranges for foraging sites, more incidentally captured sea turtles should be satellite tagged over multiple seasons.

The fact that Kemp's ridleys were not recaptured with the same frequency as the loggerheads may be a result of differences in habitat preference and foraging patterns between the two species. Radio tracking data of both species in the Bay indicate that loggerheads preferentially orient towards the outflows of rivers and along channels, foraging with the tides (Byles, 1988). In contrast, Kemp's ridleys were found to stay within shallower areas less affected by tidal flux (Byles, 1988).

Acknowledgements:

The VIMS sea turtle mark-recapture program could not exist without the dedication and help of Virginia poundnetters and watermen. Thanks are also extended to every sea turtle student, summer aide and laboratory technician who have worked on this project. Thanks to Bob George for his donated time and veterinary skills; and to Bobby Harris, Jr. for his assistance in developing the VIMS tagging database.



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INTERNESTING MOVEMENTS AND HABITAT UTILIZATION OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*) IN VIRGINIA, U.S.A

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INTRODUCTION

Virginia, is one of the northernmost nesting area regularly utilized by loggerhead sea turtles (*Caretta caretta*) on the East Coast of the United States. While it is rare for female loggerheads to nest north of Cape Hatteras, North Carolina, Virginia typically records between two and ten nests annually. Virginia's nesting season begins in late May, continuing through mid to late August (BBNWR, 1993). These nests have been historically documented on the southern shoreline of Virginia, within Back Bay National Wildlife Refuge (BBNWR), False Cape State Park (FCSP) and adjacent beaches near Sandbridge, and Virginia Beach. Adult female loggerheads have been observed to utilize the Chesapeake Bay as an internesting or foraging habitat, and compose approximately five percent of the turtle population within the Bay (Musick and Limpus, 1997).

The U.S. Army Corps of Engineers (ACOE) has utilized hopper dredges off the coast of Virginia to obtain sand for placement on oceanfront beaches along Virginia Beach for over a decade. Hopper dredging and beach nourishment are activities which have the potential to adversely affect sea turtles, either directly by encounters with dredging equipment or indirectly by alteration of nesting habitat (Coston-Clements and Hoss, 1983). This potential threat can be minimized by gathering life history data on the sea turtles inhabiting Virginia's waters and nesting along the shoreline. These data in turn may be applied to the refinement of time constraints for offshore dredging operations as well as to help determine other alternatives that may prove useful in protecting the turtles and their habitat.

Since 1992, VIMS has tracked female turtles found nesting within Back Bay National Wildlife Refuge in order to better understand the internesting movements of these turtles. The primary objectives of this study are to determine whether Virginia nesters are utilizing the Chesapeake Bay as internesting habitat, and to better define the temporal distribution of nesting sea turtles within Virginia's waters using satellite telemetry.

METHODS

Beginning in May and continuing through September, personnel and volunteers from the Back Bay National Wildlife Refuge (BBNWR) and the Virginia Marine Science Museum conducted a combination of daytime and nighttime sea turtle nesting patrols on the beaches from the northern limit of Sandbridge Beach to the southern limit of BBNWR at the North Carolina border. After nesting, the turtles were restrained and a satellite transmitter was attached to turtle's carapace. Telonics ST-14 and ST-6 satellite transmitters were used to track the at-sea movements of these turtles. After tag application, each turtle was immediately released at the nesting site location.

Data are accessed via the internet and email. Location, day and time of reception, and probability of location accuracy were among the data received, as are data on sea surface temperature, pressure, dive count and duration of last dive. All transmitter data were archived and sorted based on accuracy of transmission. Movements and behavior were monitored until positions were no longer received and transmission ceased.

RESULTS

Since 1992, VIMS has attached eight satellite tags to female turtles found nesting within Back Bay National Wildlife Refuge. The first turtle was tagged on July 30 of 1992, and was observed to travel from Virginia Beach down to the northern coast of Florida within a two-month timeframe. Between August 5 and 10, the turtle remained off shore of Cape Hatteras, North Carolina, after which she slowly moved south. By the 4th of September, the turtle appeared to remain off the east coast of Florida until transmission failed on September 8, 1992 (Keinath, 1993).

In 1993, a turtle was tagged on July 12 and subsequently remained within Virginia waters just off shore of BBNWR and FCSP until July 28, 1993. Upon last transmission (16 days after tag attachment), this turtle had moved slightly north to the southern tip of the Eastern Shore. This same turtle was found nesting on August 14, 1995, and was again tagged and tracked by VIMS. This time the turtle moved directly north into Delaware Bay where she remained until the transmitter failed on September 7, 1995. On July 15 1997, this turtle returned to nest a third time at BBNWR and VIMS had the unique opportunity to tag and track this turtle for a third season. The transmitter was activated early in the nesting season and the turtle was tracked through a second nesting event (confirmed by BBNWR personnel). Shortly after her first nesting event, this turtle moved up into the Chesapeake Bay where she remained until her second nesting event on BBNWR on July 31, 1997. After her second nest, she was tracked up to the Delaware Bay where she remained for the rest of the summer. After the first cold snap (October 18, 1997) she began her southern winter migration. The last transmission was received off of Cape Hatteras, NC on November 1, 1997.

In addition to the four tracks listed above, a nesting turtle was tagged on July 8, 1994 and observed to move south in late July, rounding Cape Hatteras on July 12th. She continued to travel south, remaining near shore and entered Florida's waters by mid-August. Continuing south past Cape Canaveral by August 24th, this turtle eventually stopped transmitting mid-October west of Key West, Florida. On August 25, 1996, another nesting female was tagged and tracked in the coastal waters immediately adjacent to BBNWR, FCSP and the northern shoreline of North Carolina for two months before migrating south on November 3rd. She continued to move south past Cape Hatteras on November 11th, finally entering Florida waters on December 6, 1996 where she continued to travel south along the shoreline. After rounding the southern tip of Florida on February 14, 1997, the final transmissions for this turtle were received on February 22, 1997 off the west coast of Florida in the Gulf of Mexico. A second nesting female was tracked by VIMS on July 22, 1997. This turtle remained close to shore in the waters adjacent to BBNWR, FCSP and northern North Carolina until October 18, 1997 when the last transmissions were received.

During the summers of 1998 and 1999, several turtle crawls and nests were recorded within BBNWR. However, due to difficulties experienced by BBNWR personnel and volunteers, nighttime patrolers did not physically encounter a nesting turtle during 1998 or 1999. As a result, VIMS was unable to utilize satellite telemetry to monitor the at-sea movements and behavior of loggerhead turtles nesting during the 1998 and 1999 seasons. On July 12, 2000 season, nighttime patrollers were successful in encountering a nesting turtle. This turtle immediately moved south remaining very close to the shoreline of the Outer Banks, North Carolina. On August 4th she entered into Pamlico Sound through Oregon Inlet, moving between the Sound and Inlet several times between the 4th and 16th of August. Temperature data from the satellite transmitter coupled with NOAA Buoy and sea surface satellite data confirmed her presence in the warmer waters of the Sound. Transmission ceased on August 16, 2000, thirty six days after tag application.

Mean curved carapace lengths (CCL) for all nesting turtles tracked by this project (n=8) was 97. 80 cm +/- 7.73 cm. CCL measurements ranged between 90.1 cm and 109 cm, with four satellite tags applied to turtles with a CCL less than 95.5 cm. Temperature ranges within which tagged turtles remained range between 13° and 31° C with a mean temperature of 23.09 +/- 3.18° C. Three tagged turtles remained in Virginia's waters until sea surface temperatures dropped to between 13° and 16° C before migrating south.

DISCUSSION

The 1997 tracking season produced some exciting data: having tracked the same turtle three separate times during the 1993, 1995 and 1997 nesting seasons, these tracks indicate that this turtle executed all nesting activity on Virginia beaches and then migrated north to her internesting habitat. This is also the first nesting female we have satellite-tracked for more than one nesting event. These data illustrate that some loggerhead sea turtles consistently use Virginia's beaches as a suitable nesting site and utilize the Chesapeake and Delaware Bays as internesting habitat.

Some of the adults tracked moved south immediately after their nesting event in Virginia. Three of the tracked turtles southward movements began in late July. Two of these turtles traveled south to Florida where winter residency was established prior to transmission failure. These adults began their southward migration much sooner than juveniles tracked by VIMS in the early 1990's (Keinath et al. 1992; Keinath, 1993). It is possible that some adults may only use Virginia's waters and beaches as nesting habitat, moving south after the last nesting event, or to nest again on southern beaches. Other turtles, however, like the turtle we tracked over the 1993, 1995 and 1997 seasons, utilize the Chesapeake Bay and Delaware Bay as interesting and possibly foraging habitat.

No data have been collected to determine the genetic stock of the adult nesters in Virginia. Juveniles utilizing the Chesapeake Bay as summer foraging grounds are comprised of both the South Atlantic and North Atlantic loggerhead sub-populations (Norrgard, 1995). Virginia hosts the northern most nesting beaches along the east coast of the United States. This would suggest that Virginia nesters should belong to the northern population. However, over-wintering patterns allow the possibility that both northern and southern loggerhead populations are represented. Future work should include a genetic analysis of Virginia's nesting stocks as well as analyzing dive and pressure data. More data will be collected in the year 2001 to better define the nesting behavior and patterns, as well as internesting movements for adult female loggerheads in Virginia waters.

Acknowledgements:

Thanks are extended to BBNWR personnel and volunteers, especially Sarah Williams and Lamar Gore for their dedication to the project. We are indebted to the Virginia Marine Science Museum's enthusiastic volunteers who patrolled the nesting beaches often under adverse field conditions. We'd also like to thank the Army Corps of Engineers for their continued support of this study. Finally, huge thanks are extended to John Keinath and Deb Barnard for laying the foundations of this project.

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THE TAMAR VISITORS CENTER AT PRAIA DO FORTE: A CASE-STUDY IN PUBLIC EDUCATION AND SELF-SUSTAINABILITY FOR CONSERVATION

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Projeto TAMAR-IBAMA initiated its activities in 1980 with a survey of the Brazilian coast, aimed at identifying sea turtle species, their distribution, status and main threats. The results led to the creation of the first three conservation stations, located at Regência, Pirambu, and Praia do Forte (Marcovaldi & Marcovaldi, 1999). The later was strategically selected as the program's headquarters for geographic and biological reasons, and located 80 km north from Salvador, the State capital. The Northern coast of Bahia State (220 km) was identified as having the largest concentration of sea turtle nests (for species *Caretta caretta*, *Eretmochelys imbricata*, *Lepidochelys coriacea* and *Chelonia mydas*), hosting 50% of the recorded number laid on continental beaches. The station began its activities in 1982. Besides the main office and fieldwork installations, it has a Visitors Center, which receives 350,000 (est.) people each year. The Visitors Center, the office and the conservation station are located in a Naval area, and share the scenery with a lighthouse.

During the first nesting season working at Praia do Forte, the team found a critical situation: 100% of the nests were exploited by people. It was necessary to choose a conservation technique capable of protecting nests and guarantying hatchling birth. Nests were then transferred to an area on the nesting beach constituting an open beach hatchery. The birth of hatchlings made it possible for the villagers, specially the children, to establish the long lost relationship between eggs and turtles. Hatchling releases joined by youngsters and adults were the first concrete experience towards gaining their sympathy and cooperation.

These positive results stimulated the TAMAR staff to build small seawater tanks where people were able to observe the turtle's behavior, identify the different species and different life stages. This way their interest in these animals increased. This strategy led to community consciousness and participation. Gradually it became possible to keep more and more nests at their original places (*in situ*). Currently an average of 2,500 nests per year are recorded in this region, of which 77,8% are kept *in situ*.

With time, this TAMAR station became an attraction to the tourists that eventually arrived at the locality. The sea turtles rapidly became famous, and therefore attracted more people to enjoy the beauty and quietness of the region. The evident educational potential of this small structure, led to an investment of time and funds towards its improvement, resulting in a greater capacity to spread the sea turtle conservation message. One of the old Brazilian Navy houses that existed in the area became the Sea Turtle Museum. Within this building, information panels and other educational pieces could be exhibited, and videos could be presented.

Currently Visitors Center is equipped with 8 sea-water tanks, aquariums, a museum with information panels, TV and video, 5 life-size sea turtle models and 5 outlines of the species occurring in Brazil, 3 shops, a restaurant and a bar. The seawater tanks display the minimum number of turtles of different ages and species required to reach the educational objective; a touch pond where visitors can experience the sensation of touching harmless reefs animals; and 6 aquariums with reef animals and fish found in the region.

Besides the infrastructure development, an important aspect of the evolution of the visitors center was a change from its entirely educational objective to also be used for fund raising. The services and products offered through the shops, restaurant, and bar, mixed with information about sea turtles and the TAMAR program, captivate the visitors. They in turn contribute through the consumption of what is offered. Visitors to the shops are willing to buy a t-shirt with the knowledge of their participation. Since 1997 a small admissions fee has been charged for visiting some of the exhibits. Through these contributions, it was possible to make improvements, offer better veterinary care for the turtles in the tanks, create new exhibits, and improve maintenance, while also investing in sea turtle protection.
An associated program with the Visitors Center is "Tartarugas by Night" (Vieitas & Marcovaldi, 1997), where tourists can symbolically adopt a sea turtle and participate in a guided tour by biologists, while learning of the management activities of TAMAR. An extension of the Visitor Center also takes place through traveling exhibits. These exhibits take the conservation message to cities and other centers, where a larger number of people can be reached. All the exhibits were derived from the experience gained from the Praia do Forte Visitors Center.

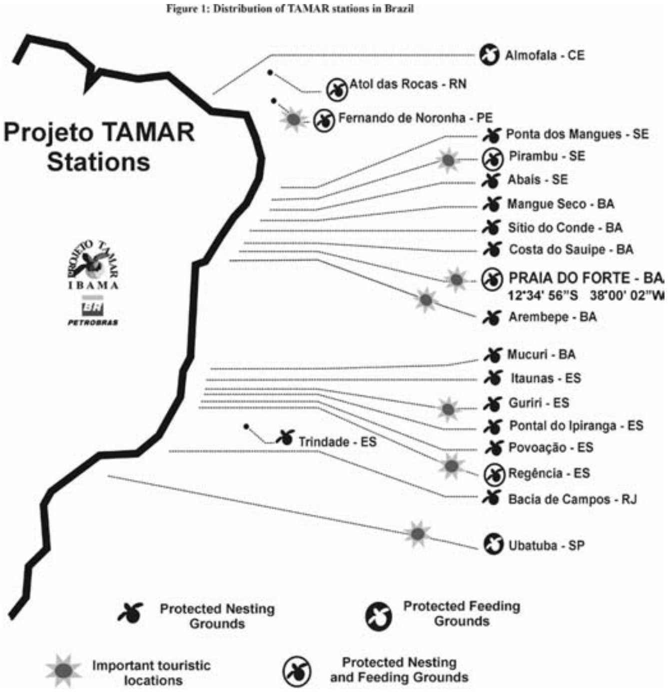
Currently the TAMAR station at Praia do Forte hires approximately 80 people from the local community, resulting in the station being the second major employer in the region. The creation of jobs through new income alternatives has always been a TAMAR strategy, by conserving sea turtles through community integration and benefits.

The Visitors Center is also a training tool. Interns receive a good experience keeping the turtles in the tanks, learning how to manage the animals and to identify different species. One of the Visitors Center's most successful training initiatives is the "Mini-Guides Program" (Vieitas, Lopez & Marcovaldi, 1999), where each year 25 local students (9-13 years of age) receive basic information about marine ecosystems and sea turtles, strategies to promote their conservation, and skills to interact effectively with tourists. Thereafter they have an opportunity to join the TAMAR team and work at the Visitors Center. Other tourism guides also receive periodical training as a way to guarantee that the visitors will receive correct information.

Veterinary studies are also carried out within the Center as captive animals may develop several diseases and can be of great value for research. Some of the seawater tanks can be isolated for keeping sick animals or even for rehabilitation of injured or sick turtles found in the wild.

With time TAMAR has realized the importance of having a structure capable of bringing to the public information about sea turtles and their conservation, in order to create a supportive public consciousness for sea turtle protection. In a larger context, visitor centers can assist with publicizing the importance of environmental protection, by concentrating information in established locations and presenting such information in an understandable format. Visitors' centers can also assist with minimizing visitor impacts in sensitive areas, such as biological reserves with restricted use and access.

Figure 1: Distribution of TAMAR stations in Brazil



Critical to the success of this Visitors Center and its activities is that Praia do Forte has a development plan which established rules for land use and occupation. As a result the locality's growth has been organized, thus maintaining natural areas, keeping its biological importance, and being strongly oriented towards ecotourism. It has become a well-known national and international destination. Currently the growth of the local economy is based on ecotourism, characterized by the continuous development of hotels, restaurants, bars, tourism and ecotourism agencies, etc.

As a result, the Visitors Center receives national and international tourists and also weekend vacationers from Salvador. The tourism high season is linked to school vacations in Brazil and wintertime in the Northern Hemisphere (December to February in the summer, and July in the wintertime). Peak visitation occurs from mid December to mid January with an average of 1,300 visitors per day.

The experience and knowledge gained at the Praia do Forte Visitors Center is being used in other TAMAR stations. Six other TAMAR visitors centers have been established at other stations where tourism is also prevalent. Together with exhibitions and other resource centers more than 1 million visitors each year are oriented through these centers and Praia do Forte alone receives 33% of this total (Ubatuba 11%; Regência 2%; Guriri 6,5%; Arembepe 8%; Pirambu 7%; Fernando de Noronha 5%; Praia do Forte 35%; exhibitions and information centers associated with the stores 28%).

Acknowledgements:

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KEMP'S AND OLIVE RIDLEY SEA TURTLES POPULATIONS STATUS

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The Kemp´s (*Lepidochelys kempii*) and Olive (*L. olivacea*) Ridleys, the first one the most endangered sea turtle (TEWG, 1998) the second, the more abundant in Mexico, both of them in recovery status (Márquez et al., 1996a,b, in press) are assessed their abundance along the nesting beaches, analyzed the density during breeding periods and the effect of this density on survival rates as a response of the species to different environmental situations.

Olive Ridley Turtle

The genus *Lepidochelys* is prone to form massive aggregations to nest called "arribazones", but it is not clear what is triggering such behavior. If the turtles are captured in front of nesting beaches, the gathering routine of the females is disrupted and some arrivals are lost, but with simple protective measures, like stop fishing five days before and after the arrivals, they are reactivated. A clear example is shown when in 1990 a Total Ban of Sea Turtles was decreed in Mexico (DOF, 1990) and the capture in front of "La Escobilla" beach, Oaxaca State was halted, soon after the arrivals were rapidly recovered and because in this beach the hatchling recruitment never stopped since 1967, it was observed that with this measure the size of the population and number of arrivals increased dramatically (Márquez-M. et al., 1996b), also in some way the use of TED´s can be assisting to this recovery.

In "La Escobilla" beach, the surveys and protection of Olive Ridley started in 1967, but since 1973 the evaluation of the nesting has been undertaken with more care. An annual basis approach of density of nests in sampled fractions of beach is presented, considering in this analysis those turtles that effectively were nesting. "La Escobilla" is a sandy beach whose length cover 7 km between two temporal river bars and small salt marshes in the land side. Usually the "arribazones" cover between 1 to 3 km by event, annually occurs between 9 to 14 arrivals and they are sliding all along the beach, in such way that at the end of the season all the beach has been used by the turtles. For this approach we consider that the beach was used in homogenized way, more detailed analysis will be presented in a future paper. The result of the nesting density for every season is presented in the Figure 1, the density was determined in stretches of beach with 10 m wide (sea front, after the spring tide line) by 30 to 50 m of bottom, over the dune, this samples were made every 100 m along the beach occupied by the arrival. The lowest value of density was 79.6 nests in the season of 1988, up to 1598.3 nests in the 2000. The survival rate during incubation is attached to the nests density, in such way that more eggs produces less success of the hatching. In this species the incubation elapses around 45 days and the frequency of "arribazones" occurs between 10 to 30 days, resulting from this behavior that it is very common to see breeding females, during subsequent nesting activities, destroying their eggs, embryos and hatchlings. In such conditions the hatching success produces survival rates, in "La Escobilla", usually less than 20 to 30%. This rate in Nancite beach, Costa Rica, was reported to be lower than 5% (Steve Cornelius, pers. com.).

Rough calculation of the weight of eggs produced by season, in "La Escobilla": Each nest of Olive Ridley have at least 100 eggs, each egg weight around 32 g (Márquez et al. 1976). Under the former conditions, the Table 1 gives a figure on how many tons of protein are lost every season and from the utilitarian point of view it is assumed that an important part of the egg production can be harvested, without producing any problem to the turtle population and with the possibility that in certain point of use the survival rate will be optimized.

Kemp´s Ridley Sea Turtle

As a consequence that in Mexico the Turtle Research and Conservation Program was started since 1966 (Márquez-M., 1996), not only several populations of the Olive Ridley and other species were responding in positive way but also the Kemp´s Ridley. Nevertheless if we compare the nesting densities between both species, the situation is very different, in fact the Kemp´s in spite of its fragile situation, as endangered species, during the nesting she never have had problem for space availability at inter specific manner, neither overlap its season with the Green Turtle (*Chelonia mydas*) which nest in the same beach but in different space and time (Márquez-M., 1994).

This turtle as the former species nests 2 or 3 times per season, principally every 2 years. The species nests between south of Texas up to northwest of Veracruz and uses for nest a segment of sandy dune whose amplitude averages between 20 to 30 m wide, over the spring high tide. This beach runs continuously along the coast line of three States: Texas, Tamaulipas and Veracruz and it is only interrupted just by river mouths, ports and some resorts.

At the beginning of the protection and research work of the Kemp´s Ridley, between 1966 to 1967, were covering only 13.4 km of beach, since 1968 up to 1977 the patrolling was increasing up to 26.7 km and after 1978, when started the bi-national program (TEWG, 2000), the protected beach was growing year by year up to reach a length of 47.9 km. In the frame of this report it is including only three contiguous beaches: Tepehuajes at north, Rancho Nuevo at the center and Barra del Tordo in the south, clearing up that for the density calculation were not used the new expansions of patrolling beaches, which actually embraces up to 231.4 km (Márquez et al., 1996a, in press).

During the first years of work (1966 - 1968) the density in each stretch of 100 m of surveyed beach, along the 13.4 km under patrolling, was 43 nests. Some time after the density was decreasing continuously up to reach 1.9 nests/100 m in 1990, when were covered 47.9 km. After that year rapid increments were observed up to reach 12.2 nests/100m of beach, along the same 47.9 km, for the last season (2000) (Figure 2).

Figure 1. Annual cumulative size of arribazones in number of nests and change in the density of nests, sampled by sectors of 10 m, in the beach of La Escobilla, Oaxaca.

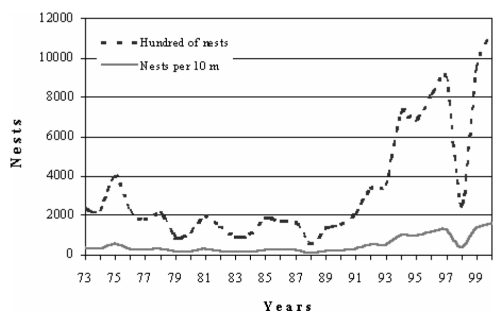

Figure 2. Change in the density of nests laid by Kemp´s Ridley sea turtle in three beaches of Tamaulipas, México and km of surveyed beach, between years 1966 and 2000.

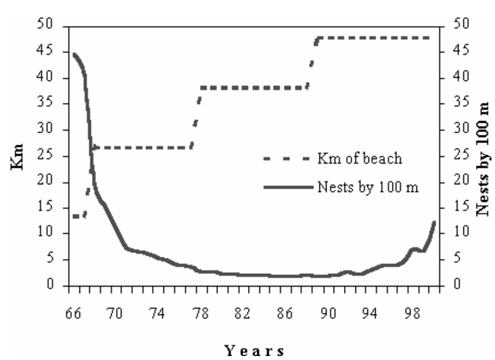

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Table 1. Number of nests (*1000) laid in "La Escobilla", Oaxaca, and quantity of eggs produced and lost by season. Weight in metric tons.

Years	Nests*	Tons	70% Lost	80% Lost
1990	154	492.8	344.96	394.40
1991	214	684.8	479.36	547.84
1992	340	1088.0	761.60	870.40
1993	357	1142.4	799.68	913.92
1994	719	2300.8	1610.56	1840.64
1995	679	2172.8	1520.96	1783.24
1996	816	2611.2	1827.84	2088.96
1997	895	2864.0	2004.80	2291.20
1998	248	793.6	555.52	634.80
1999	898	2873.6	2011.52	2298.88
2000	1119	3580.8	2506.56	2864.64

DO ARCHIMEDES AND BOYLE DETERMINE THE ENERGETIC COSTS OF DIVING GREEN TURTLES?

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The green turtle (*Chelonia mydas*) is an air-breathing marine reptile that spends over 99% of its time underwater. Descent and ascent rates of their dives are thus fundamental aspects of their behaviour when at sea. Green turtles are relatively "shallow" divers and dive with inflated lungs. Therefore, the main factor altering buoyancy during the course of a dive is the volume of air contained in the lungs. During descent, the lungs will become compressed in accordance with Boyle's Law of gas compression. Moreover, following Archimedes' Principle, the upward buoyant lift due to the low-density air in the lungs will decrease in intensity as the lung volume decreases. By adjusting the volume of air they inhale before submerging, green turtles can vary the depth at which they achieve neutral buoyancy. The greater the lung volume at the start of the dive, the greater the depth of neutral buoyancy, and the longer the dive duration will be (as oxygen stores are larger).

We investigated the diving behaviour at-sea using high resolution Time-Depth-Recorders (TDRs) that were attached to green turtles from Ascension Island. Five internesting turtles were displaced by boat and the TDRs were recovered after the turtles had returned to the island. The study found that turtles descend fast upon leaving the surface, and progressively reduce their vertical speed until they reach their depth of neutral buoyancy. We hypothesise that this behaviour minimises the time spent swimming where they are the most positively buoyant, i.e. upon leaving the surface.

If green turtles do rest at depth when migrating, optimising descent behaviour with positive buoyancy changes at depth will be fundamental for the successful accomplishment of long distance migration. The study will model the behaviour a diving turtle should adopt in order to minimise its descent costs when performing open-water resting dives.

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SIGHTINGS OF GREEN TURTLES (*CHELONIA MYDAS*) TAGGED WITH THE "LIVING TAG" TECHNIQUE

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INTRODUCTION

Through time there have been carried out investigations with marine turtles with the purpose of establishing their populations and their migratory routes. During the last decade, the marine turtles have been marked using different techniques, among them it highlights the "living tag" technique, developed by L.P. Hendrickson and J.R. Hendrickson in 1980, with different species (*Chelonia mydas* , *Caretta caretta* , and *Lepidochelys* kempi) in four areas (Miami, Island Great Cayman, Galveston and Honolulu).

In 1990, the Centro de Investigaciones de Quintana Roo (CIQRO), started the "living tag" technique as a project in a beach called Xcacel in Quintana Roo, Mexico. This area was chosen for its highest arrivals density of green turtle (*Chelonia mydas*) and loggerhead turtle (*Caretta caretta*). In the last 3 years juvenile turtles have been sighted with living tags in the costs of Quintana Roo (Boca Iglesia, Isla Mujeres, Xel-ha, Xpu-ha, Cancun, Cozumel and Akumal Bay). At the moment, few photographic registrations that give pursuit in the natural environment to the marked turtles with the living tag technique exist. The present work shows some of the pictures captured by the photographer's lens Sheldon I. Aptekar of some turtles marked in the program of Xcaret, taken in Akumal Bay in Quintana Roo, Mexico.

OBJECTIVES

Show the results of some sightings of green turtle (*Chelonia mydas*) in the central Coast of Quintana Roo, Mexico marked with the living tag technique in Xcaret Park.

METHODOLOGY

The intensive tagging of hatchlings is carried out with green turtles (*Chelonia mydas*) and loggerhead (*Caretta caretta*). The hatchlings that are used come from the beach of Xcacel, they are transported in special containers to the Park Xcaret at few hours of having been born for their tagging with the living tag technique.

At the end of the day the tagged turtles are returned to the beach they were born at to be released at night. The staff disinfects their hands, and then proceeds to dry off, to clean and finally to disinfect the turtles that will be tagged with the living tag technique. This technique consists on carrying out a circular cut of 3 mm of diameter made with a biopsy punch in the central part of one scute of the back or carapace, then it is carried out a similar cut in the central part of one of the ventral scutes or plastron. The tissue of the carapace is darker, so it will be placed in the ventral area which is lighter, and in the same way the tissue from the plastron wich is white will be placed in the darker area of the carapace. These tissues are glued with a surgical paste and with time will be part of the scute where they were implanted. The dorsal tag means the year they were born and the ventral tag means the beach where they were born at.

Of all the turtles that are tagged and later on released to the sea, in Xcaret Park the hatchlings of the last two nest of the season are kept for one year, with the purpose of maintaining an initiation program. In this program the hatchlings remain in ponds for one year, where one of the objectives is to register their development in captivity. Also, medical studies are carried out that give pursuit to their health state, this finally allows us to determine which turtles will be released at the end of the year. Once selected the turtles that will be released, a metallic monel tag is applied between the second and third flake of the front left fin, this tag presents the address of Xcaret Park and a serial number as part of the general information from the Protection Program to the sea turtles of Quintana Roo. The turtles of the initiation program are released in Xcaret Park as part of an environmental education program for more than 300,000 visitors (mexican and foreign).

RESULTS

From 1990 to 2000, 40,681 green turtles (*Chelonia mydas*) and 54,324 loggerhead turtles (*Caretta caretta*) marked with the autoinjerto technique have been released. In December of 1993, started the Initiation Program, and from November of 1994 until February of 2001, 864 green turtles (*Chelonia mydas*) have been released. From 1997, was registered the first sightings reports in the coast of Quintana Roo. The area that presents numbers of avistamientos it is the Bay of Akumal, where he was carried out a report with photographic registrations taken by Sheldon I. Aptekar, which show that in 1998 white three turtles were observed (*Chelonia mydas*) marked in the Park Xcaret with the autoinjerto technique. The first turtle receives the name of Clonia and you/he/she presents an alive mark that corresponds to the year of 1993, the second turtle she receives the name of I Toss and you/he/she presents an alive mark that corresponds to the year of 1993, and the last turtle receives the name of Ino and you/he/she presents an alive mark that corresponds to the year of 1996. Later on, in 1999 the white registrations of 6 turtles are presented (*Chelonia mydas*) that present alive marks corresponding to the years 1991, 1993 and 1995.

CONCLUSIONS

With base in the avistamientos of the Bay of Akumal, the necessity is presented of carrying out a program that he/she allows to observe the adult I number of turtles in wild state and this way to obtain recent information of sizes, weight and state of health. On the other hand, the data that are obtained can be used to carry out comparisons among the information of the turtles that you/they stay in captivity and those that are in free state.

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REPORT OF LACK OF PIGMENTATION IN LEATHERBACK HATCHLINGS *DERMOCHELYS CORIACEA* IN CIPARA BEACH, PARIA PENINSULA, SUCRE STATE, VENEZUELA

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During the development of the proyect Sea Turtle research and conservation in Cipara, Peninsula de Paria were obtained hatchlings with lack of pigmentation of Leatherback turtle *Dermochelys coriacea*, distributed like this: 27 live hatchlings, 2 dead hatchlings and 4 embryos; coming from three nests, of which two belong to a same turtle and the third one is unknown due to the nest was find but not the turtle responsible of this.

This hatchlings with lack of pigmentation were released with the other hatchlings and they had similar characteristics (to those of the normal hatchlings of *Dermochelys coriacea*) like corporal size and vigor.

Preceding reports about this, indicate the presence of hatchlings with lack of pigmentation in this species, but usually in small numbers where the most dont hatch and those who made it were apparently weaker than the normal hatchlings.

APPLICATION OF RECENTLY DEVELOPED MICROSATELLITE MARKERS IN OLIVE RIDLEYS AT 'LA ESCOBILLA', MEXICO.

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INTRODUCTION

Until recent developments in molecular genetics, analysis of the genotype was usually indirect and limited to a small number of markers. Exciting developments in DNA technology now provide scientists and wildlife managers with a wide array of genetic tools. Among the newly developed markers are microsatellites. They generally consist of short (two to five base pairs) tandemly repeated arrays, which appear to be abundant and dispersed broadly throughout the eukaryotic genome. Microsatellite loci are highly polymorphic on account of differences in the number of repeat units, show codominance, neutrality, and the primers used to amplify them are commonly equally applicable among closely related species. These characteristics make microsatellites markers, a useful and powerful tool for population studies.

FitzSimmons and co-workers (1995) were the first who designed microsatellite primers for sea turtles that, interestingly, were useful for all sea turtle species because their loci were highly conserved. These loci, and others recently developed, have proven useful to study genetic variability, sperm storage, stock identification, population structure, and mating systems in the different sea turtle species.

The usefulness of a particular molecular marker will depend on the observed level of polymorphism and the distribution of allele frequencies and these parameters (and hence their usefulness) varies between species and populations for the same locus. In the current study we applied four microsatellite loci in the Mexican rookery at "La Escobilla" in order to analyze their utility for further studies in this rookery (on mating systems, for instance).

LA ESCOBILLA ROOKERY

The olive ridleys of Oaxaca supported, in the 1960s, most of the commercial exploitation of sea turtles in Mexico. The capture of this species reached such high levels that it became over exploited (Márquez et al., 1990). La Escobilla is located in the coast of Oaxaca. It is 22 km long although only eight-km are used commonly for nesting.

Márquez (2000) mentions that after decades of protection, the size of the olive ridley rookery at La Escobilla now shows an increasing trend, with over 800 000 nests per year. Furthermore, Peñaflores and co-workers (2000) report an increment of the number of arribazones per season in the last ten years; an enlargement of the nesting season from six to 11 months; and a shortened inter-arribazon period, from 28 to 17.4 days. From this, they hypothesize the existence of several reproductive groups. These characteristics make La Escobilla, one of the most important olive ridley´s rookeries in the world and a very interesting subject of study to compare with other populations exhibiting different characteristics.

OBJECTIVE

Analyze microsatellite loci recently developed from sea turtles, in order to evaluate their utility for further studies of the *Lepidochelys olivacea* rookery at La Escobilla, Mexico.

METHODS

Blood samples were taken from the dorsal cervical sinus from 50 nesting females and 30 adult males captured in adjacent waters of "La Escobilla", from October 1999 to November 2000. Blood samples were stored in lysis buffer (Dutton, 1996).

DNA was isolated from blood samples using a standard phenol-chloroform extraction and ethanol precipitation. The extraction products were verified for quantity and quality by 2% agarose gel electrophoresis, along with a molecular weight marker. PCR amplification is being conducted for four microsatellite loci, LB106 and LB107 developed from leatherbacks by P. Dutton (unpublished), but also CM72 and CM84 developed from green turtles by FitzSimmons and co-workers (1995). Loci are amplified by PCR and products separated on 8% denaturing polyacrylamide gels. Bands are visualized using silver staining. The genetic analysis is a work in progress in the Laboratory of Genetics at the Universidad del Mar, Puerto Ángel, Oaxaca.

Genotypes will be obtained based on the relative mobility of the alleles. The analysis will consist of determining the number of alleles, their frequency per locus, and the observed heterozygosity. The frequencies will be tested for congruency to Hardy-Weinberg equilibrium expectations at each locus and linkage disequilibrium for each pair of loci.

RESULTS

ADVANCES TO DATE

We have successfully set up all the necessary techniques for microsatellite analysis in the Laboratory of Genetics that was recently initiated at the Universidad del Mar. To date DNA of 80 individuals have been extracted and verified for quantity and quality. We have determined the PCR optimal conditions for two of the four loci and currently standardizing polyacrylamide gel electrophoresis conditions in our laboratory for these two loci.

As primers for microsatellite loci LB106 and LB107 were recently developed, they have not been tested in any population yet. In this work we expect to analyze both loci in about 80 individuals which will provide a first approximation of polymorphism and provide a measure of their utility for general studies regarding gene flow and mating systems in this species. Loci Cm72 and Cm84 have been applied in several cases on olive ridley populations, all of which show that both loci are polymorphic and with high levels of heterozygosity (Table 1). Nevertheless, we believe that La Escobilla rookery has so many particular characteristics that it is necessary to analyze a larger sample of individuals and, as mating couples are readily approachable, determine and compare genetic characteristics of males with those of nesting females.

DISCUSSION AND CONCLUSION

The analysis of the parameters of loci LB106 and LB107 in "La Escobilla" rookery is very important because they have proved to be polymorphic among olive ridley individuals (Peter Dutton, pers.com.) and they promise to yield valuable data. Principally when used together with other microsatellites successfully applied before in this species (Cm72, Cm84 and Ei8), supplying elements to obtain a more accurate vision of the behavior of the abundant populations of this species.

Microsatellites Cm72 and Cm84 were analyzed for La Escobilla rookery by López-Chávez (2000) from a sample of 20 nesting females, an acceptable sample size according to Dutton (1996) who suggests 20-50 individuals from a population for a microsatellite analysis. La Escobilla is a very particular rookery due to the number of females that nest there each season, over 800 000 nests in a year (Márquez, 2000) and because several reproductive groups have been detected during the nesting season (Peñaflores et al., 2000). For these reasons we consider that a larger sample size is needed, besides it must include both sexes, although the role of males in the gene flow among populations is still unknown, it must be considered. This will supply a more realistic vision on the allelic pool and the frequencies in the population.

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Reference	FitzSimmons *et al.*, 1995		Kichler *et al.*, 1999		Hoekert *et al.*, 1999	López-Chávez, 2000		López-Chávez, 2000	
Loci	CM72	CM84	CM72	CM84	CM84	CM72	CM84	CM72	CM84
Number of	2	6	3	16	10	3	13	3	13
alleles	2	6	3	16	10	3	13	3	13
Sample size	10	9	22	22	50	177	177	20	20
Ho	0.9	0.444	0.445	0.9	-----	0.47	0.77	0.7	0.75
Rookeries represented:	Several Australian Populations		Nancite, Costa Rica		Galibi Nature Reserve, Suriname	Several populations of the East Pacific		La Escobilla, Mexico	

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MARINE BLASTING: NEW AND IMPROVED APPROACH TO MINIMIZE SEA TURTLES AND MARINE MAMMAL IMPACT

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For the last decade there has been growing concern about the effect of man-made sounds in the ocean on the marine life, specially in coastal zones. During March 5 and May 1, 1997, a series of 37 blasting activities, using an average of 1468.8 lbs. of explosive each, occurred in conjunction with the construction of the Ponce Deep Ocean Sewage Outfall Pipeline, at the bay of Ponce, Puerto Rico. A resourceful disposition and distribution of charges, along with an innovative combination of different surveillance devices provide a successful and safety protection area for marine mammals and sea turtles. Sound pressure levels less than 10 PSI were recorded at distances of 70 meters from the blasting point. Pre and post blasting surveillance activities were carried out combining a bottom scanner and a specially constructed side scan sonar, as well as visual recognition, covering an average of 0.66 nautical miles of radii from the blasting point. Although several marine mammals (72) and sea turtles (33) were observed, no animals were confirmed injured or killed during the entire blasting activity. For all purposes it was judicious environmentally and economically to consider the ecological components in advance and include them into the design of this kind of project. Mankind enhanced ecological consciousness, and the pursuits of economical development do not have to contradict each other as is still widely (but erroneously) believed. Ultimately, they must converge for an ecological and economical balance.

A COOPERATIVE EFFORT TO MANAGE SEA TURTLES IN NORTHWEST FLORIDA

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BACKGROUND

In 1958, Eglin Air Force Base (EAFB) acquired 300 hectares of coastal property along St. Joseph Peninsula in northwest Florida, known as Cape San Blas (CSB). In the early 1900s, the Natural Resources Division of EAFB recognized the need to conduct an inventory of the natural resources on CSB. In 1993, the Florida Cooperative Fish & Wildlife Research Unit (FCFWRU) was asked to conduct a massive survey of the entire area. In 1997, the Cape San Blas Ecological Study was published, indicating that this 5-km stretch of beach was crucial habitat for several threatened and endangered species, including the loggerhead turtle. This initial study has forged a unique relationship where management requirements are met through a cooperative research agreement.

MANAGEMENT OF MILITARY ISSUES

Cape San Blas is used for active military missions. The Natural Resources Division of EAFB must ensure that these missions are compatible with ecosystems management goals. Part of these goals originates from the requirements of the Endangered Species Act (ESA). This legislation requires assessment of threatened and endangered species' use of an area and provides for the continued success of that species. Through continued research on CSB, the FCFWRU provides valuable data that is used by EAFB to make management decisions that are consistent with the ESA.

MANAGEMENT OF ECOLOGICAL ISSUES

Like most species that rely on coastal habitat, sea turtles on CSB are affected by both natural and man-made disturbances. Natural disturbances have always been a part of ecological processes on CSB. Cape San Blas experiences one of the greatest rates of natural erosion in all of Florida, up to 11 meters annually (Tanner 1975). This erosion causes the loss of several sea turtle nests each year. Because of its location in the Gulf of Mexico, CSB is also prone to storms that can cause severe damage and dramatically decrease the number of hatchlings that survive each nesting season. Hurricanes such as Opal (1995) and Danny (1997) have had a direct impact on loggerhead hatching success on CSB. Man-made forces also affect marine turtles on CSB. These forces include beach driving, development, artificial lighting and recreational use. As the human population increases, so does the number of tourists using the Florida Panhandle. This has caused an increase in beachfront housing and beach use on CSB. The eastern portion of EAFB property is open to year-round recreational activities and beach driving. Vehicle traffic can leave behind deep tire ruts that serve as potential traps for hatchlings attempting to reach water. Vehicle driving can also affect the behavior of female loggerheads that come ashore to nest. Just east of the Air Force property, the number of privately owned residences is increasing, thus increasing the number of lights that are visible to emerging hatchlings. Artificial lighting can cause hatchling disorientation and prevent them from reaching the sea.

SCIENTIFIC RESEARCH

Sea turtle research on CSB is particularly important because (1) CSB supports a part of a genetically distinct group of loggerheads that nest in northwest Florida (Encalada et al. 1998), (2) CSB has the greatest density of nesting loggerheads in northwest Florida (Meylan et al.1995), and (3) CSB is one of the most dynamic barrier island systems in northwest Florida (Tanner 1975). Ecological research began on CSB in 1993 with the initiation of the Cape San Blas Ecological Study. This study indicated that CSB might serve as crucial nesting habitat for loggerhead sea turtles. From 1997 to 2000, scientists from FCFWRU began to focus their research on understanding the natural forces that influence loggerhead use of CSB. These forces included tides, currents, erosion, sand circulation and wind. Results from this research indicate a need to focus future studies on the effects of offshore characteristics on loggerhead behavior and movements. A tagging program also began in 1997, in an effort to determine the population size and site-fidelity of turtles nesting on CSB. Future research projects will include this tagging program so that long-term population and site fidelity estimates can be made.

BENEFITS FROM COOPERATION

The monitoring and research information gathered by the FCFWRU is used to answer questions that help EAFB manage endangered species and assist regulatory agencies in establishing guidelines. Issues such as critical habitat, dune system management, beach closures, beach driving, sea turtle habitat use and sea turtle population numbers are all addressed through this cooperative research/management relationship. Eglin Air Force Base uses this information to balance the need for military missions and ecological preservation. The Air Force can make proper management decisions such as when to allow missions to occur, where to build new structure, when to allow mission supporting activities and how to minimize lighting structures that may influence sea turtle hatchlings. The scientific community can benefit from increasing knowledge of sea turtle biology and population dynamics in the northeastern Gulf of Mexico.

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PREDICTING SEX RATIOS OF BENTHIC IMMATURE SEA TURTLES - DOES TEMPERATURE MAKE A DIFFERENCE?

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Although serum testosterone titer has been determined to be an accurate indicator of the sex of sea turtles, testosterone levels in immature turtles may be affected by ambient temperature, possibly resulting in an inaccurate predicted sex ratio for the population. During the fall 1995-1997, we found the sex ratio of loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) sea turtles as determined from serum testosterone levels to be the most skewed yet published for a benthic immature population. In November 1997, we verified the sex of a sample of 55 turtles through surgical observation of the gonad via a laparoscopic entry into the peritoneum. Testosterone titers of 9 of the 15 male loggerheads were < 30 pg/ml, incorrectly classifying them as female (6) or unknown (3). The green sea turtles (1 male and 5 females) were classified correctly. Sea turtles captured in pound nets set in Core and Pamlico Sounds, North Carolina, were sampled from May-November, 1998-2000 to determine if cold water temperatures (< 20 °C) were having an effect on testosterone titers. Additional laparoscopies on 20 loggerheads and 4 green sea turtles were conducted during the summer in order to confirm serum androgen sexing technique results. The percentage of male loggerhead turtles (26%) (N=372) sampled in warm water was comparable to the percentage of male loggerheads verified by laparoscopy in 1997 (32%) (N=47) and 2000 (30%) (N=20). In contrast, the percentage of male loggerhead turtles (7%) (N=446) sampled in cold water was lower. A similar relationship between water temperatures and testosterone titers was observed for green turtles, but to a lesser extent. Given the relatively small sample sizes for both temperature regimes, additional sampling of green turtles will be necessary to determine if water temperatures are influencing testosterone levels. Although testosterone levels have been used successfully to determine sex ratios of immature sea turtle populations, lower temperatures appear to have an impact on circulating testosterone and thus the reliability of this technique is reduced. Whenever possible, it is always a good practice to verify a subsample of the population (via laparoscopies) from which testosterone titers were taken when determining the sex ratio of a population.

SEA TURTLES ON THE ARABIAN SEA SHORES OF THE DOPHAR REGION, OMAN: NESTING AND FEEDING GROUNDS

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INTRODUCTION

The Sultanate of Oman is among the Indian Ocean nations with the largest nesting populations of green turtles *Chelonia mydas* and loggerhead turtles *Caretta caretta*, and the densest populations of hawksbill turtles *Eretmochelys imbricata* (Ross and Barwani, 1982; Salm, 1991; Salm et al., 1993).

The coastline of Oman, bordering the Arabian Sea is extremely stressed during summer by a Southwest monsoon, known locally as Khareef. Strong winds blow parallel to the coastline from June to September, inducing an upwelling, which replaces warm oligotrophic coastal waters by nutrient rich waters, promoting the growth of algae and seagrasses (Jupp et al., 1996). These conditions provide good feeding grounds for sea turtles.

The coastline of Dhofar Region on the shores of the Arabian is approximately 400 km long, with sandy beaches, which also provide suitable nesting grounds for sea turtles. The Dhofar Region in the Sultanate of Oman also includes the Hino Island near Marbat and the Al Hallaniyat Archipelago.

Previous records on turtle nesting populations in this region date from the late 1970s (Ross and Barwani, 1982) and late 1980s (Salm, 1991). In this study, the Dhofar Region was visited over a one year period on an opportunistic basis, and information on the turtle nesting activity was registered. Major threats to sea turtles on nesting beaches were also registered.

METHODS

Field observations were carried out in November 1999, February 2000, August 2000 and October 2000. Turtle nesting activity was assessed based on turtle tracks and nests were observed on beaches, and sea live turtles, carcasses and skulls identified. Natural predators of turtle eggs and hatchlings were also observed. Finally, all human activities were registered, and the possible effects of human disturbance explored. The total number of turtle nests on each visited beach was registered, and classified into one of the following categories: < 1 week old, 2-4 weeks old, 1-2 months old, and >2 months old. This helped to determine when the nesting season occurred. Nesting turtle species and respective nesting season were also identified. Observations of turtles in the surrounding waters also permitted the identification of species on the feeding grounds.

Threats to sea turtles imposed by natural predators and human disturbance on turtle nesting beaches were identified. Natural predators were classified into categories: predators of turtle eggs and predators of turtle hatchlings. Abundance of ghost crabs (*Ocypode* spp.) as predators of turtle eggs and hatchlings (e,g, Stancyk, 1995) was based on counts in 10 quadrats of 3 m * 3 m randomly placed on beaches. Abundance of birds of prey and seabirds, as potential predators of turtle hatchlings (e.g. Stancyk, 1995) was based on counts of bird nests in 10 quadrats of 5 m * 5 m in transects (if visits were during the nesting season), then extrapolated for the area covered by nests. Abundance of birds was also based on counts of individuals in flight, resting, and/or feeding. Information on abundance of mammal predators was only qualitative. Human activities on turtle nesting grounds were also registered.

RESULTS AND DISCUSSION

Three turtle species nest in the area: green turtles *Chelonia mydas* and loggerhead turtles *Caretta caretta*. Two short but distinct nesting seasons have been identified: one during the Khareef (Monsoon) and another in late winter - early spring. Fresh tracks of both turtle species were observed in both seasons. In February 2000, green turtles were observed on the coral reefs close to the Al Hallaniyat Islands and in October 2000, both species were observed on a feeding ground around Hino Island.

The major potential predators of turtle eggs are feral dogs around the Salalah Port, and foxes elsewhere in the coastal area. On the islands These islands are also nesting grounds for large populations of seabirds: sooty gulls *Larus hemprichii*, masked boobies *Sula dactylatra*, and cormorants *Phalacrocorax nigrogularis* (Mendoça et al., this volume). Seabirds are known to be important predators of turtle hatchlings (Stancyk, 1995).

Human disturbance is related to fishing activities and settlements, where lights are likely to disturbed nesting females and disorientate hatchlings (Witherington and Martin, 1996). Turtles are harvested for meat on the shores of the Arabian Sea.

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ECOLOGY OF THE GREEN TURTLE (*CHELONIA MYDAS*) POPULATION ON HINO ISLAND AND MARBAT AREA, OMAN, ON THE ARABIAN SEA SHORES

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INTRODUCTION

The Sultanate of Oman is among the Indian Ocean nations with the largest nesting populations of green turtles *Chelonia mydas* and loggerhead turtles *Caretta caretta*. These two turtle species have been recorded to nest in high numbers in the Dhofar Region, in southern Oman and on the Arabian Sea shores, where Hino Island is placed (Salm, 1991). Hino Island is a small almost circular island of about 500 m diameter, close to Marbat, a town in southern Oman, in the Arabian Sea.

The coastline of Oman, bordering the Arabian Sea is extremely stressed during summer by a southwest monsoon, known as Khareef. Strong winds blow parallel to the coastline from June to September, inducing an upwelling, which replaces warm oligotrophic coastal waters by nutrient rich waters, promoting growth of algal and seagras communities (Jupp et al., 1996) and providing good feeding grounds for sea turtles. Kelps (*Sargassopsis zanardinii* and *Ecklonia radiata*) become particularly abundant (Barratt et al., 1986). Green turtles feed heavily on S. zamadinii before its seasonal die-off, and as many as 100 green turtles/km of coastline can be found feeding on rocks covered by a short turf of filamentous algae (Salm, 1991).

Marine turtle nesting activities on Marbat beaches was reported by Salm (1991). However, information on turtles on Hino Island was not available prior to this study. In October 2000, Hino Island was visited and data on turtle activities was registered, as well as of predators of their eggs and hatchlings, and of human disturbance.

METHODS

Marbat area and Hino Island were visited in October 2000. Turtle nesting activity was assessed based on observations of turtles, and of turtle tracks and nests. The total amount of turtle nests on each visited beach was registered, and classified in one of the following categories: < 1 week old, 2-4 weeks old, 1-2 months old, and > 2 month old. This helped to determine when the nesting season occurred. Nesting turtle species and respective nesting season were identified. Observations of turtles in the surrounding waters also permitted the identification of species on the feeding grounds.

Threats to sea turtles imposed by natural predators and human disturbance on turtle nesting beaches were identified. Potential natural predators were classified into two categories: potential predators of turtle eggs and potential predators of turtle hatchlings. Abundance of predators was also determined, for future estimate of impact of predation. Abundance of ghost crabs *Ocypode* spp., as potential predators of turtle eggs and hatchlings (e.g. Stancyk, 1995) was based on counts in 10 quadrats of 3 m * 3 m randomly selected on beaches. Abundance of birds of prey and seabirds, as potential predators of turtle hatchlings (e.g. Stancyk, 1995), was based on counts of nests in 10 quadrats of 5 m * 5 m in transects, then extrapolated for the area covered by nests. Abundance of birds was also based on counts of individuals in flight, resting, and/or feeding. Human activities on the area were also registered.

RESULTS AND DISCUSSION

Marbat itself has nesting beaches for turtles, but strong winds do not allow fresh turtle tracks or nests to last more than a few hours or days, making any attempts to know the size of this turtle population very difficult. However, on Hino island, contrary to what is observed on Marbat beaches, the sediment is not fine sand, but coarse sand or gravel, allowing longer duration of turtle nest signs on the beaches. The area was visited in October 2000, at the end of the turtle nesting season, which lasted 2-3 months. A total of 146 turtle nests, less than 2 months old, were observed on 500 m of beach on the islands, which correspond to 0.3 nests/m of beach length. This is equivalent to at least 30 nesting females on Hino Island, assuming that green turtles nesting in Oman lay about 4 clutches per season (Salm, 1991). Mean nest density for the whole area on the island with turtle nests was low (0.03 nest/m^2), but was up to 0.5 nests/m^2 on some areas.

Seasonal algal and seagrass species were still abundant around Hino island, where green turtles especially, but also loggerhead turtles were identified swimming on this feeding ground.

No mammals were found on the island, but on Marbat beaches, footprints of carnivores (dogs and cats) were frequently observed. Ghost crabs (*Ocypode* sp.) were the only identified potential predator of turtle eggs. Their abundance was <0.5 ind/m^2 (N = 5 quadrats of 3 m * 3 m), and only limited to areas with decomposing marine vegetation. Sooty gulls *Larus hemprichii* (at least 500 breeding pairs), known as turtle hatchling predators (e.g. Stancyk, 1995) also had their nesting season coinciding with the turtle nesting season.

Artisanal fishing is common in the area, and Marbat Harbour is among the busiest in the Dhofar Region in southern Oman. Marbat is a town of fishermen, and lights are likely to disturb nesting females and disorientate hatchlings (Withrington and Martin, 1996). However, there are many beaches a few kilometres away from human settlements. Fishery related activities are only restricted to beaches close to the town. Hino Island is uninhabited.

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SEA TURTLE POPULATION ON AL HALLANIYAT ISLANDS, ARABIAN SEA

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INTRODUCTION

The Al Hallaniyat Islands (Sultanate of Oman) in the Arabian Sea are under the influence of a seasonal monsoon from June to August-September, which enhances high algal and seagrass productivity, providing good feeding grounds for marine turtles. This archipelago consists of four islands: Al Hasikiyat, As Sawda, Al Hallaniyat and Al Qibliyat.

The only available information on this turtle population was recorded in the 1980s, when green turtles *Chelonia mydas* and loggerhead turtles *Caretta caretta* were observed to nest on the islands (Salm, 1991).

In this study, we carried out field observations in November 1999, February and October 2000, and identified turtle species, nesting beaches and seasons, and potential natural predators of turtle eggs and hatchlings.

METHODS

The islands were extensively visited in February and October 2000. On most beaches on the islands, turtle tracks and nests, skulls and carcasses were identified. The total number of turtle nests on each visited beach was registered, and classified in one of the following categories: < 1 week old, 2-4 weeks old, 1-2 months old, and > 2 month old. This helped to determine when the nesting season occurred. Local fishermen and villagers were also interviewed about nesting turtle species and nesting seasons. Finally, predators of turtle eggs and hatchlings on beaches, and human disturbance, were identified

RESULTS AND DISCUSSION

Three turtle species were identified nesting on the islands; not just greens loggerheads, as previously recorded by Salm (1991), but also hawksbill turtles *Eretmochelys imbricata*. Green turtles and loggerheads nested respectively in November - February and in May – September. However, we were not able to identify when nesting of hawksbills occurred, although it is very likely that they nested from January to March, as fresh nests similar to those of hawksbills nesting in the Gulf of Oman further north (Mendonça, 2001) where found throughout February on those beaches of gravel or sand with coral rubble on Al Qibliyat and As Sawda. Elsewhere in Oman, hawksbills have been reported to nest also during this time of the year (Ross and Barwani, 1982; Salm, 1991; Mendonça, 2001).

Strong winds, especially during the monsoon, do not allow fresh turtle tracks or nests to last more than hours or days, making very difficult any attempts to know the size of this turtle population, especially during the seasonal monsoon.

AL HASIKIYAT ISLAND

There were no turtle beaches on Al Hasikiyat Island. This island has only one beach, and is too small to be a turtle nesting ground. However, it holds two large colonies of birds: masked boobies *Sula dactylatra* (at least 3,000 breeding pairs) and socotra cormorants *Phalacrocorax nigrogularis* (at least 5,000 breeding pairs). These seabirds and sooty gulls *Larus hemprichii* are the most important potential predators of turtle hatchlings on the Al Hallaniyat Islands (Stancyk, 1995). Marine turtles are still harvested for meat on Al Hallaniyat Island. Cooked turtles were found on remote beaches near fishermen´s camping sites and on the village dump yard.

AS SAWDA ISLAND

On this archipelago, beaches on As Sawda Island, were the ones where turtle nesting activity was more evident. On this island, rats *Ratus ratus* were identified as the most important turtle egg predator as their footprints were found near empty turtle egg shells on some sites on the island.

AL HALLANIYAT ISLAND

The Al Hallaniyat Island is the only inhabited island of the archipelago, with 300 people. This island was the second (after As Sawda Island) in terms of turtle activity, especially on beaches of the southern side of the island. Remains of cooked green turtles were found on remote beaches on the island, and in the village dump yard. On this island, ghost crabs (*Ocypode* spp.) were found in densities of up to 6 ind/m^2. Ghost crabs are known to be predators of turtle eggs and hatchlings (Stancyk, 1995). On the other islands, ghost crab abundance was < 0.5 ind/m^2. Feral cats and seabirds were the main potential predators of turtle hatchlings on this island.

AL QIBLIYAT ISLAND

On Al Qibliyat there were only gravel beaches, and 95% of the total nesting activity is on a single beach. The main predators of turtle eggs are crabs *Ocypode* spp., and the main potential predators of turtle hatchlings are seabirds, especially masked boobies (at least 5,000 breeding pairs).

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TEMPORARY SEQUENCES OF OVOPOSITION IN LOGGERHEAD FEMALES FROM THE CAPE VERDE ISLANDS

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INTRODUCTION

Nesting population of *Caretta caretta* in the island of Boavista (Cabo Verde, western Africa, FIGURE 1) has recently been discovered and, since 1998, it has been the purpose of management directed towards its conservation and to study the most significant aspects of their reproductive biology. This population consists of small-sized females; possibly due to the human predatory pressure for years, which could have resulted in a decrease of mean body size of females (Ballell et al., this volume).

Nesting behavior of marine turtles has largely been studied for years (Carr, 1982; Dodd Jr, 1988; Hailman & Elowson, 1992; Hendrickson, 1995; Miller, 1997) probably because it is the only time of their lifetime that they are on land and they are easily observed. Therefore, analysis of nesting behavior is a basic tool to characterize a colony, and subsequently compare it with other populations.

Our goal is to know the most important aspects of nesting behavior of females from Boavista island, especially the total nesting time and the duration of nesting phases (Dodd Jr, 1988; Hailman & Elowson, 1992; Hendrickson, 1995), and, also, the successful nesting of female emergences. It is possible that some differences in duration of nesting behavior may exist between females of different sizes.

Later, we compare these results with those of other known populations to check out if there are differences.

MATERIAL AND METHODS

During the year 2000 nesting season of the loggerhead in Boavista, we measured temporal patterns of nesting behavior of 81 female loggerheads. Night patrols were made along three beaches at the southeastern coast of the island, with different features: Ervatão, Ponta Cosme and Calheta.

The number of emergences with nest were differentiated from those that were only nesting attempts to check nesting success, depending usually on beach characteristics (Hendrickson, 1995).

When a turtle was met, the time and the phase of nesting at that moment was recorded. The nesting time was considered sensu stricto as in Hailman & Elowson (1992), as well as the duration of the different phases: nest preparation and egg-chamber digging, egg laying, and filling the chamber and covering the premises (Dodd Jr, 1988; Hailman & Elowson, 1992; Hendrickson, 1995). The phase of ascent to the beach was rejected, because the time check was difficult to measure in the first part of the process, as well as the return to the surf, because some of the females were handled when returning to the sea.

RESULTS

From the 1,188 emergences of females of *Caretta caretta* observed during the year 2000 nesting season, only 44.2% of them achieved successful nestings, while 55.7% were aborted nesting attempts. If we analyze these results between the three beaches considered, we see that in Calheta the percentage of emergences with successful nesting is 67.5% (N=80), in Ponta Cosme is a little higher than average (54.4%, N=606), and in Ervatão the percentage diminishes to 39.0% (N=502).

The nesting time sensu stricto (Hailman & Elowson, 1992) was 67.4 minutes (SD=16.97, Range=39.0-140.0 minutes, N=81). If we compare this result between the three beaches, we see that there are no significant differences (H corrected=2.701, p=0.26).

The duration of the three phases considered was as follows: digging the egg chamber was 22.6 minutes (SD=12.6, Range=10.0-90.0, N=81); mean egg laying time was 20.9 minutes (SD=10.6, Range=11.0-75.0, N=81); and covering the nest extended to 23.9 minutes (SD=7.4, Range=10.0-49.0, N=81). If we compare these results between beaches, we do not find any significant differences in either digging the egg chamber or in covering the nest (digging egg chamber: H corrected=1.338, p=0.51; covering the premises??: H corrected=2.06, p=0.35), but some differences appeared in egg laying duration (H corrected=7.435, p=0.02).

There is no relationship between female body size (curve carapace length) and time invested in nesting (Kendall-Tau b=-0.068, p=0.41). Nevertheless, if we analyze these results considering the different phases, bigger females invest less time in excavating the egg chamber (Kendall-Tau b=-0.188, p=0.02).

DISCUSSION

General nesting behavior of *Caretta caretta* in Boavista is very similar to that already described in precedent works on this species, especially based in exhaustive description of behavioral patterns of nesting loggerheads made by Hailman & Elowson (1992).

Figure 1. Map showing Cape Verde Islands, and the position of Boavista.

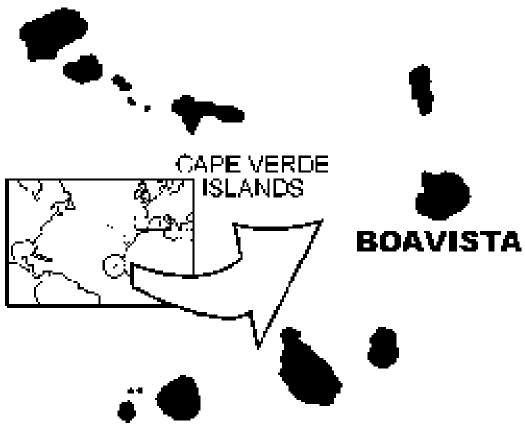
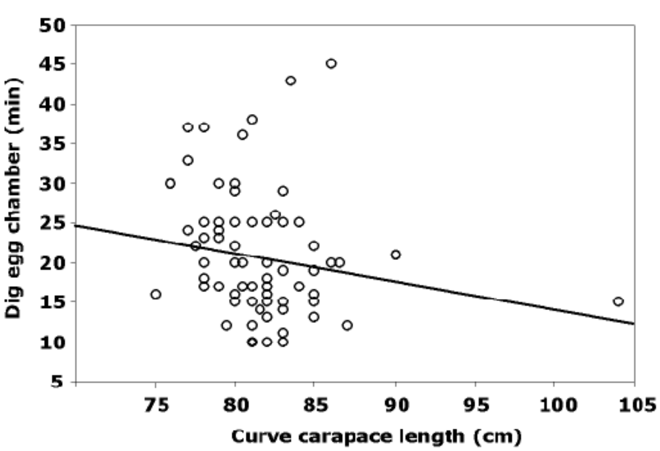


Table 1. Comparison of percentage of succesful nesting between populations.

Locality	Years	Succesful nesting	Range
Turkey (Erk´akan, 1993)	1989	25.7%	
Australia (Limpus, 1985)		100%	
Florida (Raymond, 1984)			51-54%
South Carolina (Talbert er al., 1980)	1972-1976	59.5%	52.3-71.3%
South Carolina(Andre and West, 1981)		29%	
North Carolina (Crouse, 1984)		50%	
South Africa (Huges et al., 1967)		55%	
Greece (Margaritoulis, 1982)	1977-1979	?	?
Boavista, Cape Verde	**2000**	**44.27%**	

Figure 2. Relationship between body size (CCL) and time for digging egg chamber on *Caretta caretta* from boavista.



The percentage of successful nesting (44.2%) is similar to the described ranges in other populations, which is in general variable. These data have been described to range normally between 30% and 70% (TABLE I), with the exception of Queensland (Australia), where almost all emergences recorded are successful nestings (Limpus, 1985). Possibly, the beach characteristics play an important role in this result, which might account for the difference found between our three beaches studied, especially Calheta (67.5%).

If we consider the total duration of nesting (67.4 minutes) and the different phases, the results are similar to those found in other populations (Kaufmann, 1973; Bustard et al., 1975; Dodd Jr, 1988), bearing in mind that the nesting time sensu stricto is considered, as in Hailman & Elowson (1992).

It is noteworthy that bigger females require less time to dig the chamber. It may be hypothesized that smaller females are more 'inexperienced'; according to Hailman & Elowson (1992), this is the most complex phase of those that constitute the nesting behavior of *Caretta caretta*.

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A GIS APPROACH TO ASSESSING THE SPATIAL AND TEMPORAL RELATIONSHIP BETWEEN KEMP'S RIDLEY SEA TURTLES AND BLUE CRABS

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The blue crab (*Callinectes sapidus*), a preferred prey of the Kemp's ridley sea turtle (*Lepidochelys kempii*), has experienced recent population declines along the Texas coast. Concerns have arisen as to the impact of these declines on Kemp's ridley use of Texas waters as feeding and development grounds. This study employs GIS technology to examine the relationship between Kemp's ridley and blue crab abundance in shallow Gulf waters near Sabine Pass, Texas, an index habitat for the latter species, during 1993-2000. Seasonal occurrence and abundance (expressed as catch-per-unit-effort, CPUE) of Kemp's ridleys were assessed via monthly entanglement netting operations. Similar statistics were generated for blue crabs captured in otter trawls towed adjacent to netting sites. Elevated ridley CPUEs occurred concurrently with highly variable fluctuations in annual blue crab abundance from 1993-1997. Regression analysis of these catch statistics yields no strong logarithmic correlation between Kemp's ridley and blue crab abundance ($r2=0.07$). During these years, other factors including density dependent variables related to nesting success and a possible 2-3 year cyclic pattern in recruitment to benthic habitat may have influenced ridley aggregation on developmental feeding grounds. Peak ridley and blue crab abundances in 1997 were followed by concurrent reductions in CPUE of both populations during 1998-2000. These trends yielded a strong logarithmic correlation between ridley and blue crab abundance from 1997-2000 ($r2=0.85$). The greater abundance of ridleys and blue crab on the west side of Sabine Pass ($p = 0.01$, $a = 0.05$) may be attributed to water vortices created by long shore currents and prevailing southerly winds at this site. Sediment deposition in this entrained water mass produces soft, muddy substrates characteristic of prime blue crab foraging grounds. Factors possibly influencing the decline in blue crab abundance, such as changes in salinity due to prolonged drought conditions, and their impact on Kemp's ridley dynamics are also assessed. Mean annual salinity levels failed to differ significantly across sampling sites ($p = 0.62$, $a = 0.05$), nor correlate statistically with Kemp's ridley and blue crab abundances (ridleys: $r2=0.01$, crabs: $r2=0.40$). The influence of salinity on ridley or blue crab abundance may be masked by the annual analysis conducted in this study. In order to better understand and manage this endangered species, it is recommended that future research assess how overharvesting of blue crab, nesting beach dynamics, and shrimping activity/bycatch influence Kemp's ridley aggregation to developmental feeding grounds.

NESTING OF THE HAWKSBILL TURTLE (*ERETMOCHELYS IMBRICATA*) IN DOCE LEGUAS KEYS, CUBA

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INTRODUCTION

The Hawksbill turtle, *Eretmochelys imbricata*, is distributed throughout the Cuban archipelago. The main nesting areas for the species are off the south coast, the most important of which are in the Doce Leguas Keys. Doce Leguas Keys extend some 120 km, and are located within the Jardines de la Reina Archipelago (Archipelago of the Queen's Gardens), off the southeastern coast (Camaguey Province) of Cuba. They consist of 47 keys, of which more than 40% are sandy beaches used for nesting by the Hawksbill turtle, Green turtle (*Chelonia mydas*), and to a lesser degree the Loggerhead turtle (*Caretta caretta*). The remainder of the keys consist of mangroves and rocky coasts, and are unsuitable for nesting.

Most of the keys are small, between 0.5 and 5.5 km in length, and are separated by channels. The beaches are mainly medium grain sand (0.2-2 mm diameter), but others are large grain sandy beaches mixed with coral, shells and stones. Most contain vegetation, mainly native bushes such as yana (*Conacarpus erecta*), yaraguano (*Cocothrinax miraguana*), pataban (*Laguncularia racemosa*), salvia marina (*Tournefortia anaphalodes*), platanillo (*Piper aduncum*), and grass and creeping shrubs like beach boniato (*Batis maritima*).

Beach slopes are slight (approximately 8 degrees) along most of their length, with a mean height of 1.1 m above sea level. Length of beaches ranges from 50 to 4000 m, with most being up to 25 m (mean= 9 m) wide. They present an oceanic front with ample coral barriers, more remarkable in the western part of the keys, which delimit an internal area of shallow waters between the coast and the barrier, where juvenile hawksbill turtles are abundant. Banks *Thalassia testudinum* and patches of *Syringodium* sp. on sandy bottoms are also abundant. Water depth is generally shallow.

Within the Jardines de la Reina Archipelago, positioned mainly to the east and north of the archipelago, are numerous, smaller inner keys. These keys are similar in characteristics to the larger keys, and are also used for nesting by Hawksbill turtles.

METHODS

Nesting surveys have been undertaken in Doce Leguas Keys since 1988 (Moncada et al. 1998; ROC 1998), but since the 1997/98 nesting season they have been carried out in a more systematic fashion. Notwithstanding logistic difficulties and bad weather, ten beaches are patrolled each night for at least 10 days per month, and other beaches are visited 1-2 times per month (Moncada et al. 1999).

All beaches were initially characterised during the 1994/95 nesting season (Perez 1994), and this was repeated during the 2000/2001 season. The main parameters recorded were length, width and slope of beach, and dominant vegetation and fauna.

Most nests were located by probing the sand with a wooden rod. At the time of location, nest temperatures were recorded, and nests aged on the basis of opaque band development or by the stage of development of an embryo. Hatching dates were then estimated. Where possible, nests were revisited around the time of hatching to record clutch size, hatching success, infertility and incubation failure. Additional data recorded include female track width, time of nesting, moon phase and tides. Nesting females were measured and tagged when encountered.

RESULTS

Nesting takes place throughout the year, but mainly occurs between September and March, with a peak in November-December. Nesting frequency in different beaches varies from year to year, but generally it is higher in the eastern part of the keys. Some of the most important beaches include La Ballena, El Guincho, Caballones Oeste, Cinco Balas and Boca Seca.

Nesting occurs on the darkest nights, between 2030 and 0500 h, during all moon phases but mainly in new moon and the first quarter. The distance from the high water level to the nesting site ranged between 1 and 25 m (mean= 9 m), but most were distributed between 5 and 10 m. In all nesting seasons, more than 85% of nests were found over the dunes of vegetation. The highest hatching success has been obtained when nests are placed between 3 and 20 m from the sea.

Mean clutch size has not varied significantly over time (mean of annual means= 134.2; linear regression, r^2= 0.11, p= 0.27). Mean hatching success in "normal" years was 69.2%; in one year in which excessive rainfall was recorded, hatching success was lower (around 40%), with flooding being the main cause of embryonic death. Egg size ranged from 33.5 to 38.5 mm diameter, and hatchling length (SCL) ranged from 39 to 42 mm (mean= 40.05 mm).

The smallest female observed nesting at Doce Leguas was 58.5 cm SCL (64 cm CCL), and the largest was 91 cm SCL. Measurement of tracks indicated nesting females ranged in size from 60-90 cm SCL. Mean internesting interval is 17.5 days (range 11-25 days).

There have changes in the physical characteristics of some beaches in Doce Leguas over the last few years, mainly as a result of severe storms and subsequent. For example, the width of some beaches has been reduced by up to 2-4 m, and some sections of beach have been eroded completely. Some sections of beach are now covered entirely by vegetation. The effect of such alterations on nesting by the three species of sea turtles nesting there are not known, but future work may help quantify it.

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DETERMINING PATERNITY IN LOGGERHEAD TURTLE (*CARETTA CARETTA*) NESTS ON MELBOURNE BEACH, FLORIDA USING MICROSATELLITE MARKERS

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Many aspects of sea turtle biology are difficult to measure in these cryptic migratory species, and this undercoverage continues to hamper conservation efforts. One such parameter is the health and size of breeding populations; generally it is not known how many males contribute to the next generation. Allozyme analysis suggested multiple paternity in loggerhead turtle clutches in Australia, and subsequent studies indicated that the frequency of multiple paternity varies from species to species and perhaps location to location. This study examined fine-scale population structure and paternal contribution to loggerhead clutches on Melbourne Beach, FL, USA using microsatellite markers. Mothers and offspring from 70 nests collected at two locations were analyzed using two to four polymorphic microsatellite loci. Fine-scale population structure was not evident between the sampled beaches. Multiple paternity was common in loggerhead nests on Melbourne Beach; of 70 clutches analyzed, 22 had more than one father, and 6 had more than two fathers. This is the first time that more than two fathers have been detected in sea turtle nests.

DIFFERENCES BETWEEN PHYSICAL PROPERTIES OF NATIVE AND RENOURISHED BEACHES AND THEIR INFLUENCE ON THE GAS CONCENTRATIONS OF OXYGEN, CARBON DIOXIDE AND HYDROGEN SULFIDE

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ABSTRACT

Beach renourishment pumps offshore sand onto eroded beaches to supplement natural conditions. This foreign sand is often spread and shaped to mimic native beach slopes. However, nourished beaches differ from native in a multitude of properties. Some of these differences are in the compactness and hardness of sand, temperature, humidity, shear resistance, and grain size. All of these characteristics affect the microenvironment of sea turtle clutches, particularly gas exchange. This study looks at differences between the microenvironment of native versus renourished sands. The focus is on how these inherit differences affect gas exchange.

INTRODUCTION

Marine turtles deposit their clutches in nests excavated in sandy beaches. These clutches undergo embryonic development for nearly two months. During this time, the embryo's metabolism is affected by the surrounding micro and macro environment. Because of erosional beach processes such as hurricanes, native nesting beaches in Florida are disappearing and being replaced by artificial renourishment.

Beach renourishment consists of pumping offshore sand in seawater slurry onto eroded beaches to supplement natural conditions. This foreign sand is often spread and shaped to mimic native beach slopes. However, nourished beaches differ from native in a multitude of properties. Some of these differences are in topography, compactness and hardness of sand, temperature, humidity, shear resistance, grain size, and gas concentrations. All of these characteristics affect the microenvironment of sea turtle clutches and can have a positive or negative influence on hatchling success.

EXPERIMENTAL METHODS

Experimental sites were chosen in different locations along the beach profile (vegetation line vs. mid beach),and in different beaches (native vs. renourished). The native beach is located inside Cape Canaveral Air Force Station, Kennedy Space Center, Florida, and the renourished at Jetty Park, located approximately 15 kilometers south. This beach is immediately south of the Port Canaveral Inlet and was renourished in the recent past. Two, 5 mm Teflon® tubes were inserted at depths of approximately 45 cm and 30 cm. The former sampled gas concentrations at a level similar to the middle of a sea turtle clutch, and the latter at a level similar to the top of the clutch. These tubes were labeled, capped, and standing air volume calculated. They were buried and extended to a distance of approximately one meter from the experimental site in order to prevent samplers from stepping on top of the sampling location and affecting gas concentrations. Daily 20 cc samples were collected using a 20 cc gas tight syringe, and transferred to the 3" X 5" gas sampling 'pillows'. Call-5 Bond™ pillows are made of five layers: polyester, polyvinylidenene chloride, aluminum foil, polyamide, and high-density polyethylene. (Calibrated Instruments, 200 Sawmill River Road, Hawthorne, New York 10532, (914) 741-5700) The bags were fitted with a Luer stopcock for easy connection to the sampling syringe. For analysis by gas chromatography, 0.5 mm septa were inserted into the sample pillow stopcocks. Duplicate 0.5 ml injections of air samples were made with glass gas tight syringes. Carbon dioxide analysis was completed with the 6890 Hewlett Packard Gas Chromatograph with Thermal Conductivity Detector and a 30 m x 0.53 HP-Plot Q-Q column. Oxygen was analyzed on the 5880 Hewlett Packard Gas Chromatograph with Thermal Conductivity Detector and a packed, 9'X1/8" molecular sieve column. Hydrogen sulfide analysis was performed on the portable Photovac (Perkin Elmer) 10S Plus Gas Chromatograph with Photoionization Detector and a 15 m x 0.53 mm KCl/Al2O3 column. For the Volatile Organics in Air Analysis (EPA TO15 Method), air samples from both the natural and renourished beach were taken in 1-liter summa canisters. This air sample was preconcentrated and analyzed on the 5972 Hewlett Packard Mass Selective Detector using a 100 m X 0.32 mm HP-1 column.

RESULTS AND DISCUSSION

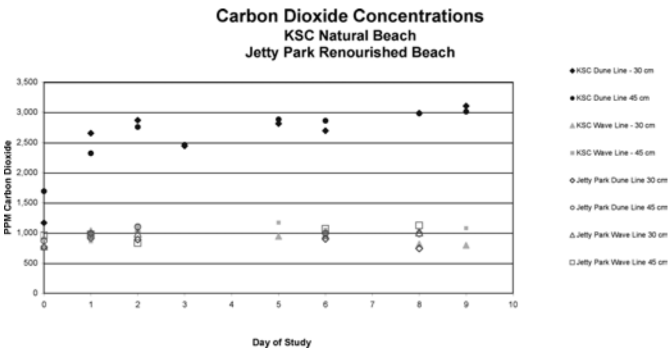
Despite the impressive work found in the literature, very little attention has been given to gas exchange within clutches and between clutches and the environment. This study looks at differences between the microenvironment of native versus renourished sands focusing on how these inherit differences affect their gas concentrations of oxygen, carbon dioxide and hydrogen sulfide.

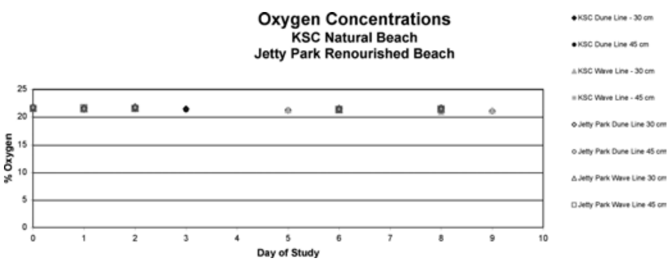
Respiratory gas exchange can occur by convection or diffusion. Convection can occur by temperature variations, changes in atmospheric pressures or displacement of soil air by water table movement. Diffusion occurs through the gradual mixing of the molecules of two or more substances due to random thermal motion.

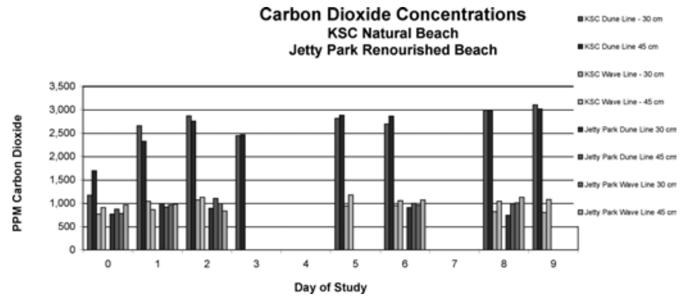
Clutch gas establishes the background concentration of respiratory gases against which individual eggs must exchange the gases necessary for metabolism. Exchange occurs between the clutch and chorioallantoic blood through the eggshell and its membranes. This gas exchange has been reviewed by Ackerman and Prange who reported the O^2 diffusion coefficient for *Chelonia* eggshell and outer shell membrane to be around 5X10 -5 cm^3 s-1 cm-2 kPa-1.

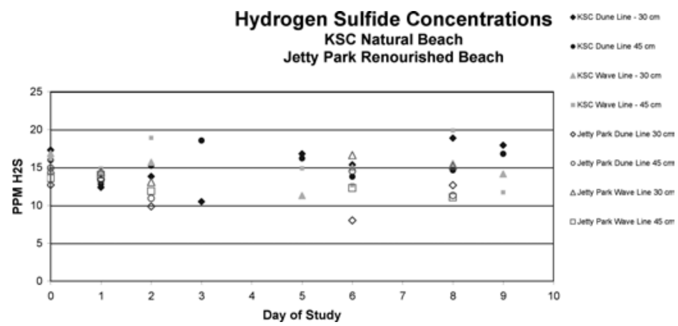
Carbon dioxide levels exceeded 3,000 PPM in the 'Dune Line' samples for the KSC natural beach. The highest level for the renourished beach at Jetty Park was 1,124 PPM. The oxygen levels did not fluctuate in this manner. The hydrogen sulfide levels were slightly higher for the Dune Line' samples for the KSC natural beach. To characterize any heavier sulfide gases, a sample from each beach was analyzed by GC/MS (gas chromatography with mass selective detector). No compounds were detected above the detectable limits. Dimethyl disulfide has a detectable limit of 0.69

µg/m^3 and dimethylsulfide (DMS or Thiobismethane) has a detectable limit of 2.7 µg/m^3.









CONCLUSIONS

Data showed that there are differences in carbon dioxide concentrations between sand type, depth and nest location on the beach. Higher concentrations in the dune line nests could be due to the type and age of vegetation present (sea grapes vs. sea oats). The oxygen levels did not vary significantly. These results are very important because they relate the physical environment surrounding a sea turtle clutch directly to the development of embryos. By correlating these differences to the respective gas concentrations measured at each site, a model is being developed to determine the impact and importance foreign sands have on native sea turtle hatching success. This study will be repeated using developing clutches. The data shows that very close attention must be paid to the type of sand used in the beach-nourishing project as it can affect the outcome of clutches. This preliminary study provides a baseline to show that physical characteristics of nourishing sands can directly affect the success of sea turtle clutches. At the end of this project, a model would be available to explain how physical differences in sand properties can be correlated to gas exchange.

LITERATURE CITED

A survey of recent literature reveals that several factors that influence hatching success have been previously investigated. Beach topography and its influence on nesting and false crawl ratio, predation, incubation duration, thermal, hydric, and respiratory climates, hatchling success, chamber depth, and emergence success, by Raymond, 1984; Nelson et al., 1987; Nelson & Dickerson, 1988; Carthy, 1994; Ehrhart, 1994; Crain et al., 1995; Rimkus et al, 1995; and Wood, 1998.

Ambient and sand temperature and its influence on nest location and false crawl ratio, thermal, hydric, respiratory climates, and emergence success, by McGehee, 1978; Mortimer, 1980; Mrosovsky and Yntema, 1980: Stoneburner & Richardson, 1981; Limpus, 1983, Miller, 1985; Witherington, 1990; Witherington et al., 1990; Cheeks, 1997, and Wood, 1998

Shear resistance and grain size distribution and their impact on nest excavation, depth and morphology, thermal, hydric, and respiratory climates, and emergence success, by Ackerman, 1980, 1981; Mortimer, 1981; Raymond, 1984; Nelson, 1987, 1991; Nelson and Dickerson, 1998; Mortimer, 1990; Lutz et al., 1991; Ehrhart, 1994; Ryder, 1992; Milton et al., 1997; Rimkus & Ackerman, 1997; and Ehrhart, 1998.

Moisture content and its influence on thermal, hydric, and respiratory climates, and hatchling emergence success by Bustard and Greenham, 1967; Mann, 1977; Packard et al., 1977; McGehee, 1990; Ackerman, 1991; and Cheeks, 1997.

TURTLE CAMPAIGN PROGRESS BY WWF INDONESIA WALLACEA PROGRAM

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Indonesia represents a major concentration of marine turtle nesting in the Asia-Pacific region, in particular for green, hawksbill, and leatherback turtles. These species are harvested intensively as both eggs and adults, providing an important resource for subsistence, cultural activities, and cash income. These harvests, among the largest in the world, are likely a major cause of recent declines in the local populations and, because the species are migratory, may also be affecting stocks in neighboring areas.

To address this situation, WWF Indonesia Wallacea Program has designed three campaign strategies: "Adopt the Beach", "Friends of Sea Turtles", and supporting the establishment of Marine Protected Areas (MPAs). The third strategy has been implemented in Southeast Aru (Maluku), and will soon be enacted in Derawan (East Kalimantan). In these two areas, WWF's main activities are turtle monitoring and facilitating beach protection and the patrol of feeding grounds. The focus of this poster is the progress of the first two campaign strategies. For more information on WWF's efforts in Southeast Aru and Derawan, please contact Kiki Dethmers (Nijmegen University, The Netherlands, kdethmers@zen.uq.edu.au) and Creusa Hitipeuw (Conservation Science, WWF Wallacea, chittipeuw@wwfnet.org).

Adopt the Beach

The goal of this strategy is to establish a sustainable community-based management and fundraising program for selected turtle-nesting beaches.

In 1997, the first model of this type was being tested in Perancak, a village located in the western part of Bali. There, local communities established the Kurma Asih Turtle Conservationist Club to conserve and handle nesting turtles and their eggs. WWF's current role in Perancak is chiefly one of education, facilitation, and guidance , and includes building mechanism for sustainable funding of current and future turtle conservation. Until now, Kurma Asih has received funds from three sponsors, namely the Bali Tourism Development Center (BTDC), Indonesian Young Businessman's Association (HIPMI), and the Government of Bali.

A similar project has also begun in the major tourist destinations of Kuta and Legian in southern Bali. This project aims to protect the Olive Ridley's turtles (*Lepidochelys olivacea*) that re-appeared to nest in this area from June-August 2000. The existing coastal development, mass-tourism and poaching of eggs, as well as the capture of turtles by local people, are obviously major impediments for conservation. Therefore, WWF Wallacea and the Hard Rock Hotel Bali (HRHB) have agreed to work together to protect nesting turtles in Kuta, Legian, and surrounding beaches through the selection and training of volunteer of 'turtle adopters'. These volunteers, who will include members of local communities, lifeguards, and hotels and other private businesses in the area, will receive training in habitat protection and ways to avoid harm to nesting turtles.

The "Adopt the Beach" model is also proposed for conservation activities in other parts of Indonesia, such as Cipatujah (West Java), Meru Betiri (East Java), and some places in the Derawan Islands (East Kalimantan). The development of an approach to include associated stakeholders is in progress.

Friends of Sea turtles

The "Friends of Sea Turtles" program relies on the use of communication tools to change the consumption practices of a wide variety of turtle consumers. The campaign also tries to maximize opportunities such as media events and international gatherings to promote alternatives to turtle consumption. The goal is to curb consumption of turtle meat and eggs in Indonesia.

At present, the "Friends of Sea turtles" strategy is focused on two sites : Bali (Denpasar and southern Badung) for meat consumption and southern West Java for egg consumption.

BALI

Initiated in 1996 under WWF Bali, the Bali campaign has shown more progress so far than the West Java campaign. In cooperation with two local NGOs-KSBK (Konservasi Satwa Bagi Kehidupan = Animal Conservation for Life) and PPLH (Pusat Pendidikan Lingkungan Hidup = Environmental Education Center)- the campaign in Bali is aimed at transforming turtle consumers into turtle conservationists. The messages are delivered through several communication channels, including public service radio and newspaper advertisements (, school and village visits, and traditional drama performances.

Radio, TV, and newspaper campaign

Radio has been proven to be an effective channel to disseminate conservation messages, especially short ones like public service advertisements (PSAs). PSAs in both local and national newspapers and magazines were used to spread the turtle conservation message. The televised turtle campaign consisted mostly of short features and reports either by private or national TV stations. TVRI in Denpasar broadcast a series of arja (traditional drama) performances and in September 1999 held a talk show on turtle conservation.

A local newspaper (Nusa, 20 January 2001) reported changing habits among previous consumers of turtle meat in Denpasar. Those who previously preferred turtle meat are turning to Muscovy duck as an alternative delicacy. It was not clear from the report whether this change is due to the duck's flavor or availability or because of increasing public awareness and societal attitudes regarding the protected status of sea turtles. It may be, at least in part, a response to the recent public service advertisements on turtle consumption in the news media. In any case, duck vendors in the market are now selling up to 50 ducks each day, ten times more than before the media campaign. WWF will undertake a survey to try to determine what consumer attitudes and preferences are connected with this phenomenon.

Traditional arts

Traditional arts such as arja (drama performances consisting of dancing, singing, and dialog) and bondres (traditional comedy) are also considered appropriate to spread conservation messages. With their creativity, traditional artists are able to translate scientific facts to more popular information for the public, even jokes, that will avoid the risk of insulting or offending Balinese people.

Popular events

In April and August 2000 two turtle art contests for elementary school children were held in Perancak (with Kurma Asih Turtle Conservationist Club) and Denpasar (with TOP FM Radio). Art contests have been proven to be effective in educating not only the school kids themselves, but also their teachers and parents. A traditional Balinese song contest was another event held in cooperation with a local radio station (Yudha) targeting the elder generation.

Communication materials and merchandise

Communication materials such as brochures and posters are used for education and exhibition programs. Stickers, postcards, and T-shirts are being distributed at special events such as art contests, etc. For the year 2001, WWF Wallacea has made a turtle conservation desk calendar. Drawings in the calendar are the results of the turtle drawing contests for elementary school students in Bali held in August 2000.

Village and school outreach

Outreach programs were successfully carried out in schools and villages in Denpasar, Badung, and Perancak. Combined with short traditional performances, such outreach programs are valuable in creating a familiar and comfortable setting in which to promote better understanding of the importance of sea turtle conservation.

Turtles and religion in Bali

In 1998 WWF held a meeting with several Balinese Hindu priests and other religious experts on the use of turtles in traditional and religious ceremonies. The result was clear: there are only a few major religious ceremonies that traditionally use sea turtles as part of the offerings. It was also emphasized that the use of turtles is not compulsory, as other meat, such as duck, or even symbolic representations, can be substituted for turtle meat. However, there are many people that still don't agree on the issue, since it is not stated clearly by many priests. Therefore, WWF continues to seek more support from within the Hindu faith for the use of alternatives to turtle meat. In cases where tradition still 'requires' the use of turtle meat, the condition of any turtles used should be clearly in keeping with Hindu beliefs, as stated in holy scripture. Considerations regarding the ceremonial use of turtles include the following:

· Health and general well-being of the turtles: Only the meat of healthy turtles is allowed to be used for offerings, not that from moribund turtles as are commonly sold commercially.
· Age: Only immature turtles may be used.
· Certification that turtles do not come from an illegal source.

WWF is currently working to gain acceptance of these criteria and is hoping to gain further support from the religious community for turtle conservation efforts.

TURTLE TRADE IN BALI

Law enforcement

The role of WWF in the legal aspects of the turtle trade includes monitoring and guidance on steps taken toward turtle law enforcement. In February 1998, representatives of local governments in Indonesia ,including Bali, gathered to propose the legal protection of green turtles (*Chelonia mydas*) in Indonesia. Since 1992 a government turtle quota had allowed a maximum of 5000 turtles to be traded in Bali each year. This quota, however, was never enforced, and the trade regularly exceeded 5,000 turtles annually. In January 1999, Indonesia enacted Governmental Act No. 7/1999 on the Conservation of Flora and Fauna, that protects all seaturtles in Indonesia from trade and other commercial uses. On June 12th,2000, the governor of Bali signed Governor's Decree no 243/2000, canceling the turtle trade quota in Bali. This means that officially the turtle trade in Bali is now illegal, and turtle protection laws can be legally enforced.

The first test of the new law came on October 4th, 2000; when local policemen and staff of the Forestry Department's Conservation Agency seized a ship in Bali carrying 90 live turtles from Sulawesi. Both the turtle trader and the boat captain were arrested and accused of trading protected species. The enforcement action however, caused a series of protests against WWF Wallacea, the Governor of Bali, the Indonesian Forestry Department's Conservation Agency (KSDA), and other governmental offices. The biggest protest gathering was held on November 6th, 2000, when almost 200 fishermen from Tanjung Benoa village vandalized the WWF Wallacea office in Denpasar, Bali. The crowd which also protested at the governor's office and the KSDA office in Bali, threatened WWF Wallacea staff but did not cause any physical damage to the offices.

Although many protests were lodged by Tanjung Benoa villagers against the turtle ban and the arrest of the trader, the government of Bali still persisted in holding the a trial. The first court hearing for the turtle trader and his boat captain was held in Denpasar on Thursday, February 8th, 2001. A WWF staff member was present as an "expert witness", and was asked to explain the population and legal status of marine turtles in Indonesia and other countries. Other witnesses were from the Indonesian Nature Conservation Agency and members of the policeme patrol who seized the turtle boat. Due to the sensitivity of the hearing, considerable police protection was provided for all witnesses, and the WWF office itself hired a special police guard for its staff. Additionally, local and national journalists were invited to cover the first-of-its-kind event. The district attorney expected that this trial might serve as a good "lesson learned" for others involved in the marine turtle trade, and would hopefully provide an incentive for them to stop their activities.

The second court session was held on February 15th, 2001, at which time the defendants were given a chance to present their witnesses and state their case. The defendants asserted their belief that the turtle trade satisfies traditional cultural needs and provides employment and livelihood for many people. Examples were given regarding the use of turtle offerings in some religious ceremonies. The existence of a traditional culture-based harvest makes it difficult, at least in the short term, to immediately curtail harvesting, as mandated by the recent ban. The defendants insisted, therefore, that the elimination of the turtle trade should be done gradually, and furthermore should be accompanied by job training in order to provide former turtle traders with alternative income sources that are both economically viable and socially accepted. These issues will be considered further at the next court session, scheduled for February 22nd,2001.

Alternative Income

Many subsistence communities in Indonesia have been hit hard by the ongoing economic crisis. People in the coastal village of Tanjung Benoa, through which much of the Balinese turtle trade passes, are already suffering the economic effects of the turtle ban. One of the most crucial steps in the turtle conservation effort is facilitating alternative incomes for those in villages such as Tanjung Benoa, who depended on the turtle trade in for their livelihood. WWF Wallacea plans to organize a workshop to bring together stakeholders and discuss potential ways of helping the people of Tanjung Benoa convert their livelihood from turtle trading to non-turtle related pursuits. Alternatives to be explored include ecotourism in the surrounding mangrove area, establishing a humpback grouper hatchery, duck farming, and non-turtle fisheries.

WEST JAVA

From October 2-4, 2000, a workshop entitled "Sustainable Management for Seaturtle Habitat in Southern West Java" was organized in cooperation with the Alami Foundation, a local conservation NGO in Jakarta. With the exception of concessionaires in Pangumbahan, all the workshop participants agreed that ecotourism is a sustainable and economically viable way to manage turtle nesting habitat. The initial phases of an ecotourism project are underway in Cipatujah (Tasikmalaya region), and will coordinate with ongoing conservation efforts by Mr. O'om Suparman, a local villager. The Alami Foundation and WWF Wallacea are currently organizing a survey on the chain of custody of turtle eggs and researching a consumer profile in order to improve the West Java campaign.

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· Alami Foundation, KSBK, PPLH Bali, Bestari Foundation (Kalimantan), Packard Foundation (for travel grant)
· Local, national, and international press
· Other partners that cannot be mentioned in detail.

A REVIEW OF FIVE YEARS OF NESTING ACTIVITY ON A SOLITARY OLIVE RIDLEY (*LEPIDOCHELYS OLIVACEA*) NESTING BEACH

Andrew Myers[1] and Randall Arauz[2]

[1] PRETOMA
[2] Sea Turtle Restoration Project

INTRODUCTION

Punta Banco is a solitary olive ridley nesting beach situated on the eastern side of the mouth of the Golfo Dulce in the Puntarenas region of Costa Rica. Poaching levels in Punta Banco were estimated to be approaching 100% before the intervention of the Tiskita Foundation in 1995 who offered poachers rewards of money or food in return for fresh turtle eggs (Peter Aspinall, pers. comm.). PRETOMA involvement began in 1996 when nightly surveys were taken to establish the size of the nesting population, and also to maximise the hatching success from the nests collected. The project is primarily community based and incorporates the employment of local workers as well as a teaching programme at the village school. In 1997 ARIGUAY (Associasion de Representantes Indigenas Guaymi) involvement began with the project with the establishment of a second station at Caña Blanca, seven kilometres south of Punta Banco. An increased police presence and also an increase in the number of volunteers, have lead to a sharp drop in poaching during the 2000 season (from 32% in 1999 to 11% in 2000), a trend which will hopefully continue in future seasons.

Hatchery Use at Punta Banco

Despite the fact that natural predators are not a threat to nests laid in Punta Banco, hatchery use is unavoidable due to the presence of poachers on the beaches. Mortimer (1999) states that hatching success is usually lower than in natural nests. Contrary to this, we have achieved a hatching success of 83% at Punta Banco compared to an average success of 44% found by Van Buskirk and Crowder (1994) when they compared the success from 11 populations of olive ridleys.

There are two hatcheries in use at Punta Banco. The Beach Hatchery lies just above the storm line and protected from unusually high tides by a pile of driftwood built up between the hatchery and the ocean. The beach hatchery has a capacity for 77 nests. During the 2000 season 66 nests (65 *L. olivacea* and 1 *Chelonia mydas*) were incubated in the beach hatchery giving us average hatching success of 81.77%.

A second hatchery, the Foundation Hatchery, was used when the Beach Hatchery reached capacity. Having only been used since 1998 and given very poor success in the past, major reconstruction took place on the foundation hatchery during the early part of the season, halving the area of the sand and doubling the depth. The depth was increased from 35-40cm to 65-80cm allowing sufficient space for drainage through the clay base during the rainy season. With this alteration hatching success at the Foundation hatchery increased from 62% in 1999 to 84% during the 2000 season. The Foundation Hatchery was initially developed due to the loss of many nests in beach hatcheries to erosion. Situated approximately 50 metres inland on land owned by the Tiskita Foundation, the Foundation hatchery has a capacity for 91 nests, and will be used more extensively next year when exceptionally high tides are expected in mid October which may destroy nests if they are to be left in the Beach Hatchery.

Nests protected and Hatchlings released at Punta Banco, 1996 – 2000

Combined with 53 nests protected in situ in 1999 and 38 in 2000 a total of 619 nests have been protected at Punta Banco. 52,983 eggs have been protected in the hatcheries producing 36,165 hatchlings, an average recruitment rate of 68.25%. As can be seen from Fig 2 nesting hit a trough in 1998 when only 73 nests were recorded, so far 1999 has been the peak season with a total of 233 nests being recorded, although 2000 saw the most nests protected in hatcheries (n=141).

Hatching success at Punta Banco

The Beach hatchery produced a slightly lower hatching success during the 2000 season (81.8%) than during the 1999 season (83.7%). This could be due to the fact that the same hatchery has been used for four years consecutively and may now contain high levels of bacteria and fungi. Mortimer (1999) recommends that the same hatchery site should not be used during two consecutive nesting seasons. Logistical problems exist at Punta Banco for new hatchery sites due to a very narrow beach at high tide and also due to the fact that many locals bury their waste on the beach. In preparation for the 2001 season, I would advise replacing the sand currently in the hatchery, or building a new hatchery

Figure 1. Poaching levels at Punta Banco 1996 - 2000.

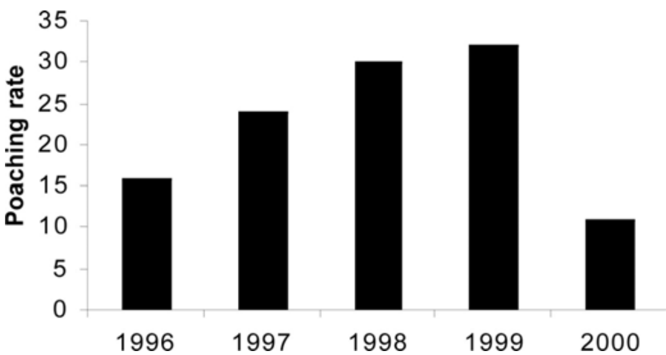
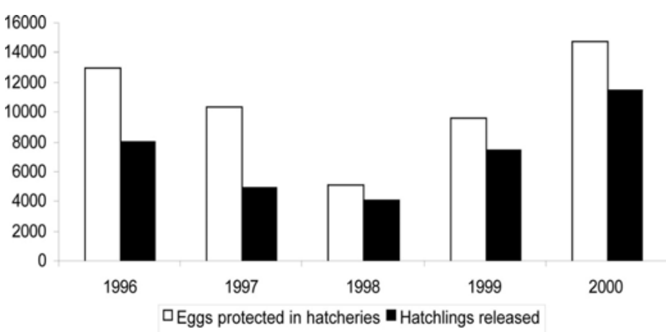


Figure 2. Eggs protected & hatchlings released at Punta Banco since 1996.



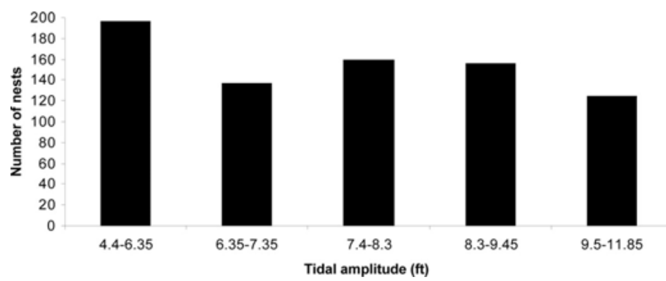
Effect of tidal amplitude on nesting activity at Punta Banco

A consensus as to the effect of tidal cycles on sea turtle nesting activity has not been reached by biologists. Caldwell (1959) and David and Whiting (1977) found no association whereas Bustard (1979) and Frazer (1981) found an association. Frazer (1983) found that on beaches with relatively high tidal amplitude peak nesting occurred at high tide, but on beaches with relatively low tidal amplitude the tidal cycle had no effect on nesting. No information could be found pertaining to the effect of the tidal amplitude on nesting activity.

All of the beach sections at Punta Banco reveal a rock substrate at very low tides which means that, with the exception of a few 'channels' through the rocks, nesting does not occur at low tide. Also, when the tide is at its highest long sections of the beach are completely submerged. This would imply that when the tidal amplitude is high, nesting would be less likely to occur, as there would be a shorter time window within which the tide level would be suitable for nesting.

Data from 1996 –2000 was combined to give 685 nights of recorded nesting activity at Punta Banco. The tidal amplitude for each night was calculated by taking an average of the two daily high tides and subtracting from this figure the average of the two low tides. The data was then arranged into ascending order according to tidal amplitude and then divided into five equal sections of 137 nights (Fig 3).

Figure 3. A comparison of nesting activity at varying tidal amplitudes, 1996 – 2000, Punta Banco.



A Chi-square test of the observed nesting frequency against equal frequencies for each category confirms that nesting activity is not random in relation to tidal amplitude (X^2=19.41; df = 4, p=0.00065). However, nesting frequency on nights when the tidal amplitude is greater than 6.35ft is not affected by tidal amplitude showing no significant difference from the equal frequencies (X^2 =5.39; d.f.=3, p=0.14483).

CONCLUSIONS

Punta Banco is a relatively young project, but is already showing great potential as a community based project. Several thousand dollars are brought into the community annually through paying volunteers and sale of merchandise. This money is fairly evenly distributed amongst the local people, discouraging poaching by allowing the villagers to see that turtle eggs are potentially more valuable to them when they develop, rather than being sold on the black market. Hopefully the children who were so mesmerised by watching the hatchlings released this year will be able to see these turtles return to nest as part of a healthy population regulated by the village, without the intervention of organisations such as ours.

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"USE OF OBSERVER DATA TO ESTIMATE FISHING IMPACTS ON LOGGERHEAD AND LEATHERBACK TURTLES IN THE NORTHWEST ATLANTIC"

Ransom Myers[1], Leah Gerber[1], and Larry Crowder[2]

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[2] Duke University

We present statistical models that use data from US observer observations on commercial longline vessels. We use spatially structured statistical models with extra Poisson error variance to analyze turtle bycatch data. We find that there is strong interannual variation in bycatch rates and that swordfish catch rates are good predictors of leatherback and loggerhead bycatch rates.

SEA TURTLES IN EGYPT - STATUS OF THE SEA TURTLE TRADE IN ALEXANDRIA'S FISH MARKET, (PART II)

Mohamed A. Nada

Friends of the Environment Association, Egypt

A pilot study to evaluate the response of the stakeholders in the sea turtle trade in Alexandria fish market, the most important fish market in Egypt, to different awareness messages. The study determines their area of interest and the most suitable way to deal with them, suggesting practical solutions.

INTRODUCTION

In the Mediterranean most of the southern and eastern coastline has been surveyed to determine main nesting sites. Two surveys were carried out on the north coast of Egypt; Max Kasparek covering the area from Alexandria to El-Salum (1993) and Michael Clarke & Andrew C. Campbell covering the whole Egyptian Mediterranean coastline (2000). These revealed that nesting figures for marine turtles were low and insignificant compared to other areas in the Mediterranean, with the nests randomly scattered along the entire coastline. Andrew Campbell's survey recorded large numbers of dead turtles washed ashore, suggesting that marine turtles congregate in the inshore waters to feed in the continental shelf sea grass beds.

A recent satellite tracking study by B.J.Godley (2000) to determine the post-reproductive migration of 6 female green turtles after nesting in northern Cyprus, revealed that 5 out of 6 turtles visited Egyptian waters, suggesting that Egypt is an important foraging and wintering area. It is clear, therefore, that it is important to protect the sea turtles in Egyptian waters.

Sea turtle predation is traditional for the inhabitants of Alexandra fish market area. Flower (1933) was the first to record this, mentioning a fairly large loggerhead turtle in the market. Recent observations confirm that the practice continues; Max Kasparek (1993), Laurent et al. (1996), Ozhan (1997) and Venizelos & Nada (1999).

It was found in part 1 of this study that the main consumers of sea turtle products were the fishing community and the uneducated individuals living around the fishmarket. They are considered to be the native Alexandrians; an ethnic society with their own language, accent, traditions, diet and personality, very keen to preserve their cultural identity, discouraging villagers coming from the nearby countryside to work, socialise and marry amongst them.
They have, however, been unable to protect their culture from new immigrants. Sea turtle meat and blood consumption has decreased slowly, however it still occurs.

It also found that in the period from December 1998 to May 1999 more than 135 turtles were slaughtered in the Alexandria fish market (El Anphoshi), with dramatically increased numbers toward the summer season. Most of the sea turtles were adult females, catastrophic for the Mediterranean sea turtle population.

METHODOLOGY

A questionnaire was filled out after an in-depth interview, as the people get confused and suspicious having their opinions written down in front of them. According to Philip Kotler, each culture consists of smaller subcultures that provide more specific identification and socialisation for their members. The stakeholders of the sea turtles trade were divided into three subgroups according their attitude, life style and age group, the first subgroup were the fishermen and the wholesalers, second the sea turtle blood and meat consumers, and third the school children.

The interview was carried out in 4 stages:

Who we are and what we do. - To break the barriers with the target group, gaining their confidence.

The sea turtle problems and the core awareness messages.

1. The life cycle of the sea turtles, species in the Mediterranean, life

span, nesting sites and feeding areas.
2. Threats facing the sea turtles like destruction of the nesting sites, injury or death as a result of fishery practice, compaction of sand by vehicles and walkers, predation of man on turtles meat and eggs, and water pollution.
3. The main awareness messages that can be used to persuade them to stop this practice, religion, law, medical hazards, biodiversity, and tourism.

Target group opinions and reasons.

According to Philip Kotler "people hear what they want to hear", and will be mainly interested and willing to pay attention to the things that are originally found in their area of interest. The target subgroups would be convinced only by messages that match their interests and point of view, otherwise they will not respond.

The target group response.

Measuring the percentage acceptance of the awareness messages for each subgroup, determining the most effective message for change, and the most significant reason for unwillingness to change.

The five messages that were given in the in-depth interview were:

- The importance of saving the sea turtles to biodiversity.
- The International and national laws to prevent the sea turtle trade.
- The religious view of killing an endangered species and the Islamic view of blood consumption.
- The relationship between the sea turtles and jellyfish, and its effect on tourism.
- The hazards of drinking blood on human health.

RESULTS

- (24) of (45) fishermen were willing to stop the trade in sea turtles (53.3%)
- (37) of (56) sea turtle consumers were willing to stop eating sea turtles (66%)
(54) of (63) children (12-16 yrs) were willing to stop eating sea turtles. (85.7%)

The five reasons given by the fishermen who were unwilling to change:

- Sea turtles are a source of income
- It is a very delicious meal
- We find blood good for our health.
- Turtle meat is part of our traditions
- I do not care

The five reasons given by the meat and blood consumers and the school children who were unwilling to change.

- It is a very delicious meal
- We find blood good for our health.
- Turtle meat is part of our tradition
- I do not care
- Others

ANALYSIS

The data showed a great variance between the responses of each subgroup to the awareness messages. The fishermen were less convinced compared to the sea turtle consumers and the children, however more than 53% of them were convinced, which is a very positive sign. The religious and legal considerations were the most effective messages for this subgroup. The reasons driving some of them to insist on slaughtering the turtles were their dependence on it as a source of income, and tradition.

The sea turtle blood and meat consumers, gave a good response (66%). Religion and the medical hazards of using blood as a tonic were the most effective messages. Tradition and the good taste of sea turtle meat were the main reasons for reluctance to change.

The school children had the best response (85.7%). The most effective messages to this subgroup were the importance of the sea turtle to biodiversity, the religious point of view, and the relation between the jellyfish and the sea turtle. The main reason for refusal to change was the good taste of the sea turtle.

CONCLUSIONS

Each of the stakeholders of the sea turtle problem in Alexandria fish market has his own point of view and reason, therefore any public awareness campaign should be designed to target each subgroup separately, taking into account their cultural background. It is clear that religion is a major influence on all the target groups.

RECOMMENDATIONS

i) Establish targeted awareness campaigns directed at the fishermen, meat and blood consumers, children and local NGOs
ii) Local police and the Egyptian Environmental Affairs Agency (EEAA) should monitor the sea turtle trade in the Alexandria fish market.
iii) The Muslim and the Christian priests should adopt an action plan aimed to increase awareness of the locals and the fishermen about the importance of protecting an endangered species and the hazards from using blood as a tonic.
iv) Ministry of Tourism should design a campaign highlighting the effect of the jellyfish on tourism and the relation between the jellyfish and the sea turtle.
v) Ministry of the Education should target schools in the area of the fish market and focus on the importance of biodiversity and the relationship between the jellyfish and the sea turtle.
vi) Enforcement of the current National Environmental law # 4 /1994, Act 28.

Acknowledgements::

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Sincere gratitude to Dr. Adel Abou Zahra (General Secretary of the Friends of the Environment Association, Alexandria) and Lily Venizelos, of the Mediterranean Association to Save the Sea Turtles, MEDASSET, for their support and advice. For the valuable help and co-operation in conducting this study from Gilan, Mohamed Refaat Sara Ahmed, Asmaa, Milda, Rehab, Nicoal and Hassan Shater. My gratitude to Dr. Talat Asaad and Mrs. Amy Devengo of the American University in Cairo, Alexandria, for their assistance at the planning stage of this study. And to Dr. Mohamed Shaker, faculty of fine arts, Alexandria University & Rehab Samee for their enormous effort in producing the poster for this study. I wish to thank Dr Mohamed Ibrahim from the (EEAA) for his co-operation and continuous support.

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INTER AND INTRASEASONAL NESTING INTERVALS OF SOLITARY NESTING OLIVE RIDLEY SEA TURTLES IN PUNTA BANCO, PUNTARENAS, AND SAN MIGUEL, GUANACASTE, COSTA RICA, FROM 1996 TO 2000

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INTRODUCTION

During the last 5 years the Sea Turtle Restoration Project and the Programa Restauración de Tortugas Marinas (PRETOMA) has been working together with Costa Rican coastal communities whose habitants have a shown a great interest in protecting the sea turtles that nest on their beaches.

Since 1996 a community based conservation project has operated in Punta Banco, while San Miguel and Caña Blanca joined the project in 1998. From July to December, local community members, usually youths are trained and hired as beach monitors to patrol the sea turtle nesting beaches of their communities. Their work is supervised by a biologist or advanced student.

Routine “beach monitor” work includes 3 – 5 hour nightly beach patrols. Turtles encountered are identified, measured, and tagged. The eggs are then relocated into a hatchery. The work of these monitors is reinforced by the supervising biologist and by “ecovolunteers”, usually foreigners who collaborate hands-on during a two week or one month stay at the study sites.

BACKGROUND

Studies on renesting intervals by olive ridley sea turtles using monel or iconel flipper tags have been carried out in the Ostional Wildlife Refuge and in Nancite, Santa Rosa National Park. However, both of these sites are “arribada” nesting beaches, where the massive synchronous nesting of hundreds of thousands of sea turtles occurs on a monthly basis. Not surprisingly, at these sites olive ridleys tend to nest during the arribadas, manifesting a one month interval. However, preliminary information gathered in Punta Banco and San Miguel during the development of the community based conservation projects is showing different nesting intervals.

RESULTS

After five years, 403 sea turtles have been tagged in Punta Banco, of which 81 were reobserved during the same nesting season they were tagged (reobserved) and 14 were reobserved after more than a one year interval (remigrants) (Table 1). After two years, 58 turtles had been tagged in Caña Blanca, of which 2 were reobsereved and 1 was a remigrant (Table 2). After three years, 160 turtles have been tagged in San Miguel, of which 19 were reobserved and 2 were remigrants.

Reobservation data was analyzed two ways. Figure 1 considers any reobservation at all, be it a successful nesting attempt or not. The most common interval recorded is 0-5 days. The second most common interval is 16-20 days. Figure 2 considers only effective nesting events. The most common renesting interval is 16-20 days, followed by intervals 11-15 and 21-25 days both with 7 turtles.

DISCUSSION

It was the author’s opinion that data was insufficient to analyze in the case of San Miguel and Caña Blanca. Only Punta Banco has enough data through time (5 years) to reach some preliminary conclusions on renesting intervals of solitary nesting olive ridley sea turtles.

Many turtles are seen soon after (0-5 days) their first appearance (and tagging) on the beach, but the vast majority of them do not nest in this short time frame. It is also quite rare to record any turtles within 6-10 days of their first appeance on the beach. Reobservations and confirmed renesting increases during the 11-15 day interval and the 21-25 interval, but increases dramatically during the 16-20 interval.

Table 1. Total number of olive ridley sea turtles (*Lepidochelys olivacea*) tagged, reobserved and remigrants during the 1996 - 2000 nesting seasons in Punta Banco, Puntarenas, Costa Rica.

Year	# Turtles tagged	# Reobserved	# Remigrants
1996	18	0	0
1997	79	13	2
1998	43	7	0
1999	146	47	4
2000	117	14	8
Total	**403**	**81**	**14**

Table 2. Total number of olive ridley sea turtles (*Lepidochelys olivacea*) tagged, reobserved and remigrants during the nesting seasons of 1998 and 1999 in Caña Blanca, Puntarenas, Costa Rica.

Year	# Turtles tagged	# Reobserved	# Remigrants
1998	25	1	0
1999	33	1	1
Total	**58**	**2**	**1**

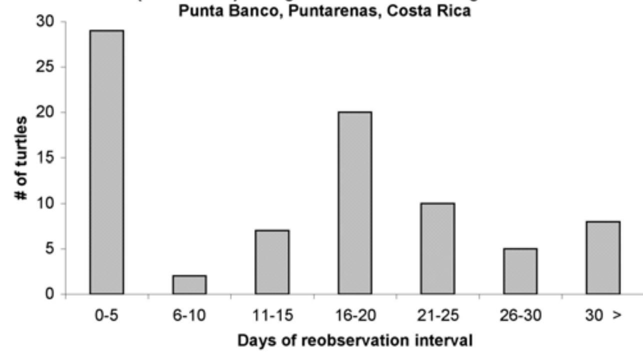
CONCLUSION

Olive ridley sea turtles seem to prefer to nest in 16 to 20 day intervals, followed by 11-15 day intervals and 21-25 days intervals alike. When evaluating a solitary olive ridley nesting beach, any turtles recorded within a 30 day nesting interval should be considered to be laying it's third nest (once when tagged, once when effectively reobserved after 30 days, and a hypothetical nest laid during a 16 to 20 day interval).

Table 3. Total number of olive ridley sea turtles (*Lepidochelys olivacea*) tagged, reobserved and remigrants during the nesting seasons of 1998 - 2000, in San Miguel, Guanacaste, Costa Rica.

Year	# Turtles tagged	# Reobserved	# Remigrants
1998	35	2	0
1999	51	7	1
2000	74	10	1
Total	**160**	**19**	**2**

Figure 1. Days of reobservation interval, for 81 olive ridley sea turtles (*L. olivacea*) during the 1996 - 2000 nesting seasons in Punta Banco, Puntarenas, Costa Rica



DOCUMENTING POST-NESTING MIGRATIONS OF LOGGERHEAD TURTLES USING SATELLITE TELEMETRY

Mark A. Nicholas

Gulf Islands National Seashore, 1801 Gulf Breeze Pkwy., Gulf Breeze, FL 32561 USA

BACKGROUND

Gulf Islands National Seashore (GUIS) is a low density-nesting site (< 1.7 nests/km) for the Federally threatened loggerhead (*Caretta caretta*) turtle. Little is known about the migratory routes and resident foraging habitats of this population of loggerhead turtle. Resource Management staff began efforts to locate and tag three female turtles with satellite transmitters in June of 2000. These transmitters, manufactured by Telonics, transmit positional and dive related data to satellites operated by Service Argos. The ability to locate turtles to tag was known to be a problem before the surveys were begun. This was due to the low numbers of females nesting in the area on any given night.

METHODS

The search for the turtles was conducted in the nighttime hours using ATV's to patrol the beaches. The first loggerhead turtle was located nesting at 0300 hours on the morning of the 28th of June 2000, the second night of surveying. After nesting was complete, she was tagged with a ST-14 satellite transmitter and then released to crawl back into the Gulf of Mexico. The tagging process was completed within two hours. She was named Sandy.

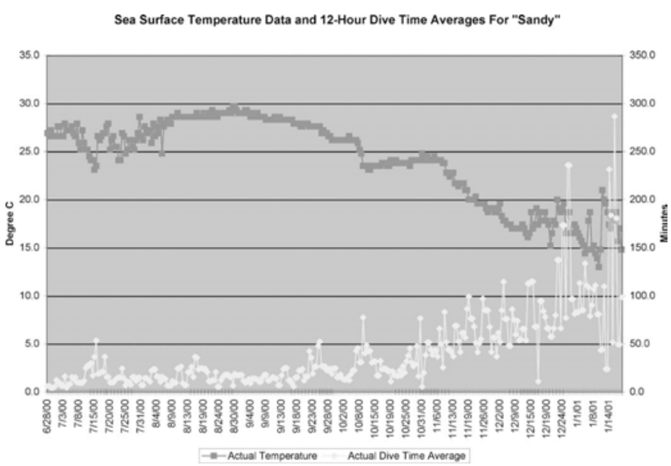
The transmitter was affixed to the carapace of the turtles by proven methods using elastomers and fiberglass (Balazs 1995). The transmitter/satellite system can provide position data of the turtles to within 150 meters. The sea surface temperature is also provided, as well as the duration of the last dive, the average dive time over the last 12 hours and the number of dives completed over the last 12 hours. The transmitters were programmed to run for 24 hours on and then shut off for the next 12 hours.

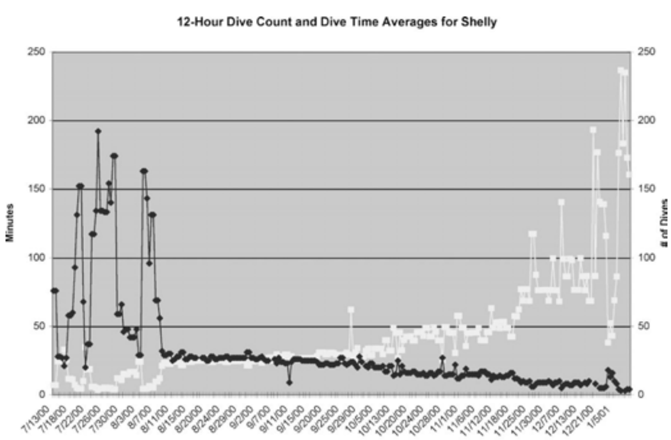
It was not until the morning of the 13th of July that the second turtle was tagged. Again the process was completed within two hours. The turtle was released and crawled into the Gulf of Mexico. She was named Shelly.

RESULTS

After Sandy was tagged she headed west along the Gulf Coast for about 200 km. until July 4th. She then turned and headed east. A few high quality transmissions indicate she may have nested at Gulf Shores, Alabama on or about July 23, 2000. She then headed west again and is now located south of Galveston, Texas. While in coastal waters Sandy conducted numerous short duration dives. There is no abrupt change in diving behavior post nesting season as exhibited by Shelly, the second turtle that was tagged. Sandy continued to perform numerous short dives until early October, when her diving behavior changed to longer dives, which coincided with a drop in sea surface temperatures.

After Shelly was tagged on Perdido Key, Florida she headed west along the coast for a short period, then headed to the east. A few high quality transmissions indicate she may have nested on Cape San Blas, Florida on or about July 25, 2000. She then continued east around Cape San Blas for approximately 100 km. She continued to stay within 50 km of land, possibly indicating she may have nested again in that area. On or about August 7th, she left the inshore waters of about 10 meters depth and moved 50 km further offshore to an area with about 20 meters of water. She remained in this general location for about 4 months. While in near shore waters, Shelly conducted numerous short duration dives. There is an abrupt change in this diving behavior beginning around August 8th, 2000 when she began to move to an area 100 km off shore. These data seems to indicate different diving behavior while the turtle is in between nests versus when she completes nesting and is then migrating to her feeding grounds.



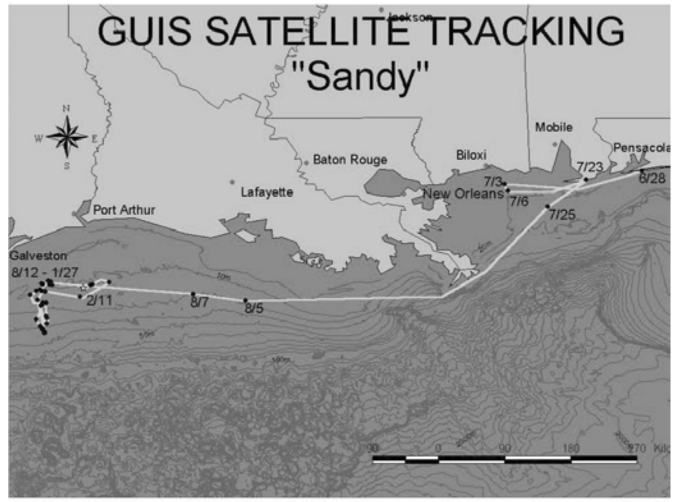


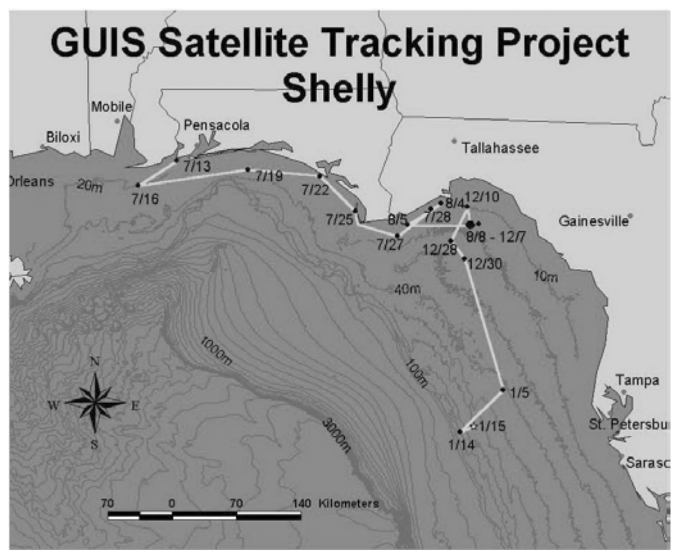
A third turtle was searched for but never encountered. A total of 398 employee and 180 volunteer hours were devoted to locating the turtles to tag. Approximately 1,972 ATV miles were driven on the beaches looking for turtles. As of April 2001 both transmitters are transmitting positional and dive data on a regular basis.

CONCLUSIONS

While little is known on the post-nesting migrations of this population of loggerhead turtles, it was intriguing to see from the first several months of data that both turtles remained in the northern Gulf of Mexico after the nesting cycle was complete. Loggerhead turtles tagged in NW Florida in 1999 headed to the southern Gulf of Mexico after nesting was complete (Schroeder, pers. comm.).

Both turtle migrations can be followed at the Caribbean Conservation Corps website http://www.cccturtle.org/sat18.htm





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TWO ADDITIONAL SPECIES OF MARINE TURTLE NEST WITHIN GULF ISLANDS NATIONAL SEASHORE'S FLORIDA DISTRICT

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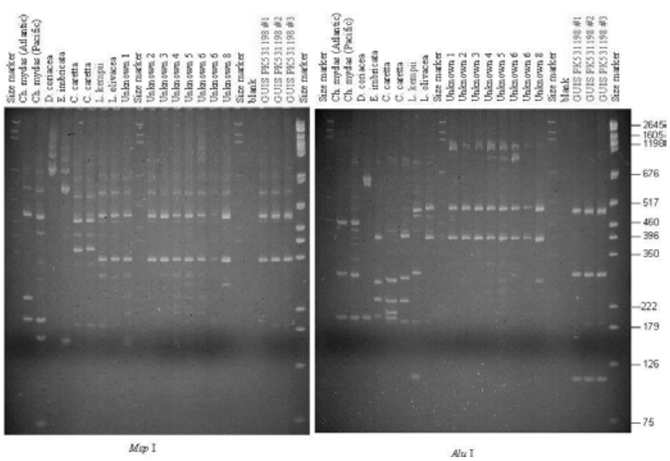
Prior to 1998, only two species of marine turtle were documented to have nested in Gulf Islands National Seashore's (GUIS) Florida District. They are the loggerhead (*Caretta caretta*) and the green sea turtle (*Chelonia mydas*). The number of documented species of marine turtle using GUIS beaches as nesting grounds has recently doubled to four.

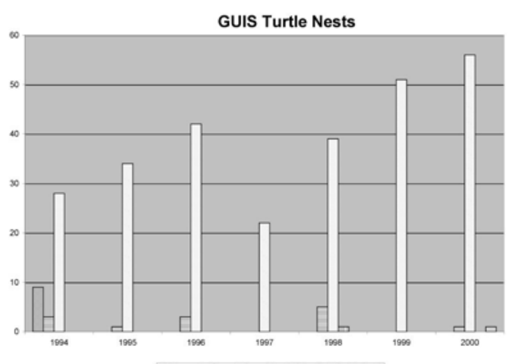
On May 31st, 1998 a turtle crawled out of the Gulf of Mexico onto the beach of the Perdido Key Area of Gulf Islands National Seashore. It was around 2 P.M. The turtle nested approximately 130 feet from the water. The turtle used an alternating gate and the crawl averaged 76.2 cm in width. The nest hatched 64 days later, when 8 hatchlings emerged. They were disoriented and only 4 were located and released into the Gulf of Mexico. On assessing the nest on August 5th, 7 more hatchlings were found and released. The nest had 130 eggs, 15 of which hatched. There were 108 eggs that were addled and 7 had varying degrees of development. Two partially developed embryos and one dead hatchling from the nest were collected and frozen for later analysis. They were then tested by Kathy Moore for DNA analysis. The results indicate that the hatchlings were *Lepidochelys kempii*.

In the Msp I section of the DNA photo, there are three distinct matches for L. kempi near 350, 480, and 520. *Caretta caretta* does not match in these areas. In the Alu I section, there are matches at/near 500, 320 and 112 indicating the samples are *L. kempii*.



On May 18th, 2000 a rather unusual turtle crawl and nest was reported by the volunteer conducting the Fort Pickens Area turtle nesting survey. It was 0615 hours when he came across a crawl that measured 152.4 cm. across. The crawl was symmetrical and the body pit was 45 feet from the water. The resource management staff were notified and investigated the nest. After locating the egg chamber, it was determined that the nest was laid by a leatherback (*Dermochelys coriacea*) and not by a green as originally suspected. It was also determined that the eggs would need to be moved. At that time, the bottom layer of eggs were already in standing saltwater. A total of 71 viable eggs, as well as 43 yolkless eggs were relocated approximately 1/4 mile to the WNW of the original nest.

On August 1st, 52 hatchlings emerged from the sand at 2130 hours. They were all disoriented from local light pollution and were moved closer to the Gulf of Mexico until they were able to crawl to the water in the shade of an escarpment on the beach. Fourteen more hatchlings were released over the next three nights.



MORTALITY OF SEA TURTLES ALONG OF THE PACIFIC COAST OF COSTA RICA

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INTRODUCTION

Sea turtles are a basic and important component in global biodiversity. Distributed throughout tropical and subtropical oceans, their populations once reached millions. Yet no sea turtles are free from human impact. Such anthropogenic factors affecting the lives of sea turtles include commercial overfishing, incidental capture during craftsmanship and industrial fishing activities, destruction of critical feeding, nesting and resting habitats, and more recently ocean pollution; boat strikes causing head and shell injuries, loss of limbs and other trauma; and the ingestion of foreign bodies. Natural factors are also important when considering sea turtle mortality, such as the increasing incidence of fibropapillomatosis, the extent and severity which is thought to be influenced by the aforementioned anthropogenic stressors (IUCN 1995).

All species of turtles, except "la kikila australiana" have been categorized as endangered or threatened, in the last red listing of IUCN, in Appendices I & II of the convention of Wildlife Migratory species (known as the Bonn Convention) and, in Appendix I of CITES (UICN 1999). For this reason, it is necessary to pursue precise, integral, joint efforts of ample scope on a global scale to contribute to the conservation and rational management of this natural resource.

In 1979, during the world conference on Marine Turtle Conservation held in Washington, DC, USA, it was reported that drowning in shrimping nets was the principal anthropic cause of mortality in sea turtles around the world. Subsequently tests were initiated with turtle exclusion devices (Ted's) to resolve the problem. Unfortunately, data continue to show that up to 44,000 turtles or more still die each year due to drowning in shrimping nets.

The lack of data about the causes of mortality impedes effective conservation management and hampers investigative efforts. As a consequence, management priorities would not be properly directed, while important management aspects may be bypassed and/or lead to inappropriate decision making (IUCN, 1995).

This paper addresses anthropogenic and natural causes of mortality in sea turtles, by necropsies on dead individuals stranded on various nesting beaches of Costa Rica's Pacific Coast whenever possible or simple visual observations by informally trained observers. It will help elaborate a protocol for the Regional Sea Turtle Network as a diagnostic guide of cause of death.

METHODS AND RESULTS

The first step to visit all possible nesting beaches and register its basic physical characteristics. If dead turtles or carcasses are found, a close inspection takes place. Also, information is sought from locals regarding dead turtles and usual nesting. After, to choose the best important for nesting and mortality. 11 beaches was select (see map), were assessed using different methodologies and time spans, depending on resources and personnel training. Fieldwork for necropsies between the months of august 2000 and January 2001 assessed causes of death in sea turtles.

For the take samples of dates postmortem is need category the carcass found and by these categories to decide if is fine to histophatological studies. In this study follow the manual Wolke, R., and A. George. 1981. Sea Turtle Necropsy Manual. Marine Pathology Laboratory. Department of Aquaculture and Pathology. University Rhode Islands. Kingston, RI 022881. NOAA Technical Memorandum NMFS-SEFC-24. 20 p.

Current mortality at 11 beaches reached 423 turtles, 84 having been linked to anthropogenic causes, 20 to natural causes and 319 unidentified due to tato postmortem autolysis (see1).

The results suggest anthropogenic factors as an important source of sea turtle mortality, such as: capture and forced immersion by shrimp nets, entanglement in nylon lines, cranial traumas, boat strikes that may cause injuries and predation of eggs and meat by humans. The Natural factors such as: natural depredation by coyotes, cocodriles and shark in Nancite beach. And the greater part of record of mortality by high autolisys postmortem.

Figure 1. Mapa de las playas de estudio en el Pacífico de Costa Rica, con los registros de mortalidad durante el período de agosto 2000 a enero 2001.

CONCLUSIONS AND RECOMMENDATIONS

In general, the anthropogenic factors are an important source of sea turtle mortality, for this reason research in this field must not only be continued by it must be increased, in order to achieve the active participation of all the actors and ensure efficient management and conservation strategies for sea turtles.

Several discoveries are product of fishing as for examples the hooks in the mouth and esophagus could to suggest an attraction of turtles by the bait for fishing, fishes or mainly squids (Achaval et al, 1997), and as mainly of carcasses founding in this study are lora (*Lepidochelys olivacea*), and as this turtles is omnivorous specie (Barragán et al, 1992) but primarily crabs, shrimp and mollusks

(Wynne and Schwartz 1999), this could to explain that almost all the founding are of this specie. However, is very important to increase the observers in boats that can to register founding important of the causes of mortality in sea turtles, as also take samples for medical studies could to contribute in all management plans of sea turtle.

Table 1. Relation by beaches of Mortality of the Sea Turtles between September 2000 y January 2001 along the Pacific coast in Costa Rica.

Beaches	Antrophogenic Causes	Natural Causes	High Autolisys	Total
Nancite	20	20	15	55
Naranjo			5	5
Ventanas			5	5
Grande o Baula	1		2	3
Langosta			7	7
Ostional	50		233	283
Camaronal			7	7
Punta Islita			3	3
San Miguel	13		11	24
Puntarenas			24	24
Bajamar			7	
TOTAL	84	20	319	**423**

Acknowledgements:

To all the volunteers who collaborated in the taking of data at several beaches. To the Ministry of the Environment personnel of Costa Rica (MINAE) who also collected data at several beaches and for support in logging and food. To Elizabeth Vélez for contributing information on sea turtle mortality data from Langosta beach during November and December. To The University of Costa Rica personnel stationed in Ostional from September to October. To Asociación Desarrollo Integral de Ostional (ADIO). To Red Centroamericana de Tortugas Marinas for the ticket for to travel the symposium. To Wildlife Conservation Society (WCS-COSTA RICA) for logging. To Programa Regional en Manejo y Conservación de Vida Silvestre (PRMVS) -Universidad Nacional - Costa Rica and To Asociación Programa Restauración de Tortugas Marinas (PRETOMA) Costa Rica.

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THE ACTION PLAN FOR THE CONSERVATION OF MEDITERRANEAN MARINE TURTLES

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ABSTRACT

Having already prioritised marine turtle protection for several years, the Mediterranean countries adopted a new action plan for their conservation. The action plan, which constitutes a regional strategy defining priorities and activities to be undertaken is coordinated and put into practice by RAC/SPA. Activities to date have included field studies to assess marine turtle nesting in close collaboration with several NGOs and a coordinated tagging programme. Priorities at national level have been drafted for most MAP countries. MAP priorities for turtle protection involve greater collaboration between fishermen and conservationists and an improved information flow between scientists and the wider community.

INTRODUCTION

As a relatively small marine area, the Mediterranean Sea has a very special situation in regard to marine turtles, characterised by:

· Five of the seven species of sea turtles living in the world are found there : the loggerhead *Caretta caretta*, the green turtle *Chelonia mydas* and the leatherback *Dermochelys coriacea* are common, whereas the hawksbill turtle *Eretmochelys imbricata* and the Kemps Ridley turtle *Lepidochelys kempii* are occasional.
· Two unique breeding populations, one the loggerhead population (may be the third largest in the world), and the other the green turtle population, containing endemic genotypes and significant diversity for this species.
· A traditional exploitation of sea turtles by both fishermen and local
· Difficult and complex conservation and management issues resulting from fishing activity, the tourist industry, coastal development, and cultural and economic links with marine turtles.

There are several international conventions containing provisions for the protection of marine turtles in the Mediterranean region (Table 1). These conventions are applied to various degree in the Mediterranean countries with the exception of the Barcelona Convention to which all riparian Mediterranean nations are signatories. The significance of the Barcelona Convention, as far as marine turtles are concerned, is reflected not only in the Protocol concerning specially protected areas and biological diversity in the Mediterranean but also in the elaboration of an Action Plan for the Conservation of the Mediterranean Marine Turtles in 1989 and its recent revision in 1999.

The Revised Action Plan takes a holistic approach to processes threatening Mediterranean turtle populations and sets out mutually reinforcing objectives, priorities, and implementation measures. Its three objectives are:

· Protection, conservation and, where possible, enhancement of marine turtle populations in the Mediterranean, with special priority accorded to *Chelonia mydas* where appropriate;
· Appropriate protection, conservation and management of marine turtle habitats including nesting, feeding, and wintering areas and migration routes;
· Improvement of current scientific knowledge by research and monitoring.

An important feature of the Revised Action Plan is its emphasis on addressing interactions of marine turtles with Mediterranean fisheries. It generally recommends that coastal States combine legally-backed tools and awareness-building programmes to address deliberate and incidental taking and take steps for the protection and management of known nesting, feeding (benthic and pelagic) and wintering areas and migration routes. The Plan emphasises that appropriate legal measures are essential to successfully carry out the priorities and implementation measures.

The Annex to the Revised Action Plan lists concrete actions for individual States, many of which concern the adopting or strengthening of legal protection for turtles and critical habitats. These actions are to be taken forthwith and are not contingent on further research. In addition, the Plan provides for ongoing research into turtle status, biology and behaviour and recognises that readjustments may be needed when further information becomes available.

Lastly, the Revised Action Plan emphasises the importance of developing public awareness, information and education measures to meet the needs of different target groups. Depending on specific conditions, these may include the local population and visitors to nesting areas; fishermen and other stakeholders; tourists and relevant organisations; schoolchildren and teachers; and decision-makers at local/regional levels.

Within the framework of the Action Plan for the Conservation of Mediterranean Marine Turtles, RAC/SPA (the body in charge of implementating of the Action Plan) has carried out and continues to carry out many concrete field actions with NGOs, inter alia: assessment of the marine turtle nesting activity, elaboration of the Manuel on the marine turtle conservation and tagging programme, annual organisation of a training session on marine turtle conservation techniques at the Lara station, elaboration of guidelines for legal frameworks for conservation and management of Mediterranean marine turtles, a training/awareness module to educate fishermen in the need to release incidentally-caught turtles and the list continues.

Acknowledgements:

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To obtain copies of the Action Plan you can download it at the following address or please contact the Director of RAC/SPA at the following address :

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	Berne Convention Annex 2	Bonn Convention Annex 1	Bonn Convention Annex 2	CITES Convention Annex1	Barcelona Convention Protocol ASP & Bio Annex 2	Habitat Directive
Caretta caretta	X	X	X	X	X	X
Chelonia mydas	X	X	X	X	X	
Dermochelys coriacea	X	X	X	X	X	

INVOLVING LOCAL COMMUNITIES IN A NATIONAL STRANDING NETWORK: THE CASE OF CRETE

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INTRODUCTION

Crete with an area of 8,261 km^2 is the largest island in Greece and also the 5th largest in the Mediterranean. The discovery of three important loggerhead (*Caretta caretta*) nesting sites (Rethymno, the Bay of Chania and the Bay of Messara) between 1989 and 1990 by ARCHELON - the Sea Turtle Protection Society of Greece led to the initiation of a long-term monitoring and conservation programme (Margaritoulis et al., 1992). A Management Plan, compiled in 1997, determines the socio-economic background and suggests a strategy towards the long-term protection of sea turtles in the area, involving the local community (Irvine, 1997).

THE NATIONAL SEA TURTLE STRANDING NETWORK

Despite the existence of both national and international legislation protecting sea turtles, many are found stranded in Greece, with injuries primarily resulting from fishing activity. In 1992, ARCHELON formed the Sea Turtle Rescue Network in co-operation with the Ministry of Mercantile Marine. The objectives of the Rescue Network include collecting information on live and dead strandings throughout Greece. This information revealed the large number of turtles requiring rehabilitation treatment, which resulted in the establishment of ARCHELON's Rescue Centre in Glyfada, Athens in 1994 (Kopsida et al., 2000).

This presentation discusses how the Rescue Network operates on the island of Crete and how the local community has been involved in reporting sea turtle strandings.

SEA TURTLE STRANDINGS ON CRETE 1996-2000: COLLECTION & PRELIMINARY EVALUATION

Once a sea turtle is found dead or injured, a "stranding sheet" is completed. The stranding sheet provides information as to the location, circumstances and fate of the turtle. Photographs, thus enabling a fairly accurate evaluation of the cause of stranding, usually accompany records. All stranding sheets are subsequently forwarded to Athens and entered in a central database in order to be able to analyse the information collected. In cases of injured animals, arrangements are made with the help of ARCHELON for the turtles to be transported to the ARCHELON Rescue Centre as soon as possible. Dead animals are recovered and disposed of by the local authorities.

A rapid assessment of strandings recorded on Crete between 1996 and 2000, have provided ARCHELON with valuable information as to the particularities of the situation on the island.

1. There is a significant increase in the number of sea turtle strandings recorded over the last 5 years. The turning point was 1998, when the total number of strandings bounced from 11 to 28. During 2000 there were three times as many strandings as in 1996 (Fig. 1).

2. The percentage of injured turtles reported in 2000 is larger than previous years (1996: 16.7%, 2000: 37.5%) (Fig.1).

3. Sea turtle strandings take place all year round, with an increase during the nesting/hatching season (May to October) (Fig. 2).

4. Strandings reported are currently spread all around the island, often in areas far away from those regularly monitored by ARCHELON.

All these factors have made it necessary for ARCHELON to incorporate the local community in the National Sea Turtle Stranding Network, in order to ensure accurate data collection and to be in a position to transport all injured animals to ARCHELON's Rescue Centre in Athens for treatment and rehabilitation.

ACTIVE MEMBERS OF THE NATIONAL SEA TURTLE STRANDING NETWORK ON CRETE

1. Port Authorites

Since the Ministry of Mercantile Marine was instrumental in the operation of the Rescue Network, the local Port Authorities became directly involved in the collection of stranding information. A circular containing information on first aid and handling of injured, sick, weak and dead sea turtles was handed out by the Ministry of Mercantile Marine to all Port Authorities in 1999. There are 12 Port Police Stations on Crete, which are ARCHELON's principal contacts for stranding reports. In 2000, 62.5% of the total strandings were reported by the Port Authorities, the remaining percentage being shared between ARCHELON members (21.9%) and locals (15.6%).

2. Research Institutes

ARCHELON collaborates with the Institute of Marine Biology of Crete and the Natural History Museum of Crete. They report cases of turtle strandings and are actively involved in sending injured sea turtles to ARCHELON's Rescue Centre.

3. Local Environmental NGO's

Local environmental NGO's are mainly involved in the transportation of injured sea turtles to the Sea Turtle Rescue Centre for treatment and rehabilitation. The most important ones, The Environmental Initiative of Hania (West Coast) and the Environmental Team of Sitia (East Coast), have assisted ARCHELON in transporting 26.9% of the total cases of injured animals over the last three years.

4. Diving Schools, Sailing Clubs

They report sea turtle strandings and are available in cases of sea turtles trapped in rivers or lagoons. They are also a good source of information for sea turtle sightings all around the island.

5. Concerned individuals

The publicity obtained through media coverage of sea turtle strandings, as well as the intense public awareness programme carried out by ARCHELON has resulted in the local community becoming interested in the plight of the sea turtle and being willing to get involved in the protection of this endangered species. During

2000, 69.2% of turtles found injured have been transported to ARCHELON's Rescue Centre thanks to the voluntary contribution of those individuals.

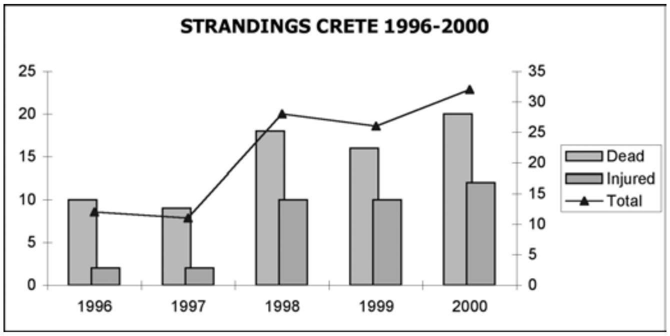
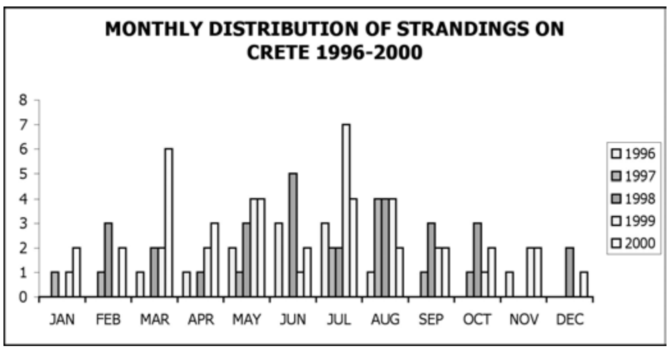


Figure 2. Monthly Sea turtle stranding analysis for Crete between 1996 and 2000.



CONCLUSIONS

Thanks to the participation of the port authorities, research institutions, environmental organisations and individuals, ARCHELON has managed to:

1. Receive information about strandings even in areas that are not regularly monitored by ARCHELON.

2. Have a clear picture as to the major causes for sea turtle mortality all around the island, which improves ARCHELON's conservation policy on the island.

3. Get a clear indication of how the local community increasingly supports the effort to protect sea turtles and their habitats.

Figure 1. Total number of turtles reported dead or injured on Crete between 1996 and 2000

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STUDENTS AS RESEARCHERS IN SEA TURTLE MONITORING PROJECTS

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A case study involving local high school students demonstrated that students can be reliable and effective research assistants for sea turtle monitoring programs. 49 students and 12 teachers from public and private schools in Costa Rica worked with partner scientists at the Pacuare Nature Reserve on the Caribbean coast of Costa Rica to assist with the leatherback monitoring program. Over 8 nights (~120 person-hours; May 9-16, 2000) student patrols collected data on 39 leatherback sea turtles, relocated 23 nests, covered ~210 km of shoreline, and collected 40% more data points for the reserve biologist. Moreover, the students collected high quality data; measurements of sea turtle carapace length and width were within 2% (+/- 1.5%, n=24) of measurements taken on the same turtles by researchers earlier in the season. Beyond the students' contribution to the scientific process, student-scientist partnerships help to increase the public's understanding of conservation biology, provide inspiration to future scientists, and educate local communities about sea turtle ecology and conservation. The success of this project depended on appropriate preparation and training of both the students and biologists prior to and during the site visit, to ensure that expectations were met and quality data was collected. Program collaboration and implementation was facilitated by the non-profit conservation education organization Ecology Project International (http://www.ecologyproject.org).

SURVEY AND UP-DATING OF COLLECTED MATERIAL OF SEA TURTLES IN ARGENTINEANS MUSEUMS

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The Argentine Sea is part of the habitat of three sea turltles species: *Caretta caretta*, *Chelonia mydas* and *Dermochelys coriacea*, which spend prolonged period of the time in the area. Occassionaly dead specimens are found washed ashore or cough up in nets of local fishermen. Some of the specimens have been taken to the Museo de La Plata,'Dr. Francisco P. Moreno' (which belongs to the University of La Plata) and the Museo Nacional de Buenos Aires, 'Bernardino Rivadavia' (which belongs to the University of Buenos Aires). This procedure has provided both institutions with a large amount of study material. In most cases specimens lack proper information and/or have not been preserved. For this reason an extensive revision of their collections has been done including counting, description and identification of the material: skull, skeletons, shells, measurements and state preservation. Out of 24 specimens studied, 10 are *C. caretta*, 5 Ch. *mydas*, 6 *D. coriacea*, as well 3 *Eretmochelys imbricata* specimens were found, which although are well of their distribution area were included. Resulst are shown in charts and graphics. By this means we try to increase the know ledge of the aforementioned species for Argentine and to support the efforts that international community has been making the last decades to save the sea turtles.

GREEN TURTLE FIBROPAPILLOMATOSIS (GTFP): CORRELATIONS WITH EGG PRODUCTION, HATCHING SUCCESS, AND BODY CONDITION AT FRENCH FRIGATE SHOALS

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INTRODUCTION

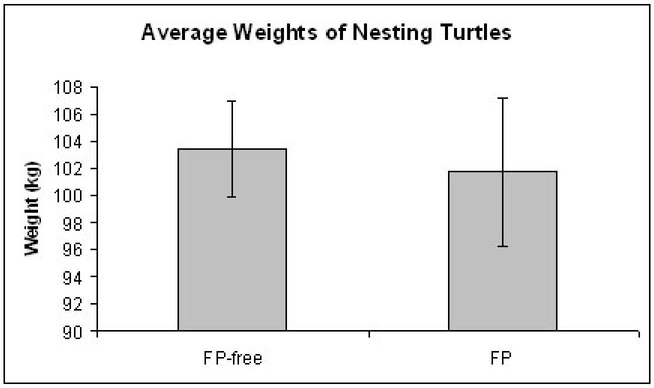
An estimated 90% of all Hawaiian green turtles (*Chelonia mydas*) nest at French Frigate Shoals, Hawaiian Islands,National Wildlife Refuge (Niethammer, et. al. 1997). While the turtle population has been increasing at the nesting colony and at coastal foraging pastures, (Murakawa, et. al. 1999), the sightings of turtles with fibropapillomatosis (FP) have also been increasing (Balazs 1991). It has not been determined whether the reproductive effort of the turtles has been affected by the occurrence of FP. The objective of this study was to understand the impact, if any, of FP on the reproductive effort of the Hawaiian green turtle. Specifically, how FP may affect clutch size, hatch success and adult body condition. Nesting activity of the turtles was monitored during the 1999 season solely on Tern Island, French Frigate Shoals (lat, 23 degrees 52'N, long. 166 degree 17' W). Data were collected during 140 nightly walks from May through September. A total of 157 turtles, 24 of them with fibropapillomatosis (FP), were recorded. Twenty-four FP-free turtles and twelve FP turtles were selected for more intensive monitoring. Selected turtles were followed throughout the entire season and all nests laid per individual were recorded, marked, and mapped to the extent possible. Body weight was obtained for each female before the first nest and after the third nest. Clutch size (number of shells in nest) and hatch success (number hatched/number unhatched) were determined by excavating the nest three days after a pre-hatch pit was observed.

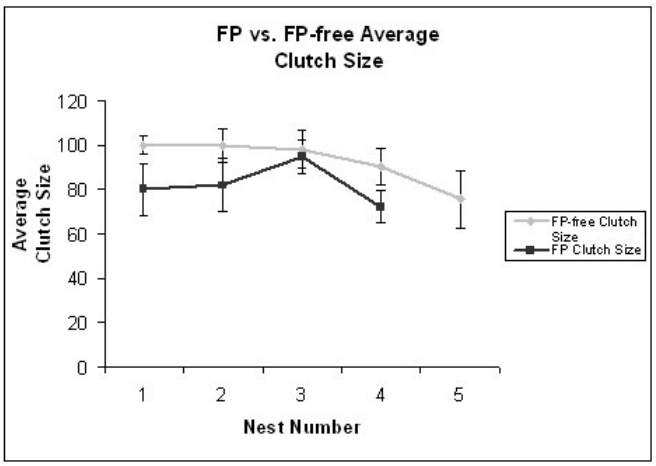
RESULTS AND DISCUSSION

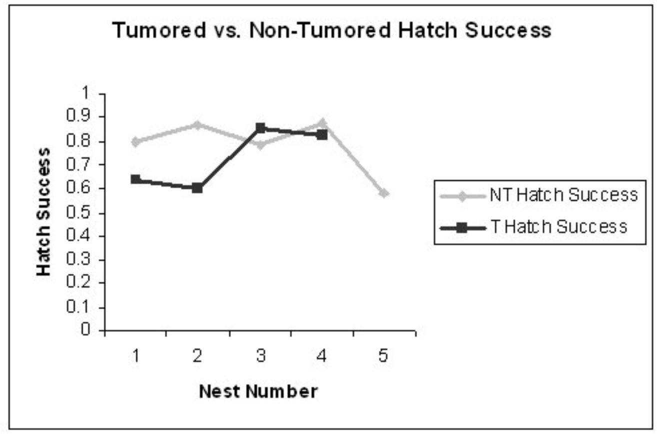
The majority of the turtle nesting on Tern Island occurred on the south beach. A total of 157 turtles were observed nesting, of which 15.3% (24 ind.) were observed to have FP. Out of 70 recorded nests, the mean incubation period was 68 days. The average weight of FP and FP-free turtles combined was 102.8 kg (SE ± 2.92), while the average weight of FP-free turtles were 103.5 kg (± 3.49), and with FP were 101.7 kg (± 5.45). There was not a significant difference in the average weight of nesting turtles between FP-free (NT) and FP (T) turtles. (Fig.1).

The overall average clutch size for FP-free turtles was 92 eggs with an average hatch success of 78%. The overall average clutch size for turtles with FP was 93 eggs and an average hatch success of 76%. There was not a significant difference in the average clutch size (Fig. 2) and average hatch success (Fig. 3) between FP-free turtles and turtles with FP throughout the nesting season.

According to indices examined in the present study, FP does not have a significant effect on nesting success. Turtles nesting at French Frigate Shoals appear to follow the findings of previous studies (Bjorndal and Carr 1989 and Hays and Speakman 1993). Turtles with large, apparently debilitating tumors were not observed to nest.







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TRACKING THE MIGRATION IN OCEANIC WATERS OF TWO OLIVE RIDLEY TURTLES *LEPIDOCHELYS OLIVACEA* AFTER THEY NESTED AT LA ESCOBILLA BEACH, OAXACA, MEXICO

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INTRODUCTION

The olive ridley turtle *Lepidochelys olivacea* is considered the most abundant in the Pacific Ocean. It is a pantropical species that lives mainly in the northern hemisphere. The biggest quantity of reproductive colonies is located in coastal waters and it has been observed that during reproductive seasons they travel and feed in groups, mainly in the Eastern Pacific and in the Indian Ocean. It is possible that the adults use oceanic currents to travel to various distant points to their nesting areas. The habits of these organisms in juvenile stages are not very well-known since they have only been observed close to the mature stage and in some occasions they can be observed in the feeding areas (Márquez, 1990).

The Escobilla beach is considered the most important nesting area of olive ridley turtle in Mexico and amongst the three most relevant beaches in the world, together with the Ostional in Costa Rica and the beaches of the State of Orissa in India; it is situated between the

96°45 ' 667 " western longitude and 15°43 ' 661 northern latitude, where it is limited by the bar of Cozoaltepec river and between the 96º 41 ' 921 western longitude and 15º 43 ' 921 northern latitude to the west of the Bar of Tilapa, in the corridor that exists between the populations of Puerto Angel and Puerto Escondido in the municipality of Sta. María Tonameca, Oax. The length of the area is of 15 km adn the width 30 to 100 meters, approximately. The concentrated nesting area is of 8 km, approximately, at the western end of the beach.

OBJECTIVES

To identify the migratory route of the olive ridley turtle nesting in the Escobilla beach and the factors that influence it.

METHODOLOGY

We selected two specimens of the turtles present in the Escobilla beach during the "arribazón" that occurred between 10th to 16th November, 1999, the selection criteria used were that of good health and size superior to the average of the population; before egg-laying all action that could interfere with the process was avoided. Once the females finished depositing and covering their eggs, a Teletonics ST-10 transmitter was attached to both ot them on the peak of the shell, fixing it according to the method of using fiber glass cloth and resin proposed by Balazs (1996). The length and width of the shell was measured and recorded and blood samples were taken. The eggs of each female were collected and transferred to the facilities of the Centro Mexicano de la Tortuga (Mexican Turtle Center), to be incubated in the incubation room of the Center. After the transmitters were attached, the females were released in the place where they had nested, taking this as the starting point and indexing it with a portable GPS 12 Garmin geographical positioning system.

The data on the movement and location of the turtles during the 129 days of the experiment (from November 13, 1999 to March 31, 2000) was obtained by satellite telemetry using the satellites NOC1, NOC2, NOC3 and NOC4; with the data sent for ARGOS Service the routes were traced and drawn onto a map to facilitate understanding and confrontation with the diagrams of oceanic surface temperature.

The diagrams of the information on the oceanic surface temperature were obtained from NOAA satellite data with remote sensors (SST).

Characteristics of the turtles that had satellite transmitters attached to them.

Name	Length (cm)	Width (cm)	Number of eggs	Tag	Transmitter
Golfi	69.0	73.5	117	BM757	22149
Oliva	68.5	73.8	105	BM950	24187

RESULTS AND DISCUSSION

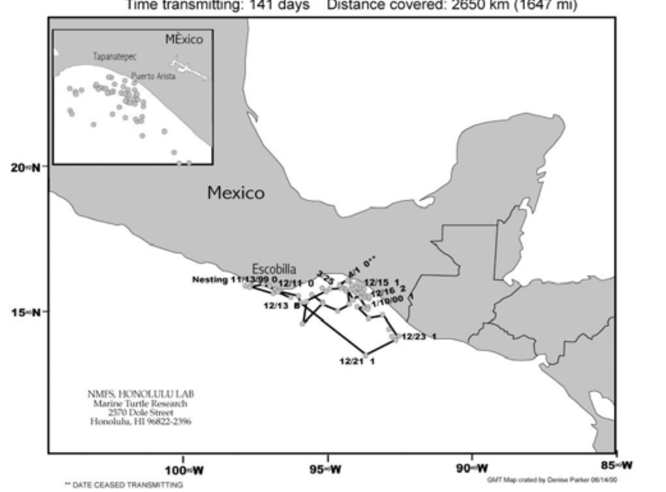
The pursuit of the displacement of both turtles could be carried out in the lapse of November 13, 1999 and April 5, 2000, with the result that for the turtle denominated "GOLFI", ID 22149 a total of 141 days of transmission was received; the displacement range was 2650 kilometers, (1647 miles) from the Escobilla Beach, Oaxaca 15° 43' 553 N and 96° 44 ' 825"W and the southern part of Chiapas, 15.795 N and 94.149W (map 1), whereas for the turtle denominated "OLIVA", ID 24187, information was received for 172 days and during the displacement it reached the coasts of Guatemala and El Salvador with a traveled distance of 3748 km (2330 miles) at the coordinates 14.322 N and 88.316 W (map 2).

NAME	ID	DAYS TRANSMITTING	DISTANCE COVERED (MI)
Golfi	22149	141	1647
Oliva	24187	172	2330

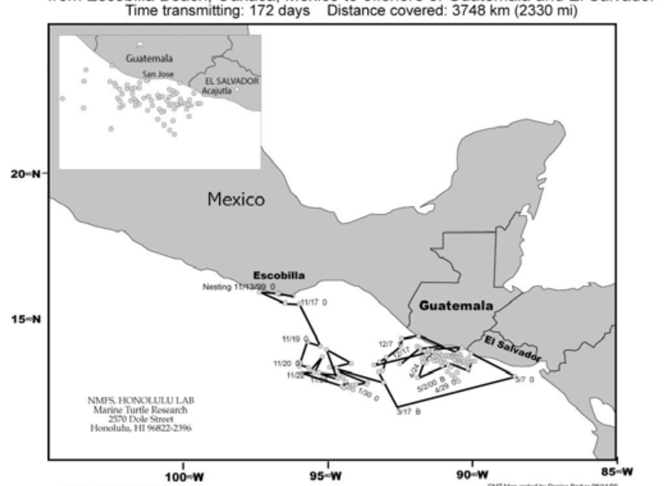
The pattern of the oceanic surface temperature in the Gulf of Tehuantepec shows a remarkable descent with regard to the surface temperature observed in front of the nesting area, due to the northern winds coming from the Gulf of Mexico and influencing the Gulf of Tehuantepec. By overlapping the maps that show the routes the turtles migrated with the diagrams of the oceanic surface temperature, we can observe that both females avoided to cross areas with very low temperatures, the reason why they did not enter the Gulf of Tehuantepec.

The turtles have remained in the region, one offshore of the state of Chiapas and the other offshore in the middle of the area of El Salvador, which most likely are feeding areas for this species.

1999-2000 Post-nesting satellite-tracked movements of female olive ridley (ID 22149) from Escobilla Beach, Oaxaca, Mexico to the Golfo de Tehuantepec, Mexico
Time transmitting: 141 days Distance covered: 2650 km (1647 mi)



1999-2000 Post-nesting satellite-tracked movements of female olive ridley (ID 24187) from Escobilla Beach, Oaxaca, Mexico to offshore of Guatemala and El Salvador
Time transmitting: 172 days Distance covered: 3748 km (2330 mi)



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To Dr George Balazs of the Laboratory of Honolulu of the NMFS for providing us with the equipment and training. To Porfirio Hernández, and enthusiastic students Miguel Angel Angeles, Deyanira Vasconcelos Castillo, Shyamoli Mehta, Alejandro Tavera and Miguel Angel Licea. Equally to the workers of the Temporary employment of the Escobilla Community who supported us for the localization and handling of the turtles used.

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THE INFLUENCE OF THE MOON AND TIDES IN THE NESTING OF THE LEATHERBACK SEA TURTLE (*DERMOCHELYS CORIACEA*)

Humberto Pineda, Libertad Cuellar , and Adriana Laura Sarti

Proyecto Laud. INP

INTRODUCTION

With the experience and work a the nesting beaches, an influence of the moon and tides on the females nesting can be observed, but unfortunately few studies have been made to evaluated this relation. In this work, was evaluated the number of nesting with relationship to lunar position, lunar phase and tide cycle, to observer if exist any influence on the nesting of this species.

STUDY AREA

Tierra Colorada beach nesting is located in México, at Guerrero State southeast part and burdening with Oaxaca state, between Barra de Tecoanapa (16° 30 ' 03 " N and 98° 43 ' 40 " W) and Punta Maldonado (16° 22 ' 36 " N and 98° 35 ' 40 " W) in the region known as Costa Chica of Guerrero. This beach remains on 26 km of sandy fringe extension and 48 m wide which is relatively uniform except by the Punta Maldonado near area, where the beach becomes very narrow due the hill proximity, and also caused by invading waters all over the vegetation area at high tide hours. The tides regime of is mixed seminally, with two high and two low tides per maritimes day and different height each one (Peredo, 1990). The water surface temperature fluctuates about 28 °C, and the salinity is 34 0/00 (De la Lanza, 1991).

METHODS

Lunar position

In the study of each female at night, lunar position was observed. The observer stood facing at sea tracing an imaginary line for the path of the moon from "rising" to "setting", supposing that the line pointed a clock horizontal half line. The Moon's position observed refers to numbers 9,10,11,12,1,2 and 3 and were recorded in the field notes, considering position 9 before rising (southeast of the beach) and 3 right after the sunset (Northeast of the beach). Turtles coming out from the nest in different lunar positions were evaluated and ANOVA's test for observing whether the turtles show a preference for nesting during a particular lunar position was completed.

Lunar phases

Based in date of each lunar phases (full moon, waning moon, new moon, crescent moon) categories were assigned for each one of them, including 3 days prior to and 3 days after the phase with a term of seven days. The results were compared to an ANOVA test to establish the influence, in any of the lunar phase on the females nesting.

Tides

For each female observed during the nights rounds it was noted the activity in which was founded, evaluating the time in that she arrived to the beach (according with the time registered for each activity for Benabib (1983), Hirth and Ogren (1987) and Sarti (1994)).

Mexican Pacific beaches present a mixed system semidiurnal tides (tidal, with 2 high and 2 low tides of different height each a day) (Peredo, 1990). Therefore, a division was made into eight categories to the tide cycle, first dividing the period between the low tide and the following high tide into 4 parts of equal duration based on data gathered by tide charts and following the same process for the period included between the high tide and the following low tide. To observe if the turtles show a preference for nesting in any of the tides categories we used, we employed an ANOVA test, comparing the number of nesting in said categories.

RESULTS AND DISCUSSION

Lunar position

During this work it was observed that turtles (66.4%) prefer to nest during the darkest part of night (when the moon is hidden) in the lunar position 3 y 9 (ANOVA test $p= 0.0056$ $a = 0.05$). The same is reported by López and collaborators (1994) in Mexiquillo Michoacan and this conduct of the females can be explained based on the supposition of o signify an adaptive technique to reduce the probability of being found by predators.

Lunar phases

Besides the lunar position the lunar phase (crescent, waning, full or new) is a factor, which can influence nesting, but there is great disparity in the results of different studies. On one hand, Marquez and collaborators (1981) say "nesting increase during the new moon phase", while Sarti and her group (1988) found that increase occurs during the quarter wanings and quarter crescent phases. At variance to these reports, in Tierra Colorada was found that there is no relation between nestings and lunar phases.

The fact that the turtles prefer the night darkest period for nesting could lead to the supposition that the majority of nestings occurred during new moon phase as Márquez and collaborators mention (1981). Nevertheless, during the other lunar phases, generally the females nest when the moon has not yet arise or when it has already gone down, thus avoiding nest under the moonlight, but there are nesting during the full moon phase.

Tides

The tidal cycles are a phenomenon that influence the females nesting behaviour, although according to the results, this influence is minimal. It can be supposed that there exists a relation between the tidal cycle and the nesting of the turtles, since it would be an advantage to the turtles to come out during the high tide, due to fact of the energy amount on time and distance travelled in order to avoid their susceptibility to predators (Frazer, 1983; Chang, 1989; Fretey and Girodot, 1989).

Even though, some studies report that "tiding" has no influence on the turtles nesting (Caldwel, 1959 in Frazer, 1983; Davis and Whiting, 1977), in other reports, a relation was found for instance, Frazer´s study (1983) with loggerhead sea turtle, in which he found that the nesting coincided with the tidal cycles on beaches with slight slopes and relatively high tides, also observed by Brooks and Webster (1988), who had a peak number of nestings around a high tide on a beach with low sloping hills. The same is the case with the leatherback sea turtle, in a study in Mexiquillo, Michoacan, in which during a high tide nesting is clearly concentrated (Barragán and Argueta, 1995).

CONCLUSIONS

The sea turtles show preference for nesting on a moonless night. But it was founded no relation between nesting and the lunar phases, or with the tidal cycle, even though an increase in nestings was observed during the full moon phase, as during the high tide.

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OBSERVED SEA-TURTLE BY-CATCH IN PELAGIC LONGLINE SETS OFF SOUTHERN BRAZIL

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To provide information on potential sea turtles by-catch in longline fisheries in southern Brazil (26ƒ-35ƒ), forty-one sets were monitored. These sets were conducted in the vicinity of the shelf edge break as part of the ARGO research cruises undertaken by the

University of Rio Grande (FURG). Cruises were conducted over four years (1996-1999) during spring, summer and winter. The gear and setting procedures were similar to those used in the commercial Brazilian longline fleet targeting swordfish (Xiphias gladius) except lightsticks were not used. A total of 19 sea turtles were caught on 14 of the 41 sets (34%), and the overall catch rate was 1.5 turtles per 1000 hooks. The loggerhead turtle (*C. caretta*) was the dominant species caught comprising 71% of those positively identified, followed by the olive ridley turtle (*L. olivacea*) (24%) and a single leatherback (*D. coriacea*). This is the first time this species has been reported as having been caught in longlining fishery off South America. All of the turtles, except one, were captured live and released. The straight carapace lengths indicates that they were most likely sub-adults base on the reported size of nesting females. Turtles were caught in waters ranging from 14-25ƒC and tended to be caught on those sets that fished shallower. Differences in proportion of sets in which a turtle was captured were not significantly different for the three seasons sampled , which suggest a year around presence and vulnerability to longlining of sea turtles in this area.

SATELLITE TELEMETRY GREEN SEA TURTLES (*CHELONIA MYDAS*) NESTING IN LECHUGILLAS, VERACRUZ-MEXICO

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Satellite transmitters were attached to green turtles (Chelonia mydas), at Campamento Tortuguero in Lechuguillas, Veracruz-Mexico. Tagging was done between August 20 and September 20, 2000. Two adult female turtles were captured following the deposition of their egg clutches and transported to the base camp to be fitted with the radio transmitter. Telonics model ST-18 transmitters, programmed with a duty cycle of 6 hour transmission period followed by an 18 hour passive cycle were attached to the second central scutes of two sexually mature female turtles. The turtles' movements have been monitored by collecting longitude and latitude data using The Service ARGOS Satellite System. All data points have been interpreted and plotted using ArcView 3.2 GIS mapping software. Both turtles traveled form their nesting ground in Mexico to feeding grounds off the coast of Florida, in an area called Tortugas Bank. Zyanya traveled approximately 984 km in a southeastern curve, at an average speed of 0.631 km/hr. Roberta traveled at a pace of 0.362 km/hr for a total estimated distance of 1430 km. The tracking will be continued for a period of up to one year, dependent on equipment performance and battery life. The GIS plots will be analyzed to determine migration routes, swim speeds and habitat utilization by the two tagged turtles.

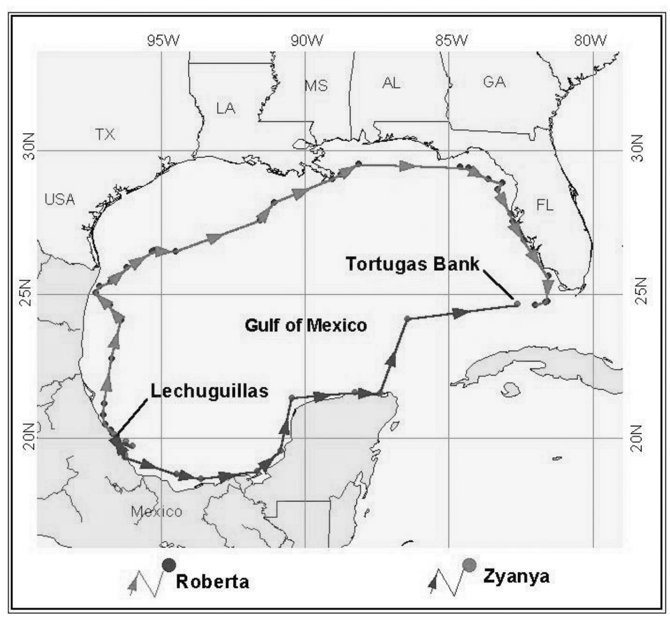
METHODS

Both turtles were fitted with Telonics ST-18 transmitters using the method described by Balazs, et. al., 1996. The tracking is being conducted using The Argos Satellite System and the data is being analyzed and plotted with ArcView 3.2 mapping software. Swim speeds were calculated using the Greater Circle Equation.

RESULTS

Both turtles were released on their nesting beach in Lechuguillas, Mexico at approximately 97°18'11" W and 19°51'89" N. The first turtle tagged, Zyanya, remained within 10 km of the nesting beach for 21 days after she was released. Roberta, the second turtle, reamained near the release site for 10 days (Figure 1). Both turtles migrated to approximately the same location off of Florida, to a location known as Tortugas Bank, along an underwater rise called the Florida Keys Ridge at approximately 82°16'65" W and 24°53'08" N (Figure 2). Both turtles have remained in this approximate location since November 11, 2000. The detailed open ocean movements of the two turtles were plotted and analyzed for 94 days for Zyanya and 88 days for Roberta. During that period, ARGOS satellites reported 33 transmissions for Zyanya and 75 transmissions for Roberta. Satellites were within range for an average of 270.02 seconds for both turtles, with a maximum time of satellite overpass reported as 768 seconds. The majority of signals were registered as location class B for both turtles, 51.52 % for Zyanya and 62.16% for Roberta. Of these positions, the frequency of occurrence of acceptable location classes, or LC > 0 (LC = 0, 1, 2 and 3) were 21.21 % for Zyanya and 18.92 % for Roberta. Using the transmitted data, total distance traveled was calculated with the Great Circle Equation, and it is estimated that Zyanya traveled a total of 985 km while Roberta traveled an estimated 1,430 km. Using only the total distance traveled and the total number of days, Zyanya swam an average of 27.65 km/day and Roberta swam approximately 108.47 km/day. Zyanya's mean swim speed was 0.631 km/hr, and Roberta´s mean swim speed was 0.362 km/hr.

Figure 1. Map of tagging site and migration routes.



DISCUSSION-SWIM SPEED

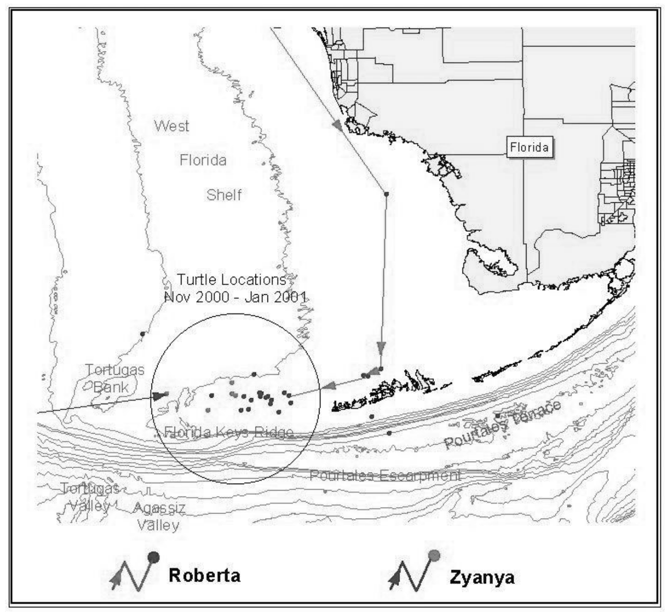
Green turtle swim speeds have been measured at 1.4 to 3.6 km/hr by Prange (1976) and over 1.0 km/hr over longer periods of time, weeks to months, by Nichols (1999). The results of this study are slightly lower at .631 km/hr for Zyanya and .362 km/hr for Roberta. The transmitter attached to the shell could have increased the drag on the turtle, but these effects are probably minimal due to the size ratio of the turtle to the transmitter, and the low profile of the transmitter on the turtles' carapace. The swim speeds calculated in this study seem to show a higher reading for satellite points close together in date. This may indicate a large error when the transmissions are received in close proximity to each other. Zyanya's average swim speed, 0.631 km/hr was almost twice that of Roberta's, calculated at 0.362 km/hr. Comparing these swim speeds with the plotted map points (Figure 1) shows that the turtle that swam the shorter distance, Zyanya, approximately 984 km, as compared to Roberta's estimated 1,430 km, also had the faster average swim speed. Calculated swimming speeds are subject to errors from satellite location and assistance or hindrance due to currents. For simplicity, the results presented here have neglected the influence of currents. The frequency of occurrence of acceptable location classes, LC> 0, was low, 21.21% for Zyanya and 18.92 % for Roberta. This could provide an inaccurate basis for calculating swim speeds. Additionally, there is error inherent n the low number of points used to calculate the swim speeds. The majority of ARGOS location classes received from these two turtles were Class B and only Class 0, 1, 2 or 3 are accurate enough for reliable data analysis. To obtain an accurate reading, the transmitter must be above the surface and the satellite must receive multiple transmissions during the time of the satellite overpass. The average time of the satellite overpass for this study was measured as 270.02 seconds. Future plans for tagging studies will consider the results obtained with this data, and use a different duty cycle for the transmitters. By setting the transmitters to a 24 hour on and 48 hour off duty cycle, we will attempt to maximize transmission time with battery life duration.

DISCUSSION-MIGRATION ROUTE

The turtles headed away from the nesting beach and followed known currents in the Gulf of Mexico to their current location, approximately 82°16'65" W and 24°53'08" N. The turtles showed a degree of affiliation with shallow water, remaining in waters approximately 30 m deep for the majority of their migratory route (TOPEX/Poseidon Satellite Altimeter and NOAA/NEDIS World Ocean Atlas, 1998). This study revealed that sea turtles nesting at Lechuguillas, Mexico, originate from an area of the Gulf of Mexico along the Florida Keys Ridge. It is likely the turtles are occupying an area of pelagic convergence zones, feeding on sea grass and algae in the shallow waters along the oceanic rise. The two turtles followed different migration routes to navigate across the Gulf of Mexico to the same oceanic location. Navigation in sea turtles has been hypothesized to occur with chemosensory cues (Grassman and Owens, 1987), celestial cues (Ehrenfeld and Koch, 1967), experience based behavior (Able, 1996) and magnetic "map sense" or the ability for the turtle to maintain headings toward homing locations despite current drift or displacement (Papi, te. al., 1997). Experience based behacior is possible, as the satellite tagged turtles were of average size for a nesting female on the beach of Lechuguillas and had probably laid egg clutches in previous years. Given that the two turtles followed different routes in the Gulf of Mexico to the same feeding grounds, some sort of map sense or detection of magnetic fields could also be occurring. For these sexually mature green sea turtles, a combination of "map sense" and experience based behavior probably guided them to the feeding grounds along the Florida Keys Ridge.

The migratory routes followed by these turtles overlap with several commercial fisheries in the Gulf of Mexico, the predominant one being the shrimp fishery. Shrimp fishery related mortality is an important conservation issue and recent developments in mitigating this problem include the development of a turtle excluder device (TED) for shrimp nets and the closure of the shrimp industry during certain times of the year. This study emphasizes the need for further research on the migratory routes of the green sea turtles, Chelonia mydas, through the Gulf of Mexico. Satellite telemetry will prove to be an invaluable tool in marine conservation biology and fishery management decisions.

Figure 2. Map of turtle's current location.



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STUDY TO DETERMINE WHICH NESTING COLONIES ARE IMPACTED BY LOGGERHEAD TURTLE MORTALITY IN NW MEDITERRANEAN SEA BY LONG-LINE FISHERIES

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ABSTRACT

In 1991 a small volunteer group of vets decided to create an organization for the direct and efficient rescuing and reintroduction of threatened marine species which are victims of accidental captured by different kinds of fisheries, pollution, tourism, etc. That enterprise led into the creation in 1995 of Marine Animal Rescue Center (CRAM), a non-profit organization with the aim of conservation and recovery of marine animals. The action lines are focused on three main targets:
§ The rescue, recovery and reintroduction to the sea of protect marine animals that are either ill, have been stranded, or caught or accidental caught by fishing.
§ To create awareness programs to show and to alert people about endangered and threatened marine species.
§ To promote research projects on endangered sea species.

Since 1999 we are performing a study in order to determine the origin populations – Mediterranean or Atlantic - of the turtles that are accidentally captured by long-line fishery every summer in Spanish waters.

INTRODUCTION

During the summer, the coast regions of Spain in the NW Mediterranean Sea are an important foraging habitat for juvenile and subadult loggerhead turtles (*Caretta caretta*). In this area long-line fishing effort is intensive. Annually a large number (15,000 – 20,000) of juveniles and subadults loggerhead turtles are accidentally caught, many of them will die due to hook wounds. Since 1995, Marine Animal Rescue Center (CRAM) has been running a program for the conservation of sea turtles. Every summer the rescue and rehabilitation of turtles, which has been involved incidental captures or subject to other injures, is undertaken. This has involved a great deal of cooperation with long-line fishermen.

Relying on these facts it is a high priority to know in detail the temporal stock of juvenile, subadult and adult *Caretta caretta*. Since 1998 CRAM and Biochemistry Department of Autonomus University of Barcelona (UAB) have been using molecular markers to identify loggerhead populations. These markers have been used to determine which rookeries contribute to a particular feeding area like NW Mediterranean Sea and which of them are impacted by loggerhead turtle mortality by Catalan long- line fisheries.

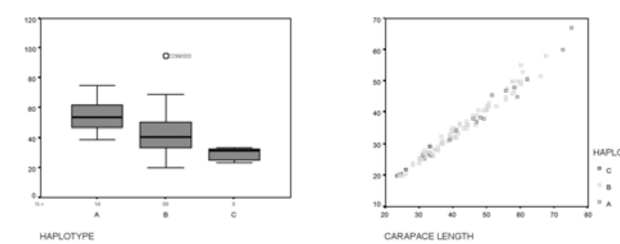
MATERIALS AND METHODS

For the studies of genetic markers in the loggerhead sea turtles (*Caretta caretta*) we are planning to work with about 100 samples per year, coming from different geographical areas of the NW Mediterranean Sea. The blood samples are mixed with saline buffer and SDS plus proteinase K to induce the cellular lysis. After a saline precipitation with NaCl we obtain the DNA from the upper phase and finally we precipitate this DNA with ethanol. The PCR fragment that we propose to amplify is a promoter region of mitochondrial DNA from about 400 nucleotides in length. All PCR fragments will be sequenced directly with the same oligonucleotides used for the amplifications, in a cyclic reaction with fluorescent dideoxynucleotides. Both strands will be sequenced in an automatic DNA sequencer Applied Biosystems 373A at the DNA Sequencing facility of the Autonomus University of Barcelona (UAB).

Table 1

	n	Mean	Std dev	Minimum	Maximum
Haplotype A					
Weight	13	28.2	18.1	9.9	60.0
Carapace length	14	55.3	11.5	39.0	75.0
Haplotype B					
Weight	85	16.3	14.9	2.0	100.0
Carapace length	89	42.8	12.5	20.0	95.0
Haplotype C					
Weight	8	5.4	2.8	2.3	10.7
Carapace length	8	29.4	4.1	23.5	33.5

Figure 1. Box plots and Frequency distributions.



The morphology of the turtles was characterized by the variables: weight, length of carapace, head, front extremity, rear extremity, plastron, tail and cloacae and width of carapace, plastron and head. Mean values and standard deviations were calculated for haplotypes A, B and C. Frequency distributions and box plots were used to graphically assess the differences among haplotypes. To explore the possibility that haplotype B could be constituted by two populations, Kolmogorov-Smirnov test for normality together with two multivariate statistical techniques, Principal Component Analysis and Cluster Analysis were independently applied. Principal Component Analysis was performed to transform the original set of 11 intercorrelated variables into a new smaller set of uncorrelated variables. This procedure normally leads to a simpler and clarifying representation of the system. To classify the turtles into two populations according to their morphological characteristics a K-means clustering on the basis of aforementioned 11 variables was performed. The numbers of clusters was fixed to two. Statistical analyses were carried out with the SAS/STAT® statistical package.

DISCUSSION

During these two years of research in NW Mediterranean Sea we have found a mixed stock population formed by Haplotype A – Atlantic rookeries – and by B and C haplotypes- Mediterranean and Atlantic nesting areas - loggerhead turtles.

We have observed some morphological differences among haplotypes. On the one hand Haplotype A loggerhead turtles, from Atlantic nesting areas, are larger in size than those with B and C haplotype. On the other hand C haplotype loggerhead turtles are the smallest and B haplotype loggerhead turtles vary within a range of size values comprising haplotypes A and C. We know that small haplotypes frequencies must be used with caution in mixed samples and we are conscious that our results are not enough to provide firm conclusions. However we have observed some points that we think are important for discussion.

Most of Atlantic loggerhead turtles (12.5 % in our study) that were accidentally caught by Catalan long-line fishermen were large subadult and adult animal. C haplotype loggerhead turtle was relatively frequent in our study (7.1%). Most of them were small juveniles. The rest of loggerhead turtles (80.4%) that arrived into the recovery center had B Haplotype. These turtles had the most high in variation size ranging from small juvenile, to big adult loggerhead.

Due to the fact B and C haplotypes are shared by both American and Mediterranean nesting areas, it is difficult to determine the origin of the animals that were accidentally captured in Spanish waters. Nonetheless we tried to achieve this goal using morphological differences that we have found among A, B and C haplotypes. Statistics results suggest that 26 B haplotype loggerhead turtles are morphologically more similar to our Atlantic exemplars samples than Mediterranean ones. Accordingly, it could be hypothesized that relatively important number of Atlantic *Caretta caretta* are incidentally captured by long line in Spanish waters.

Turtles with haplotype A are bigger than those with haplotype B or C. Turtles B vary within a range of values comprising haplotypes A and C.

Kolmogorov-Smirnov test leads to the conclusion that carapace length data from turtles with haplotype B do not come from a normal distribution ($p<0.002$). Thus, the question arises as to whether two populations (Atlantic and Mediterranean) are present.

The first two components account for the 93% of the standardized variance. These two variables are sufficient to summarize our data. The first component is a measure of the overall size since the first eigenvector shows approximate equal loading on all variables (L_tail and L_cloac in a less degree).

Bigger B haplotype turtles are classified within Cluster 1 whereas smaller ones are classified within Cluster 2.

Figure 2. Distribution of Carapace length within Haplotype B.

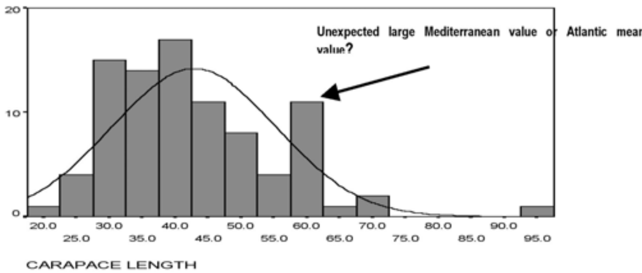


Table 2. B haplotype Cluster Analysis.

	Mean Values	
Morphological variables	Cluster 1 (N=26)	Cluster 2 (N=64)
Weight	33.7	9.0
L_carapace	58.4	36.4
L_head	13.0	9.3
L_front flipper	31.5	23.0
L_rear flipper	20.5	14.6
W_carapace	46.9	30.3
W_head	11.3	7.6
L_plastron	43.5	29.3
W_plastron	40.1	25.7
L_tail	10.4	6.1
L_cloacae	7.1	4.1

Table 3. Multivariate Statistics of Haplotype B

Principal Component Analysis

	Propor of stand Variance	Cumulative
PRIN1	0.852326	0.85233
PRIN2	0.077637	0.92996
PRIN3	0.017655	0.94762
PRIN4	0.015653	0.96327
PRIN5	0.011076	0.97435
PRIN6	0.009494	0.98384
PRIN7	0.005896	0.98974
PRIN8	0.005055	0.99479
PRIN9	0.002706	0.99750
PRIN10	0.001780	0.99928

Eigenvectors

	PRIN1	PRIN2
Weight	0.309803	-.128398
L_Carap.	0.323177	-.093548
L_Head	0.306616	-.155436
L_Fr flip.	0.304677	-.087578
L_R Flip.	o.312747	-.059868
W_Carap.	0.321043	-.141374
W_Head	0.307949	-.085542
L_Plast.	0.317506	-.132167
W_Plast.	0.317675	-.116598
L_Tail	0.254752	0.584967

EGG MORTALITY IN LOGGERHEAD AND GREEN SEA TURTLES

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Marine turtle reproductive behavior has been monitored at Melbourne Beach, Florida for 20 years, however little research has been completed specifically on the hatching success, egg mortality, and true extent of nest predation. The main objective of the study presented here was to define the potential causes of hatching failure in marine turtle eggs by examining infertility, predation, surf inundation, root invasion, etc. The purpose of this research was to redefine egg fates used to classify unhatched eggs, to find a protocol that would aid in distinguishing infertile eggs from those of early embryonic death, to further study the effects of ghost crab predation, and to compare the hatching success and egg fates of loggerhead, *Caretta caretta*, and green, *Chelonia mydas*, sea turtles.

The study was conducted on a 21-km stretch of beach along the central Atlantic coast of Florida. This stretch of beach, representing the Archie Carr National Wildlife Refuge (ACNWR), runs between Wabasso Beach in Indian River County and Melbourne Beach in south Brevard County.

Sample loggerhead and green turtle nests were chosen randomly during both morning and night surveys within the 1999 nesting season. The nests were marked using the protocol established by the Florida Department of Environmental Protection in accordance with the Index Nesting Beach Survey. The U.C.F. Marine Turtle Research Crew then watched all sample nests daily for signs of predation or other disturbances. Three days after the first hatchling emergence was observed, or after 60 days of incubation, the nests were excavated. From the exhumed contents, eggs and remaining hatchlings were placed into the following twelve categories: hatched, pipped dead, pipped live, live hatchling, dead hatchling, infertile, addled, early embryo, late embryo, ghost crab depredated, raccoon depredated, and root inundated. These egg classifications were defined using a combination of literary accounts, personal correspondence, and laboratory work in the 1998 nesting season. The egg and nest fates for each species were summarized and then compared to one another using the Mann-Whitney U test of medians at an alpha level of 0.05.

Table 1
Fates of marked study area nests for Caretta caretta during the 1999 nesting season

Nest fate	Number of nests	Percent nests (%)
Undisturbed	42	43.75
Raccoon predation	25	26.04
Plant roots	12	12.50
Surf inundation	8	8.33
Ghost crab predation	4	4.17
Unknown disturbance	3	3.13
Other*	2	2.08
Total	96	100

* Both roots and ghost crabs disturbed one nest, while sprinklers inundated the other.

Of the 96 sample loggerhead nests, only 43.75% remained undisturbed by predators, plant roots, or surf inundation throughout incubation (Table 1). The 34 sample green turtle nests, however, had a larger percentage at 71% remaining undisturbed (Table 2). The greatest disturbance to the loggerhead nests was raccoon predation, while plant roots more adversely affected the green turtle nests. Egg mortality in both loggerhead and green turtle nests occurred in the highest frequency during the early embryonic stages. In addition, twice as many eggs failed as early embryo rather than at later stages indicating that environmental factors were most likely involved as the early stages represent the most sensitive in terms of abiotic conditions. The significant difference seen between the species in the proportion of eggs failing as early embryos is a direct correlation to surf inundation (Table 3). A number of loggerhead nests were inundated early in incubation, thus resulting in the loss of the clutches. No green turtle nests, however, were inundated during the 1999 nesting season. Removal of those particular nests from the data analysis resulted in a p-value showing no significant difference in the number of eggs failing as early embryos between the two species. The significant differences seen in the number of pipped dead and live hatchlings were most likely due to the timing of the nest evaluation.

Table 2
Fates of marked study area nests for Chelonia mydas during the 1999 nesting season

Nest fate	Number of nests	Percent nests (%)
Undisturbed	24	70.59
Plant roots	5	14.71
Raccoon predation	3	8.82
Ghost crab predation	1	2.94
Unknown disturbance	1	2.94
Total	34	100

Table 3
Comparison of egg fates and clutch size between Caretta caretta and Chelonia mydas for sample nests evaluated during the 1999 nesting season within the Archie Carr National Wildlife Refuge. Comparisons were made using the Mann-Whitney U test of medians.

Egg Fate	# of eggs (Cc)	Percent total (%)	# of eggs (Cm)	Percent total (%)	P-value
Hatched	5497	69.36	3235	79.98	0.0624
Pipped dead	235	2.97	215	5.32	0.0002
Pipped live	4	0.05	2	0.05	0.6336
Infertile	1	0.01	3	0.07	0.5346
Addled	422	5.32	110	2.72	0.1931
Late embryo	207	2.61	138	3.41	0.133
Early embryo	1385	17.48	320	7.91	0.0246
Ghost crab	152	1.92	16	0.40	0.1061
Plant roots	21	0.26	6	0.15	0.7138
Other	1	0.01	0	0	---
Total	7925	100	4045	100	---
Live	49		2		0.0434
Dead	233		74		0.7914
Emerged	5215		3159		0.0339
Clutch size	112		129		0.0003

While genetics may play an indirect role in the increased embryonic mortality through nest-site selection or nest construction, the environment seems to have a larger influence on hatching success. Neither species showed an adaptive advantage in embryonic development in order to overcome adverse environmental conditions.

Unfortunately, a higher percentage of eggs are now failing at early embryonic stages due to inundation by sprinklers. The affected clutches during the 1999 nesting season had hatching success rates of less than 13%. Out of the 48 marked loggerhead nests used in a ghost crab study, 6% were "watered" daily by sprinkler systems at either single-family homes or hotels. Post-emergent nest evaluations of those 6% revealed that 74% of the total number of eggs failed at early embryonic stages. Such failures will only continue as land development does unless corrective measures are taken. In the meantime, further observations and research are required in order to document this new cause of embryonic death and quantify the total contribution to egg failure over several seasons. Additional research needs to be completed on the influence of other anthropogenic factors on egg mortality as well so that effective conservation practices can be put in place.

The data presented here were meant to provide useful information for other researchers and conservationists who are interested in beach hatcheries or protection of our natural beaches worldwide. While further investigations are needed, this research does contribute to a greater understanding of the most critical life history stage in threatened and endangered marine turtles.

Acknowledgements:

I'd like to thank Doctor Ehrhart for the opportunity, Doctor Hoffman for the statistical support, the UCF MTR crew for the fieldwork, and the UCF Bio. Dep. (and Bioprep) for their support. Special thanks to Karen Frutchey and Karen Holloway-Adkins for the hours of torture they went through to further my research. And finally, thanks to my family for always being there for me.

TRANSPACIFIC MIGRATION ALONG OCEANIC FRONTS BY LOGGERHEAD TURTLES RELEASED FROM SEA WORLD SAN DIEGO

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INTRODUCTION

Loggerhead turtles (*Caretta caretta*) are a highly migratory circumglobal species. Major nesting areas for loggerheads in the Pacific Ocean are located in Japan and Australia. Pacific loggerheads make transoceanic migrations from nesting beaches through pelagic developmental habitat to feeding areas offshore of the western coast of Mexico. This is based on evidence from genetic stock analysis from juvenile loggerheads captured in the high seas driftnet, the Hawaii-based longline fishery in the North Pacific, and those found feeding off Baja California, all of which were of Japanese origin (Bowen et al. 1995, Dutton et al. 1998). Recently, the frontal areas in the North Pacific have been documented as developmental habitat and probable feeding areas for juvenile and sub-adult loggerheads (Polovina et al. 2000). The present study follows the tracks of two loggerheads released from Hubbs-Sea World San Diego after over 20 years of captivity.

METHODS

Two loggerheads were held in captivity for over 20 years as part of a sea turtle display at Sea World San Diego. The turtles were measured at 77 and 80 cm curved carapace length. They were assumed to be female based on their size and short tail length. Genetic mtDNA analysis showed that the turtles were of Japanese origin. ST-10 Telonics satellite transmitters were attached to the carapace of each turtle using polyester resin and fiberglass cloth (Balazs et al. 1996, Figure 1). One ST-10 (ID 22130) had a duty cycle of two hours on, four hours off, but was modified with a different battery configuration, and the transmitter antenna was placed facing posterior on the carapace. The other ST-10 (ID 22131) was not modified, and the transmitter antenna was facing toward the head on the carapace. ID 22131 had a duty cycle of two hours on, four hours off and four - 2/3-A batteries. Both turtles were released together approximately 5 miles offshore of San Diego, California. Locational data from the transmitters were collected and relayed by Argos Service, Inc. Sea surface temperatures encountered during the turtles migrations were extrapolated using temperature data from Advanced Very High Resolution Radiometer (AVHRR) satellites.

RESULTS

After release, both turtles headed west across the Pacific Ocean. Loggerhead ID 22130 traveled 3300 km at an average speed of 1.8 km/hr over a two month period before the transmissions ceased. The other loggerhead (ID 22131) traveled 8300 km at an average speed of 1.5 km/hr over a six month period. Both turtles traveled mainly along a 19 °C isotherm (Figure 2).

DISCUSSION

Earlier theories regarding the migration of juvenile loggerheads assumed that they traveled with prevailing currents rather than actively swimming against them (Bowen et al. 1995, Hays and Marsh 1997, Musick and Limpus 1997, Figure 3). Recent data have shown that loggerheads moving towards Japan swim along the northern side of the subtropical gyre against weak geostrophic currents which are along the edge of thermal fronts (Balazs et al. 2000, Nichols et al. 2000, Polovina et al. 2000). Work done by Balazs et al. (2000) and Polovina et al. (2000) focused mainly on juvenile and sub-adult turtles captured in the Hawaii-based longline fishery. Although adult-sized loggerheads are not usually found in the feeding areas off Baja California, Mexico, the two captive adult loggerheads which were released demonstrated similar migration patterns to that of the immature wild turtles by swimming along the northern side of the subtropical gyre following a front defined by a 19 °C isotherm. The movement of the two captive loggerhead turtles along this thermal front suggests that this is an innate behavior and that these fronts may be used as a navigational aid in loggerhead transoceanic migrations. Pelagic thermal fronts also provide a rich source of food such as the pelagic prey items *Janthina* spp., *Velella velella*, and *Lepas* spp., known pelagic food sources for loggerheads (Parker et al. In Press). Many other factors are likely also involved in the migration of these animals and research should be continued on this subject. In conclusion, thermal fronts are important developmental habitat and migratory routes for loggerheads in the Pacific Ocean.

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Figure 1. Attaching satellite transmitter (ID 22130) with polyester resin and fiberglass cloth.

Figure 2. Satellite tracks of captive released loggerhead turtles over sea surface temperature data.

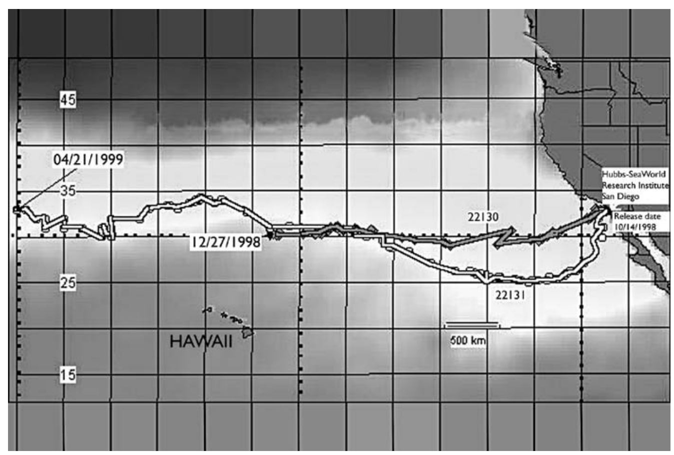
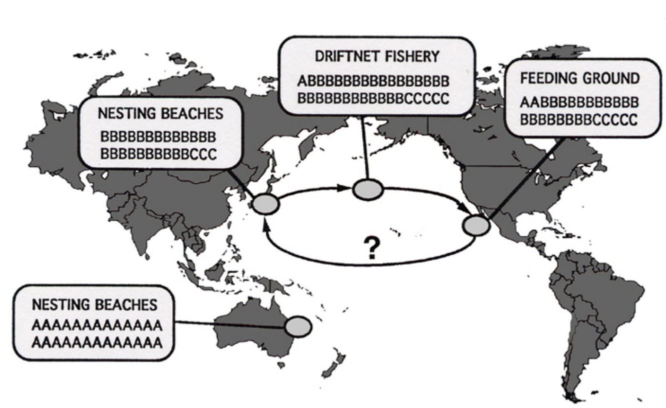


Figure 3. Distribution of loggerhead mtDNA haplotypes in Pacific nesting areas, North Pacific driftnet fisheries, and Baja California feeding grounds (modified from Bowen et al. 1995).



MONITORING SEA TURTLE BASKING BEHAVIOR WITH REMOTE VIDEO CAMERAS

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INTRODUCTION

Although it is common for freshwater turtles to bask on land, it is comparatively uncommon for sea turtles to do so. Only the green turtle (*Chelonia mydas*) has been reported basking on land, and it does so only in certain parts of the world, one notable place is the Northwestern Hawaiian Islands (Whittow and Balazs, 1985).

Green turtles have been observed basking at Kiholo Bay Hawaii, on the Kona/Kohala coast, since 1994 (Harrington et al., In press; Rice et al., In press; Rice and Balazs, 2000; Balazs, 1996). The lagoon where they are seen has a shoreline consisting primarily of basaltic rock. The north shore is consolidated pahoehoe lava from the 1859 eruption. The south shore, which separates the lagoon from the ocean, is made of large rounded basaltic rocks, with a small gravel beach we call Turtle Beach. The lagoon is ocean water with a substantial amount of fresh ground water running into it. The surface water (down to ~0.5 meters) has a temperature between 20-22 ^{o}C and a salinity of 8-15 parts per thousand (ppt). The subsurface water (>0.5 meters) has a temperature of 24-26 ^{o}C and a salinity of 28-30 ppt. Seawater outside of the lagoon is 28 to 36 ppt (Rice et al., In press). While basking occurs on both sides of the lagoon the majority of turtles emerge at Turtle Beach. Work done by Rice et. al., (In press), has shown that basking occurs most frequently between 0900 h and 1000 h and 1300 h and 1400 h. It was also observed that basking was only initiated during the day but may extend into the night. Basking turtles at the lagoon stayed out an average of 2.6 h, but times ranged from 13 min to 11 h. Monitoring basking behavior is a time consuming process, and the physical presence of an observer was required until now. Modern technology has made it possible to place digital video cameras at remote locations for sea turtle research and monitoring purposes (Balazs et al., In press). The two cameras we installed at Kiholo Bay have given us the ability to remotely monitor basking behavior over extended periods. With this technology, we are able to identify individual animals and record unique behaviors constantly during daylight hours.

MATERIALS AND METHODS

Two digital video cameras were powered by 12-volt solar-charged storage batteries. The digital video cameras have 15x optical zoom lenses, as well as pan and tilt capabilities. The video signal is transmitted 19 miles using Primer wireless™ microwave (2.4GHz) transmitters and receivers. The signal is received at the Hawaii Preparatory Academy, and served at times over the World Wide Web through the SeeMoreWildlife web site (http://www.seemorewildlife.com) at 80 Kbs.

Only turtles that basked on Turtle Beach were studied for this project. When a turtle was observed basking it was identified using head-scale patterns, scars, deformities or other unique, permanent characteristics (Bennett and Keuper-Bennent, this volume). Some turtles had a number lightly etched on the left and right second lateral scute (Balazs, 1995). If the turtle could not be identified we captured still images of the turtle's head-scale pattern and any other identifying marks or scars, using Xclaim vr™, for future identification. We often videotaped basking when we could not be observing. A time/date stamp on the videotape allowed us to reconstruct the basking episode.

Turtles were considered basking when at least half of their carapace was above water for a minimum of 10 min. The time the turtle came out and went in, and digital images that were taken, were recorded in a journal, and later entered into a File Maker Pro database. Many basking episodes continued into the night, and we could not observe their termination. These episodes are not included in the confirmed basking duration data.

RESULTS AND DISCUSSION

We observed turtles basking over a 27 day period from May 5, 2000 to June 3, 2000. Over the course of those days, 24 turtles were individually identified. The number of basking episodes for each of the 24 turtles was recorded, and varied from 1 to 16 episodes. The total cumulative time that each turtle was observed basking ranged from 0.2 h to 25.9 h (Figure 1). The basking duration mean was 2.2 h (SE=0.3, N=52) and the range was from 0.2 h to 8.8 h. Basking behavior at Kiholo has only been observed starting during daylight hours (Rice, et al., In press). Basking was initiated from 0600 h to 1800 h with the highest frequency occurring at 1300 h (Figure 2). Turtles were sometimes observed initiating more than one basking episode in a single 24 h period. For example, one turtle came out to bask three times in one day (1.3 h, 0.8 h and 2.9 h +).

Previous research done on basking turtles at Punalu'u, Hawaii using TDR's, and also at Kiholo Bay (Rice et al., In press) found that turtles basked for a mean of 2.6 h and ranged from 13 minutes to 11 h (Rice et al., 1998, Rice et al., In press). The lower mean 2.1 h, calculated from our data may have been lower because the animals could not be observed at night. The longest basking duration we observed was 8.8 h, which is shorter than Rice's, which was 11 h. Our data may have underestimated basking intervals because we could not observe the turtles after dark, and we could not observe or identify them very well if they basked somewhere else in the lagoon.

Although the head-scale identification method aided us greatly in identifying the turtles, it also created some problems. Often we would only capture one side of the turtle's head, hoping the next time we saw it we would be able to photograph the other side. In one case we had one turtle listed under two different names. As the project continues, however, our database of known turtles will become more complete and these types of problems will diminish.

Overall the head-scale identification method aided us greatly. The cameras enabled us to identify individual turtles, observe turtle behavior and characterize basking patterns accurately and consistently without having to be in the field.

Figure 1. Total Amount of Time Each Turtle Spent Basking over the 27 day period where the total is greater than 1 hour.

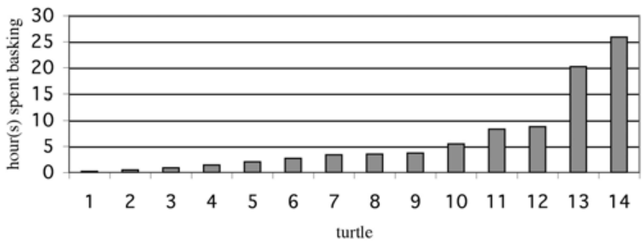

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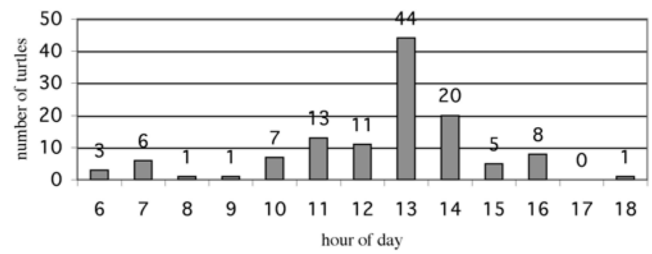
Figure 2. Frequency of Basking Initiation Versus Time of Day (N=120)



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SECOND CASE OF MORTALITY OF THE BLACK SEA TURTLE (*CHELONIA MYDAS AGASSIZII*) ON THE COLUMBIAN PACIFIC COAST – GORGONA NATIONAL PARK

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INTRODUCTION

The increase in the exploitation of marine resources has caused factors such as the industrial fishing of shrimp to become a principal cause of mortality in sea turtles (Magnuson, 1990 and Oravetz, 1999). On top of this, other natural causes, such as disease and intoxication, cause numerous individuals to die every year (George, 1997). In the Columbian Pacific, this is the second case of mortality reported within ten years, which may have had its cause in one of, or the interaction between, various natural phenomena or human activities.

METHODS

During the mortality event, monitors were put throughout the marine area and the coast to locate and count bodies. When it was possible, corporal measures were taken, depending on the state of decomposition. To establish the possible causes of death, fine sections were taken of intestinal tissue and put in 10% formalin. Samples for toxicological analysis were preserved in ice. The remainder of water in the stomach was collected to identify the presence of planktonic organisms such as those which cause red tides.

RESULTS

There were 31 turtles found dead in Gorgona National Park (X= 65.15 cm Straight Carapace Length; S. D. + 8.46 cm). Eight necropsies were done permitting us to collect stomach contents and organ samples (stomach, lung, liver and heart). 19% were male and

81% were female. The high grade of decomposition in which the bodies were found made it difficult to establish signs of drowning, like the scratches on their fins or water in the lungs (Orrego, pers. comm), although the presence of fluids in the mouth of some turtles as reported (Acevedo, pers. comm). Toxicological analysis was done by the Regional Autonomy of the Valley of Cauca (C. V. C) and showed no toxic substances like cyanide, arsenic, mercury or hydrocarbons. The analysis of the stomach contents showed planktonic tunicates of the family Thaliaceae to be the only component in the samples. Within the planktonic organisms identified, none corresponded to the genders or typical species of red tide.

ANALYSIS AND DISCUSSION

The results obtained and their relation to prevailing conditions of the moment, permitted us to plan the following hypothesis as the cause of the collective decease.

Incidental capture by shrimp boats. Between January 20 and March 20 of the year 2000 there was a prohibition of fishing shrimp in all of the Columbian Pacific. One week after the end of this period the mortality event was registered. Incidental capture can cause death to turtles directly or indirectly. Studies show that after 30 minutes of permanent dive, lactate levels become very high in the blood and anaerobic glycolysis begins, generating a comatose state before the death of the individual (Lutcavage, 1987 and Stabenau et. al., 1991). Knowing that there are no commercial interests in the black turtle of the Columbian Pacific (Duque - Godman, 1988), it is possible that the turtles captured in the shrimp trawling are being put back into the waters with out giving them any assistance in reestablishing basic oxygen levels, making recovery harder, especially if we keep in mind the considerable presence of boats in the area that might regenerate recaptures (30 – 40 individuals for each cast according to Duque - Godman, 1988. In this way, many turtles may be exposed to a high chance of mortality.

Intoxication by red tide. Interviews that were conducted with fishermen and civil servants of the park during the event recorded the presence of a red stain in areas near the park. Turtles can ingest saxotoxins (present in red tide organisms) indirectly because they condense in the tissues of varied secondary consumers which are their prey. The severity of poisoning varies according to the types of red tide and the concentration of saxotoxins. The effects have been catalogued in three types: the first causes the paralysis of various organs due to the attack of the nervous system or the heart, the second produces diarrhea and gastrointestinal disturbance, and the third combines both previous symptoms.

Hypothermia. Surface and 5 m-depth temperatures at the time of the mortality event were 26.1 and 25.9 ºC respectively (Perdomo and Pinzón, in prep.), however at the end of January 2000 on the east coast of the island there was a cold current registered at 17 ºC at 24 meters of depth (Pinzón, pers. comm.) This began a progressive increase until it rose to the surface at the end of March. Marine turtles are sensitive to drastic changes of temperature, and when these go under normal tolerance for long periods of time, symptoms of lethargy, hypothermia, in some cases hypoglycemia are produced. Other problems such as septicemia may result (Walsh, 1999 and Spotila et., al 1997). All such effects cause a loss of ability to swim and dive. If there is no intervention death can be rapid.

At the moment, it is impossible to confirm or reject the hypotheses given, although similar events off the coast of Ecuador between August and September, 1999 were considered to be caused by the industrial fishing of shrimp (Alava, 2000). During the same period, captures of between 5500 and 55,000 turtles per year were registered, which can be up to 150,000 worldwide (Oravetz, 1999). In both cases, the mortality was basically of individuals that were subadults (71% in Gorgona) because the metabolic activity of subadults and young turtles is more elevated than that of adults, therefore they require more oxygen (Ogreen, 1989).

CONCLUSION AND RECOMMENDATIONS

Similar to the case of mortality that was recorded ten years ago (Rueda, 1990), the present study has not been able to identify the real cause of the collective decease. The lack of an operative permanent plan that will help evaluate these events in an immediate way causes the loss of eminent information when searching for explanation. It would be advisable to create a permanent station for monitoring areas of nesting and foraging presided over by Columbian and Ecuadorian organizations, because these are the countries that have recently been affected by these phenomena. Also, there would be an expected increase in the understanding that authorities have over the technical issues in marine reptiles safety.

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INFLUENCE OF THE COASTAL CIRCULATION OF TAMAULIPAS IN THE ARRIVAL OF FEMALES AND DISPERSION OF HATCHLINGS OF *L. KEMPII*

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INTRODUCTION

One of the biggest obstacles in the study of the life cycle of marine turtles is the pursuit of the organisms away from the nesting beach. Collard (1987) and Collard and Ogren (1990) wrote about the importance of describing marine currents because they are one of the dispersion mechanisms of marine turtles. These authors supposed that the hatchlings of Kemp's ridley (*Lepidochelys kempii*) are transported by a western boundary current described by Sturges and Blaha (1976) on the border of the continental shelf of the northeastern Mexican coast. This current is forced by the seasonal distribution of the wind stress curl and the collision of the Anticyclonic gyres detached from the Loop current with the continental slope. The circulation of these rings is clockwise and their cores have high temperature and salinity as well as a low content of nutrients (Biggs, 1992).

The coastal currents of the nesting beach have been studied little, but a jet-like flow (Vidal et al., 1992) and the seasonal presence of a thermal front like a plume (Brooks and Legeckis, 1982) leaving the Mexican coast with northeastward direction have been described. This front has been related with the mesoscale current circulation of Center and North of the Gulf of México (Cochrane and Kelly, 1986; Vidal et al., 1992; Glenn and Ebbesmeyer, 1993; among other) and with the seasonal changes of the wind pattern (Fernández-Eguiarte et al., 1998). During the winter and beginning of the spring, the flow of cold fronts ("Northers") dominate the atmospheric circulation, while at the end of the spring and the summer the Trade winds prevail.

With this background, the objective of this paper is to elaborate a qualitative description of the coastal currents of the Kemp's ridley nesting beach (23.15°N-97.45°W), located in the state of Tamaulipas (Mexico), between the first week of April and July in 1996 and 1998. Most of laying and hatching of the Kemp's ridley marine turtle of eggs happen during these months.

METHODS

The qualitative description of the marine currents starts with the descriptions of the mesoscale currents and the photo-interpretation of 30 weekly composites of daily satellite infrared (IR) radiometer images. The daily imagery were obtained by the HRPT station of the Instituto de Geografía (Universidad Nacional Autónoma de México) from the AVHRR (Advanced Very High Resolution) sensor installed on the satellite NOAA 14. The sea surface temperature (SST) was calculated with the algorithms included in the Terascan system (Monaldo, 1996). The precision of the values was of + 0.5°C. The analyzed area was among the coordinates 20 - 30°N and 94 - 98°W. The imagery was enhaced with some methods included in IDRISI v. 2010 SIG (University of Clark Worcester, MA). The thermal fronts were compared with the images of sea level height of the Gulf of Mexico that the University of Colorado publishes in its website. These images show the cyclonic and anticyclonic eddies.

RESULTS

The IR images of the northeastern Mexican coast show a front like a plume, very similar to the one described by Brooks and Legeckis (1982). The front leaves the Mexican coast from the 22-24ºN parallels (Fig 1). The seasonal variations of this front, the descriptions of mesoscale circulation included in the literature and the seasonal changes of the wind patterns allow us to suppose that the northeastern Mexican coast currents have different characteristics.

The direction of the coastal currents changes seasonally. In the winter and the beginning of the spring, the currents flow with a southern direction forced by the winds from the North and the cyclonic eddy of the Texas-Louisiana (T-L) shelf. These processes advect cold water from the Texas' shelf and from the mouth of the rivers Bravo (Grande) and Soto la Marina to the northeastern Mexican coast. In this period the front was very clear and is located on the limit of the continental shelf (Fig. 1).

The front is nearer to the coast at the end of spring and during summer than in winter. Some of the processes that are favorable to the displacement of the front are the weakening of the T-L cyclonic gyre, the semi-permanent presence of an anticylonic gyre on the center of the Gulf and the constant flow of the Trade winds. The position of the front is an indicator that the direction of the current on the shelf is reversed during these months and that the North direction prevails.

Some weeks in May the front "disappears" as a result of the homogeneity of the SST on the continental shelf that happen between spring and summer. It is also probable that the front has traveled toward the North, as Lewis et al. (1989) described. They observed a very small front in the vicinity of the Bravo River (26°N -97ºO) and they described it as a result of the interaction of an anticyclone eddy with continental shelf.

On the other hand, with the presence of the front, the SST is 2 to 3°C lower near the coast than in the oceanic area. During the winter and the beginning of the spring the water advected from the Texan shelf and the rivers contribute to cool down the coastal water. On the other hand, the loss of heat was bigger near the coast than in the oceanic area, especially during the passage of the cold fronts (Mann and Lazier, 1996). The position of the front on the border of the shelf is favored by these processes. It can be also an explanation to the wide separation of the winter-spring front from the coast than the spring-summer front. The current direction on the continental slope, in contrast with the shelf, is toward the North during the whole year. According to Monreal (com.pers.) the semi-permanent presence of the anticyclone outside of the shelf force the flow toward the North. Gyres are the main forcing mechanism during winter, but in summer the Trade winds also force the current. The constancy of Trades also produce a moderate upwelling (Howard et al., 1996; Aldeco, com. pers.).

This circulation system joins the cyclonic system that prevails on the T-L shelf (Cochrane and Kelly, 1986; Barron and Vastano, 1994; Vastano et al., 1995) and aid the females to migrate from the North of the Gulf between March and April (Fig 2) to the nesting beach and it is confirmed by the total of observed nests. In May, when the coastal current of Tamaulipas reverses and the cyclonic gyre of the platform T-L shelf weakens, it is probable that most of the females have already arrived and considering that a high proportion of these nest 2 or 3 times during the season, they remain around 30 to little more than 50 days on the nesting beach.

During the summer, when the dominant currents on the shelf have a Northern direction the dispersion of females and hatchlings is favored toward the NE of the nesting beach. There the cyclonic circulation dominates and the primary productivity is high (Abdullah Al-Abdulkader, 1996). In contrast with the paper by Collard and Ogren (1990), we locate seasonal changes on the coastal currents and suppose that the current with Northern direction flows near the coast during summer.

Fig. 1.-Direction of coastal currents between first week of April to the end of July in 1998. Arrows indicate direction, but not velocity.

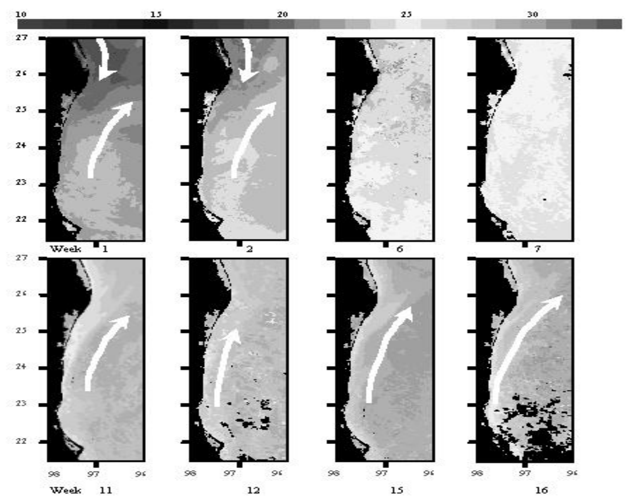

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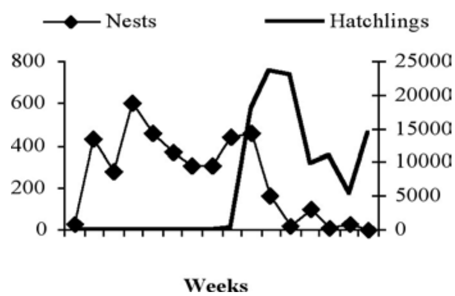
Fig. 2.- Weekly variarions of nests and hatchlings of *L. kempii*.



LESSONS LEARNED ON SEA TURTLE CONSERVATION AND COMMUNITY AWARENESS ACTIVITIES IN BANGLADESH

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INTRODUCTION

Bangladesh has a coastline of over 700 km along the south starting from Sundarbans on the southwest to the tip of southeastern Teknaf Peninsula. Five species of sea turtles found in the global water are reported to occur in the territorial waters of Bangladesh viz. *Lepidochelys olivacea* (Olive Ridley), *Chelonia mydas* (Green turtle), *Eretmochelys imbricata* (Hawksbill turtle), *Caretta caretta* (Loggerhead turtle) and *Dermochelys coriacea* (Leatherback turtle). As reported, nesting population of sea turtles was higher compared in the past compared to that of the present time. Day by day, the nesting population is declining in the coast of Bangladesh due to several man made causes. Exploitation of eggs, killing of turtles on the beach and killing of adult turtles due to entanglement by fishing nets.

There is no separate legislation for the conservation of sea turtle in Bangladesh though there is "The Marine Fisheries Ordinance", for the protection and conservation of all the marine resources. Under the ordinance, measures can be taken for the conservation of marine turtle. It is noted that an executive order was issued by the Govt. of Bangladesh to use Turtle Excluder Device (TED) in the shrimp trawl nets under the Marine Fisheries Ordinance. A case filed by the trawler operators against this executive order is pending in the court and TED is not being used due to court injunction. The Department of Fisheries in collaboration with the U.S. National Marine Fisheries Services and the U.S. Embassy in Bangladesh conducted a training program for the trawler operators on the use of TED.

Although sea turtles have been nesting at the southeast and southwest coast, information on sea turtle in Bangladesh coast is meager. No effort from the government was undertaken to protect sea turtles though the Department of Forest is responsible for protection of wildlife in Bangladesh. Now a day, only two species (olive ridley and green turtle) were observed to nest over the last five years except a single leatherback. Nesting extends over August through February with the peak in November-December.

It was reported that about 100% nests were either poached or predated in St. Martin's island and other beaches in Bangladesh. Common threats are poaching of eggs, disturbance of nesting females, killing of turtles on the beach and entanglement in the sea. Consumption of turtle meat is not known in the southeast but investigation is needed in the southwest Sundarbans area. The government's of making the St. Martin's Island (major nesting site) as Marine Park would demand civil constructions, attract more tourists would have adverse impact on sea turtle if proper measures are not taken. Higher numbers of dead turtles are observed at the beach of Teknaf Peninsula including St. Martin's island every year during nesting season (dry season August to March).

Objectives

The goal of the activitiy is to maintain an healthy population of sea turtles in the territorial waters of Bangladesh through reducing threats, demonstrating conservation activities and building awareness. However, the specific objectives are:

· To increase the number of sea turtles in the wild through beach patrols and hatchery - release activities conducted under conditions closely resembling those of undisturbed nests.
· To gather and collate information and data on sea turtles in the Bay of Bengal (Bangladesh) for use in further educational/research activities, dissemination of information on the ecology of sea turtles and future planning and conservation efforts.
· To support, strengthen and assist local organizations in having an increased role in the management and conservation of sea turtles.
· To campaign, build an increased understanding and awareness of sea turtle conservation and coastal ecology among the general public and related stakeholders.

METHODOLOGY AND APPROACHES

As an environmental organization formed by the conservationists, CNRS started sea turtle conservation activities since October 1998 with its own resources. Later USDA provided funds through Winrock International for 18 months starting from April 1999. Activities include beach hatcheries, night watching, in situ nest protection, community awareness campaign, motivation to fishermen, and database development. CNRS also trying to form a local committee comprising of 11 members as sea turtle conservation local committee headed by the elected union Chairman. Awareness billboards are erected in various public places along the nesting beaches and tourist spots. In addition, keeping contacts with the conserved government agencies in the area viz. the coast guard, forestry department, fisheries department, marine fisheries research institute and other stakeholders.

RESULTS

Since inception of the work in 1998, CNRS released over 15,000 hatchlings to sea both from in situ and ex situ nests. The hatching success has been recorded 89% from in situ nests while low rate of 78% was observed in ex situ hatchery nests. Another group namely CARINAM also worked in St. Martin's Island during 1996-97 and released over 12,000 hatchlings. The survey conducted by CNRS revealed 12 and 5 nesting sites in Teknaf Peninsula and in the Sunderbans respectively. Nesting frequency found vary from season to season. Lower nesting frequency of 50 was observed in 1999 season (August to November) compared to 121 nesting during the same period in 2000.

Mortality of adult turtles is very high, during July 1999 to September 2000, 83 dead turtles were observed at the beaches of St. Martin's island. Similar or higher rate of observance of dead turtles reported in other beaches. As observed, eggs were stolen from 5 nests out of total 148 nests during the nesting season of 1999-2000. It means that CNRS has been to reduce over 95% egg stealing as against nearly 100% nests were stolen before starting of sea turtles conservation work in the area.

Activities of CNRS have been able to attention of the journalists and policy makers towards conservation of sea turtles in Bangladesh. Various national dailies reported on the dead turtles on the coast of and also highlighted the activities of CNRS in St. Martin Island. The Minster for Environment and Forest while her visit in the Teknaf Peninsula advised the District Commissioner to investigate the causes of adult turtles in the coastline of Bangladesh. Following her visit a district level meetings was held where concerned government and non-government officials discussed issue related to sea turtle conservation. Although it is late but should be considered as good start.

Presentation of an oral paper by CNRS in the first international conference on the environment of Bangladesh in late 1999, made many people aware about the sea turtles population, threats and conservation issue in Bangladesh. Publication and distribution of Poster & leaflets and awareness campaign of CNRS on sea turtles created interests among the wider communities in sea turtle conservation. Students and teachers and other visitors visited the turtle hatchery and observed other related activities also draw attention of concerned people.

Lessons learned

It was learned that poaching of eggs is an age-old practice and could be reduced if alternative income opportunities can be created. Fishers are not aware of the importance of sea turtles as well as they do not know the law about protection of wildlife. It is not clear who should take care of sea turtles and the forest department put less or emphasis sea turtle conservation. Journalists are active and writing articles on the treats and issues of sea turtles.

This paper describes the works done so far on sea turtle including the views of different stakeholders regarding sea turtle protection in the coastal waters of Bangladesh. There are many people in the coastal area where turtles come for nesting have a feeling that the turtles should be protected from any threats. Many villagers expressed frustration that no body came to the area for turtle conservation initiatives. It is learned that cooperation would be obtained from local community if an appropriate sea turtle conservation initiative were undertaken. Catch composition of sea turtles or catch-composition in relation to fish/shrimp has not been studied and the trawler operators do not keep incidental catch data. Information on catch composition of sea turtle is not available. Fisheries Research Institute (marine branch) was found positive and cooperative about sea turtle conservation though they do not have activity in this field.

RECOMMENDATIONS

The most important thing is that the sea turtle conservation activities in Bangladesh should be strengthened and put priority at the government policy level as well as the relevant international organizations should have dialog with the government to come forward to protect sea turtle in the territorial waters of Bangladesh. Turtle conservation initiative is fairly new in Bangladesh and based on the experience we gathered over the last three years, following specific recommendations are made for consideration from all corners:

· Fishing boat owners and operators need awareness and technical support so that they release turtles safely from their nets.
· Instead of focussing only on sea turtles conservation, it may better work if an integrated marine/coastal biodiversity project is undertaken.
· It is very important to urgently identify, delineate and map all the nesting beaches in Bangladesh.
· Ecology of nesting sites should be charcterized and the local government authorities should take measures that the sites are not damaged or establishments are built.
· The nesting sites and take locate the Beach ecology and integration needs to be maintained. There should be regulation on tourism and establishment on the beach.
· There must be some sorts of regulation or closed period on shrimp fry catching at the coast for successful nesting females.
· Some beach sites should be protected as turtle reserve and all other

human activities there should be controlled.
· In order to reduce by-catch mortality, it is very important conduct a turtle by-catch survey along with the fishing communities to know the accidental mortality of turtles due to fishing activities.
· Land record and tenural system should be updated and all public land along the beach should be delineated so that illegal encroachment can be protected.
· Detailed EIA and SIA should be done for the Marine Park Project being implemented by the Ministry of Environment and Forest in the St. Martin's Island - the most important nesting sites in Bangladesh.
· Strong policy a advocacy/lobbying should be undertaken so that the government take measures or assist relevant organizations to undertake turtle conservation activities in Bangladesh.
· International and regional linkages is required to streamline and strengthen the activity in Bangladesh.

SAND DUNE RESTORATION ON A LOGGERHEAD NESTING BEACH IN GREECE

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INTRODUCTION

The coastline of the Evrotas Delta and the nearby beaches comprise a significant nesting rookery in Greece for the Loggerhead sea turtle (*Caretta caretta*), hosting an average of 200 nests annually. The area of the Evrotas Delta is also an important stopover site for thousands of migrating birds having flown over the Sahara desert and the Mediterranean without resting or feeding. The sand dune system that once extended between the beach and the low-lying wetlands are now greatly reduced in area due to agricultural conversion, and degraded by numerous damaging activities. Main problems are sand extraction, vehicle use on the dunes and illegal use of public land.

THE STUDY SITE

Lakonikos Bay is located in the southern part of the Peloponnese, Greece. The nesting beaches in the area have been monitored by ARCHELON since 1985. Sand dunes exist behind most of the 15 km of the Evrotas nesting beach. In 1996 a road was constructed by the local forestry department along the nesting beach, effectively cutting the sand dune system in half and introducing foreign plant species brought with the road material. The construction of the road made it possible for the same department to plant a number of thousands of non-naturally occurring plants in the sand dune area. Furthermore vehicular access through the sand dune system let visitors access the beach at any point creating considerable erosion of the sand dunes. The River of Evrotas reaches the sea in the middle of the beach and the whole Evrotas Delta has been proposed for the NATURA 2000 network, which is a network within the European Union of sites containing priority habitats and species. The actions presented take place on three different locations along the Evrotas nesting beach.

THE PROJECT

After an experimental period, the action was developed according to a Management Plan for the area prepared by ARCHELON under the LIFE-Nature project with the title «Implementation of Management Plans for Pylos Lagoon and Evrotas Delta» which was produced in collaboration with the Hellenic Ornithological Society. LIFE-Nature is a financial instrument for actions aiming at the conservation of natural habitats and of wild fauna and flora of EU interest.

Three locations, one blowout and two wash-overs, were selected for sand dune restoration. Sand trapping fences were constructed from wooden poles and a double layer of degradable plastic netting (Table 1). The first location, Kiani Akti, was monitored from February 1999. The other two locations, Pougka 1 and Pougka 2, were monitored, respectively, from September 1999 and March 2000. Monitoring lasted until the end of September 2000. Measurements took place approximately every 2-3 weeks at all the 30 fences (Table 1). All measurements were taken in the same day. The measurements where taken from a centimeter scale written on the wooden poles of the fence. Experimental planting of marram grass was effected on certain sites. Furthermore a wooden path was constructed from local sawmill off cuts to facilitate access to the beach and reduce erosion due to trampling by visitors.

RESULTS

Accumulation of sand at the fences over the monitoring period for each location is presented in Figure 1. Monitoring showed significant accumulation of sand during the windy season with an almost completely restored sand dune profile in certain places. The best results of sand accumulation were observed in the beginning of the spring and by fences with an orientation perpendicular to South-South West, the direction of the prevailing wind of the season.

It was seen throughout the monitoring period that fences with a height of about 30 cm were to be preferred. They were covered in a rather short time and additional fences could be put to expand the action or to further adjust the dune profile. If new fences are put before the existing ones are covered the sand supply might be cut off for some fences. In some cases the sand trapped by a fence might be transported away when new fences change the wind flow. This means that continuous monitoring and adjustments of the action is usually necessary to achieve best results.

CONCLUSIONS

For the effective protection of sea turtle nesting beaches of Lakonikos Bay, ARCHELON is focusing its attention on the protection and restoration of the coastal zone. In close collaboration with the local community and for the first time in Greece a successful sand dune restoration action was implemented according to the management plan produced for the coastal zone of the Evrotas Delta. After the successful results of the three pilot actions presented here ARCHELON went on, implementing the restoration action on a bigger scale. With good organization and a small team of volunteers five hundred meters of sand trapping fence and 2500 m of wooden path (including a “Nature Trail”) was put in 16 different locations along the Evrotas beach during the autumn of 2000. The local authorities understanding the problem of the sand dune destruction and recognizing the success of the pilot action participated actively in the expansion of the action.

The Environmental Scientific Center of Evrotas, constructed with the assistance of the Municipality of Skala (February 2000), and the construction of the Nature Trail in the sand dunes of Evrotas with the help of the Municipality of Elos (December 2000), contributed to making known the results and the importance of the action, achieving the support of the local society.

As a result the majority of the local people stopped considering the sand dune zone as a place for sand extraction, vehicle use, garbage dumping, and an area for recreational housing and agricultural use. It is worth to mention that, despite the big scale of the action area none of the sand trapping fences or wooden paths was destroyed intentionally.

The proven results of scientific work in addition to public awareness activities focusing mainly on children, will provide a foundation for the acceptance of a future protected area and local participation in the management of the Evrotas Delta.

ACKNOWLEDGEMENTS

We thank the ARCHELON volunteers who made possible this project.

Table 1. Main data of fencing used to restore sand dunes in Evrotas nesting beach, southern Peloponnese, Greece.

TOTAL LENGTH OF FENCES (m.)	165.5
TOTAL NUMBER OF MEASURING POINTS	168
AVERAGE NUMBER OF MEASURING POINTS PER METER	1
TOTAL NUMBER OF FENCES	30

A PRELIMINARY STUDY ON EMERGENCE PATTERNS OF LOGGERHEAD HATCHLINGS IN KYPARISSIA BAY, GREECE

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INTRODUCTION

ARCHELON, the Sea Turtle Protection Society of Greece, has been working in Kyparissia Bay since the early 1980s. Descriptions of monitoring and nest protection work have been previously published (Margaritoulis, 1988 and Margaritoulis et al, 1996).

In Kalo Nero (a village at the southern end of the bay) approximately 900 m of beach length is strongly illuminated by municipality streetlights that are situated seaward from a road running along the top of the beach. Additionally, a bar, taverna and an apartment block have floodlights positioned so that the beach is lit up. This area of beach is one used by loggerheads to nest and each year 20-50 nests are deposited here. Almost all emerged hatchlings become disorientated by the artificial illumination causing them to crawl onto the beach road and further into ditches and fields behind. This increases their mortality rate from predators, vehicular crushing and entrapment away from the sea. To combat the disorientation problem we have adopted a policy of “boxing” nests in the affected area rather than relocating them to less illuminated areas. “Boxing” nests also provides opportunity to investigate hatchling emergence patterns and other specific morphological aspects of the hatchlings themselves. To date hatchling emergence patterns have not been investigated on mainland Greece and this preliminary study was carried out to test methodology for a more full investigation the following season.

METHODS

“Boxing” involved placing open-bottomed and partly open-topped wooden boxes over the nests at dusk (21:00 hrs). Boxes were 50 x 40 x 10 cm. Attached to the surface was a sign, in three languages, stating that the box was there for a purpose, it was continually monitored by ARCHELON volunteers and should not be moved. The boxes were placed to confine hatchlings to the nest site until they could be collected and released on a darker region of beach.

Nests used in this study had undergone a variety of events that may have affected their hatching. They had been previously inundated by the sea or originally relocated on the morning after deposition etc. All clutches had been located by hand excavation of the nest site until the first eggs were seen and the sand replaced as part of the daily routine for clutch protection.

Data were collected during the year 2000. Boxing for each nest started on its 48th day of incubation, as this was two days earlier than the average incubation on the affected beach (data from previous seasons). Box checks started at 23:00 hrs and the final patrol commenced at 03:00 hrs. During this period, at half hourly intervals, the boxes were systematically checked for emerged hatchlings by observation through the open top. The emerged hatchlings were collected into a sand-bottomed bucket. At the end of each patrol the hatchlings were transported to a darker area of beach and immediately released 10m or more from the sea to allow natal beach imprinting to take place. Then at first light (06:30 hrs) the boxes were removed and any hatchlings encountered were watched into the sea, in situ. The number of hatchlings, their nest code and time of encounter in the box were recorded. Time assigned to each hatchling encounter was the start time of the patrol along the beach.

RESULTS AND DISCUSSION

Data presented are from the peak month of hatching. This was from August 9th until September 9th and includes data for 20 boxed nests. During the study period 1007 hatchlings were collected. In addition to these a further 177 hatchlings emerged, prior to boxing at dusk or after box removal at first light for which we have no accurate emergence timing and are therefore excluded. The peak emergence hour was from 00:30 until 01:30 hrs, during which, 23,7% of the hatchlings exited the nest (Figure 1). This peak is considerably earlier than that of the northern shores of Cyprus where 47% of loggerhead hatchlings emerged between 02:00 and 0330 hrs (Glen et al, 2000). From a similar timeframe less than 21,4% of hatchlings emerged during this study. These differences may be explained by seasonal or location dependent environmental factors.

No shift of peak emergence hour is observed when emergence data are edited so that only emergence events of 5 or more hatchlings are included (Figure 2). This may indicate that social facilitation for emergence (Carr and Hirth, 1961) plays no significant part in the timing of emergence during the night. It is interesting to note that the present data show a dip in emergence for the interval of 00:00 to 00:30 hrs for both grouped and total hatchlings. Data from Florida (Witherington et al, 1990) also show a drop in emergence during the peak hatching time (23:30 to 00:00 hrs) and this artifact requires further investigation.

The above results strongly suggest that nocturnal hatching occurs mainly before 02:30 hrs. However, a significant number of hatchlings emerge, during the hours of darkness, after this time (21,4%). Thus, for conservation reasons, periods of light shutdown would be far less effective than a strategy of light removal or replacement with non-disorientation causing, low-pressure sodium vapour bulbs. Further studies, of longer nocturnal duration, will more completely reveal hatching tendencies and more promptly release the emerged hatchlings to the sea.

Data were also compiled for hatchling emergence on successive nights from individual nests. Results show that although the majority of hatchlings emerged on the first night of hatching (39.7%) a large proportion remained to hatch over the following 2 to 3 nights (Figure 3). This extended hatching period concurs with the findings for loggerhead nests on the northern shores of Cyprus and on Cephalonia, Greece (Glen et al, 2000 and Hays et al, 1992 respectively). This may indicate that large within nest temperature variations exist, as found for loggerhead nests in Cyprus and Turkey (Kaska et al, 1998). Within nest thermal variation causes some eggs to incubate more slowly than others do and thus may reflect sexual differentiation between early and later emerged hatchlings. Experiments in the following seasons will endeavour to establish the validity of these hypotheses.

Acknowledgements:

The author would like to extend his thanks to Dimitris Margaritoulis for valuable suggestions and corrections to previous drafts, to the David and Lucile Packard Foundation for provision of accommodation during the Symposium and finally a huge thank you to all the hard working volunteers that made this study possible.

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Figure 1. Within-night hatchling emergence, total number of hatchlings recorded. NB: paler shaded columns show total hatchling emergence for greater than half-hour patrol intervals and the corresponding darker shading is the averaged half-hourly value for that interval.

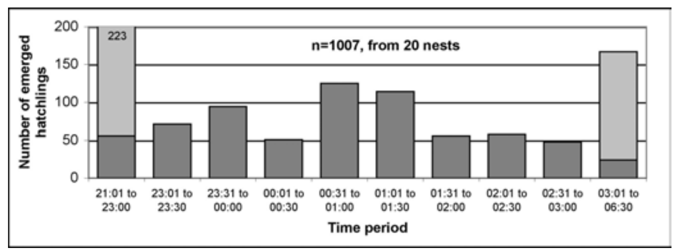


Figure 2. Within-night hatchling emergence, events involving five or more hatchlings. See Figure 1 for explanation of data presentation.

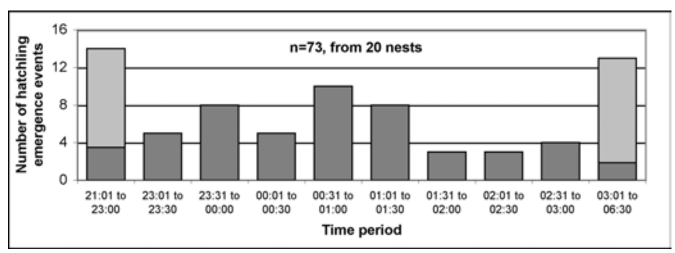
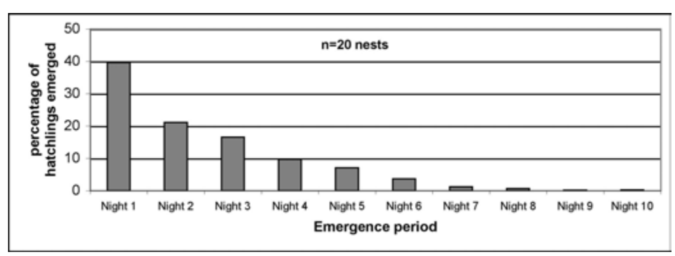


Figure 3. Distribution of nocturnal hatchling emergence over consecutive nights.



NEST SITE SELECTION BY THE LOGGERHEAD SEA TURTLE *CARETTA CARETTA* IN KYPARISSIA BAY, GREECE

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INTRODUCTION

Through the selection of a suitable nest site, it may be possible for a female turtle to exert some influence over the development and sex of her offspring, subsequently enhancing her own reproductive success. Mortimer (1990) noted a tendency for turtles nesting on beaches composed of coarser sand types to abandon multiple nesting attempts prior to successful selection of a nest site. Bustard & Greenham (1968) suggested nesting attempts may be abandoned in response to egg chamber collapse, or obstruction.

This study aims to determine the reasons for females abandoning their nesting attempts by providing a comparison of sand particle size parameters and moisture content at sites where females completed laying (nest sites), and sites which were abandoned during construction of the egg chamber (attempt sites), potentially permitting insights into female nesting behaviour.

METHODS

Sample collection: During the 1999 nesting season in Kyparissia Bay, Western Peleponnese, Greece (37.150N, 21.400E) samples from nest and attempt sites were collected on the morning following emergence. At each sample site sand was collected from two depths. These equated to the depth at which digging attempts were abandoned (30 cm) and average nest depth (50 cm). We could therefore compare conditions of nest and attempt sites at the depth digging was abandoned, and determine whether these differences persisted to nest depth. From each depth a 300 g sample was collected for particle size analysis, and a 150 g sample for moisture content analysis. Samples were kept in sealed bags and weighed on return from the beach to the nearest 10th of a gram. They were then stored in sealed bags and shipped to Aberdeen for analysis.

Moisture content analysis: Sand samples (300 g and 150 g) were oven dried for 14 days at 50 ^{o}C, when a constant weight was achieved.

Particle size analysis: Each sample was mechanically shaken for 10 minutes through sieve sizes 32 mm - 0.06 mm (at 0.5 phi increments). Percent contribution was determined by weight. Sand is a matrix of interactive particles, and samples composed of interdependent proportions. A Principal Components Analysis (PCA) was performed to redescribe the data set, enabling each particle size class to be considered as an independent variable.

Hatching success rates: Nest excavations were carried out 8 days after the last hatchling emerged (Margaritoulis et al 2000). Contents were divided into hatched and unhatched eggs and trapped hatchlings, alive or dead. Unhatched eggs were distinguished as containing no visible embryos, dead embryos or live embryos. Hatching success was expressed as the percentage of the total clutch which hatched.

RESULTS

Results and summary statistics in the comparison of nests and attempt sites are shown in Table 1.

Moisture Content

Moisture content of samples (300 g and 150 g) from each site were compared using a paired T-test, and did not differ significantly ($p>0.05$). Samples considered erronous were excluded from the analysis. Attempt sites had a significantly lower moisture content than nest sites at both 30cm and 50cm depth.

Mean Particle Size and Sorting Coefficient

Analysis was carried out using the phi scale (phi = -Log 2 mm). Higher phi values are indicative of finer particle sizes. A significant difference was found in the mean particle size of nests and nesting attempts at 30 cm depth (the depth at which attempts were abandoned). Attempt sites were composed of coarser sand at 30 cm depth, but there was no significant difference at 50 cm depth.

No significant differences were found between sorting coefficients at either depth. The mean values obtained indicate the sand was moderately sorted.

Grain Size Percent Contribution by Weight: Principal Components Analysis.

The first 6 principal components combined explained 98.2% of the total variation. The first principal component (PC1) explained 46.3% of this total. There were positive loadings (negative relationships) of the scores on PC1 against the contributions of coarser particles and negative loadings (positive relationships) of scores against the contributions of finer particle sizes. Higher scores on PC1 indicate the sample was composed of a higher proportion of fine sand. PC1 is therefore an integrated measure of sand fineness. ANOVA was used to compare the scores on PC1 of nest and attempt sites at both depths (Fig. 1).

There was a significant difference between nest and attempt sites at 30 cm depth. Nests had a higher mean score, indicating they were composed of a higher proportion of finer sand grains than attempts at 30 cm ($n = 39$ nests, 30 attempts, ANOVA, $F = 8.65$, $p = 0.04$). No significant differences were found at 50 cm ($n = 39$ nests, 34 attempts, $F = 1.68$, $p>0.05$), confirming the results of the mean phi size analysis.

Sand Parameters and Hatching Success Rates

Mean particle size and sorting coefficient at 30 cm and 50 cm were regressed against hatching success rate. There was no significant relationship (by ANOVA) with mean particle size at 30 cm depth ($F = 1.83$, $p>0.05$, $n = 13$) or 50 cm ($F = 0.89$, $p>0.05$, $n = 11$), or sorting coefficient at 30 cm ($F = 0.9$, $p>0.05$, $n = 13$), or at 50 cm ($F = 1.74$, $p>0.05$, $n = 11$).

A second PCA was performed to identify the first 6 principal components of samples obtained from nest sites at both 30 cm and 50 cm depth. PC1 described 68.8 % of the total variation. The first 6 components accounted for 99.8 % of total variation. Increasing scores of PC1 indicated higher contributions of coarse sand particles, lower scores a higher contribution of fine particles. No significant effects of PC1, or any of the other principal components, were found on hatching success rates from samples taken from 30 cm depth (ANOVA, F = 1.73, n = 13), or 50 cm (ANOVA, F = 1.64).

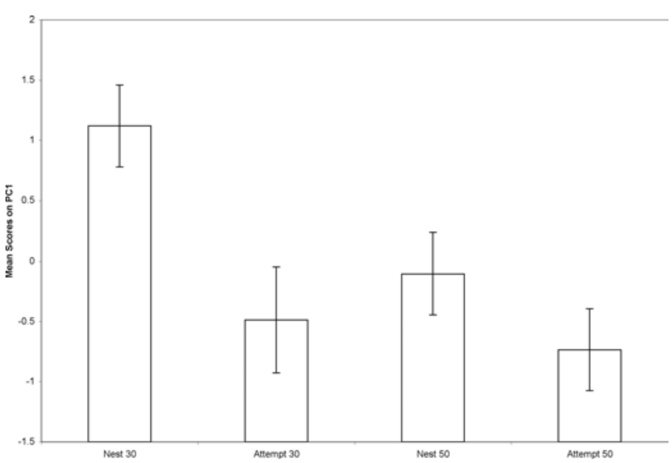
DISCUSSION

Mortimer (1990) described digging attempts abandoned on the Ascension Islands as being associated with comparatively coarser, drier sand types. Our results are consistent with these findings, indicating that turtles nesting in Kyparissia Bay (Greece) select against potential nest sites composed of higher proportions of coarse sand with lower moisture content.

Table 1: Sample means, statistical values (ANOVA) and sample sizes for sand parameter analysis of nest and nesting attempt sites.

PARAMETER	SAMPLE (DEPTH (in cm))	MEAN (+/- SE)	F	p	n
MOISTURE CONTENT	NEST (30)	4.11% (0.16)	4.33	0.046	16
	ATTEMPT (30)	3.51% (0.25)			15
	NEST (50)	4.18% (0.16)	4.95	0.032	19
	ATTEMPT (50)	3.73% (0.12)			20
PARTICLE SIZE	NEST (30)	0.54 Φ (0.07)	10.99	0.001	39
	ATTEMPT (30)	0.13 Φ (0.11)			30
	NEST (50)	0.32 Φ (0.08)	3.11	0.080	39
	ATTEMPT (50)	0.14 Φ (0.07)			34
SORT COEFFICIENT	NEST (30)	0.85 Φ (0.03)	0.30	0.590	39
	ATTEMPT (30)	0.83 Φ (0.03)			30
	NEST (50)	0.85 Φ (0.03)	0.37	0.550	39
	ATTEMPT (50)	0.82 Φ (0.03)			34

Figure 1: Results of the principal components analysis. Higher mean scores on PC1 indicate a higher proportion of finer sand grains in sand samples obtained from nest sites, than sites where nesting attempts were abandoned.



Although we have identified the physical parameters influencing nest site selection, the reasons behind this behaviour are less clear. Mellanby et al (1996) described an increased tendency for both green and loggerhead turtles nesting in Cyprus to abandon their attempts higher up the beach due to a deeper layer of dry topsand. Low moisture content is consistent with conditions determined, by experimental manipulation, as sub-optimal for incubation (McGehee 1990). Our analysis did not consider the relationship between moisture availability and hatching success, as samples collected at the time of nest site selection were not representative of the entire incubation period. Mortimer (1990) observed that higher proportions of coarse sand grains in nest sites composed of biogenic substrate had a positive effect on embryonic mortality.

At present, considering a small sample size within our study area, there is no evidence associating nest sites composed of a higher proportion of coarse sand with decreased hatching success rates. Without the inclusion of incubation temperature and water potential as additional variables, it is not possible to resolve whether turtles abandon their nesting attempts due to difficulty in egg chamber construction, or whether some form of adaptive behaviour may be taking place.

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SEA TURTLES IN BONAIRE: PAST, PRESENT AND FUTURE

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INTRODUCTION

Bonaire (Netherlands Antilles, Caribbean Sea) possesses healthy coral reefs and seagrass meadows, as well as undisturbed sandy beaches. These areas provide sea turtles with excellent foraging and nesting grounds. Hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*), and loggerhead (*Caretta caretta*) turtles nest in Bonaire, while juvenile (rarely adult) hawksbill and green turtles forage in coastal waters. Gravid leatherbacks are occasional visitors. Until 1991, sea turtles were legally hunted in Bonaire. In 1991 the Island Council of Bonaire amended the Marine Environment Ordinance to include all sea turtle species (Van Eijck and Eckert, 1994), offering them full protection.

Sea Turtle Conservation Bonaire (STCB) was founded by Albert de Soet in 1991 with an aim to protect the sea turtles of Bonaire. In 1993, Dutch biologist Drs. T. J. W. van Eijck was appointed Project Co-ordinator. Dr. K. L. Eckert (WIDECAST) visited Bonaire to assist him in developing program objectives and activities. Based on recommendations provided by the Sea Turtle Recovery Action Plan for the Netherlands Antilles (Sybesma, 1992), a project proposal was designed to embrace two major components: public awareness and research. Since 1995, two Dutch biology students have been selected every year to undertake ongoing STCB project activities (June-December), which continue to emphasize public awareness and research.

SEA TURTLES IN BONAIRE: THE PAST

For the past seven years, STCB projects have provided valuable information to local managers and policy-makers on the distribution of sea turtle populations and critical habitats. More than 30 beaches on Bonaire are now known as successful nesting sites, and Klein Bonaire (an uninhabited islet) is consistently the most important nesting area. The nesting season extends from April and to December, peaking in July and August. Foraging by juvenile, subadult and (very rarely) adult green and hawksbill turtles has been documented year around, with coral reef habitat being clearly important to local hawksbills and the seagrass beds of Lac Bay and Lagun providing important foraging resources for green turtles.

STCB's Photo Identification Project has positively identified 3 nesting females and 3 resident juveniles (Den Haring and Renshoff, 1999). The data from the photo identification is still being analyzed and more adults and juveniles are expected to be identified. An island-wide Sightings Network has also proved to be a valuable tool, both in expanding our knowledge of the distribution and seasonality of sea turtles and in involving the professional dive community. The intensive exchange of information between STCB and the dive industry has resulted in the finding of nests, tracks, dead turtles and injured turtles. In 1998 the first case of fibropapillomatosis (in a juvenile green turtle) was witnessed by STCB (Den Haring and Renshoff, 1999). The ongoing Public Awareness Campaign, launched in 1993, features slide shows to tourists, local schools, and youth centers. A "Turtle Box" was created for use in the schools. Together with the Bonaire Marine Park (BMP) and Tourism Corporation Bonaire (TCB), a very popular youth snorkel program ('Turtuganan di Boneiru') was also initiated.

The first STCB newsletter appeared in 1995 and, since 1999, it has been published twice yearly in two languages: English and Papiamentu. Regular press releases, radio and TV interviews are also amongst the activities of STCB. Twice each year STCB coordinates a Coastal Clean Up, during which various nesting beaches are cleaned. One Clean Up is organized at the beginning of the nesting season and the other one during World Clean Up day; the results are reported to the Center of Marine Conservation in Washington D.C. In 2000, a children's book ('Shanta and Friendly the Sea Turtle') was published. That same year, the first STCB video was released.

SEA TURTLES ON BONAIRE: THE FUTURE

Nesting populations

After nearly a decade of intensive surveys, the STCB has laid a strong foundation for more in-depth research into the distribution, abundance and biology of three species of locally nesting sea turtles. STCB is now working in collaboration with WIDECAST to define its research objectives for the coming 3-5 years. It is clear that in order to address critical management questions, the STCB must expand its efforts in two directions simultaneously -- research on land (nesting habitat) and research at sea (foraging habitat). The following have been identified as important questions to answer:

? How large is the nesting population (by species) on Bonaire? What are the trends?
? Do individual females return at predictable intervals and to particular beaches?
? Is there nesting interchange between Bonaire and Klein Bonaire, or between Bonaire and other range states?
? What is the reproductive success of Bonairian populations? Can we identify and mitigate major threats to reproductive success?
? What is the nest:false crawl ratio, and can we use it to infer (from morning crawl counts) the number of nests laid each year and the number of nesting turtles?
? What is the genetic signature of locally nesting females?
? Where do post-nesting females go after the nesting season has been completed? Can we identify their range state destination(s)?

These questions are central to the development of a local management strategy in Bonaire that builds on Sybesma (1992). Once population sizes are known, potential threats (e.g., illegal harvest, fishing, habitat loss) can be better defined and evaluated. From reliable sources the STCB believes that approximately 20-30 turtles are caught illegally every month. The effect of this harvest is presently unknown. Insight into individual nesting behavior and migration patterns will also contribute substantively to better management at the regional level, including providing information to Government about range states with whom Bonaire must collaborate for effective management of the sea turtle resource. To this end, STCB will continue daily monitoring of 34 nesting beaches on Bonaire, as well as to designate an "Index Beach" as the focus of a three-year intensive study.

By emphasizing a combination of day and night surveys, STCB can most efficiently utilize its human resources while at the same time ensure that the next generation of data collection will provide specific information about nest:false crawl ratios (enabling a more accurate estimate of the nesting population, based on the last seven years of morning crawl counts), nest site fidelity (are the Klein Bonaire nesters distinct from mainland nesters?), reproductive periodicity, and reproductive success. Blood sampling will enable mtDNA (genetic) analysis, thereby "fingerprinting" the Bonairian nesting assemblage for the first time, allowing researchers to identify "our" turtles on distant foraging grounds, and identifying potential range states with whom we must collaborate.

Foraging assemblages

In addition to data collection on the nesting beaches, sea turtle management planning is impossible without information on the status, residence patterns, and habitat utilization of juveniles and adults encountered in coastal waters and lagoons. Sea turtles, especially hawksbills (classified by IUCN as "Critically Endangered"), are an important component of the biodiversity of the Bonaire Marine Park (BMP) and should be integrated into Park management planning. Bonaire has a unique opportunity to advance the study of this species by implementing a long-term study of local foraging assemblages. The results will not only serve the management needs of Bonaire, but will contribute meaningfully to management programs throughout the region.

The STCB is well qualified to undertake such an assessment, building on many years of informal at-sea monitoring, coordination of the island-wide Sightings Network, compilation of sighting reports, and recent training in "at-sea research techniques" offered by the Bermuda Aquarium, Museum and Zoo (BAMZ) and WIDECAST in August 2000. The following questions are considered to be essential to management planning for non-nesting sea turtles in Bonaire:

- How large are the foraging assemblages of sea turtles in Bonaire? (The effect of various threats, such as illegal harvest, can only be evaluated if estimates of population size are available.)
? Where are the most important foraging grounds located? (There are many examples of existing coastal developments that have had a negative impact on nearshore reef habitat … yet it remains impossible for policy-makers, managers, and communities to evaluate the potential effects of development or recreational activities on sea turtle survival if critical areas have not been identified.)
- What are the population dynamics of resident sea turtle assemblages? (Are foraging assemblages stable, declining, or increasing over time? Can natural fluctuations be measured?)
- What are the diets, growth rates, foraging behaviors, and diving patterns of resident sea turtles? (Studies of habitat utilization and behavior will determine if BMP boundaries are sufficient to protect the sea turtles of Bonaire, and will provide insight into whether additional regulations might be useful in order to safeguard critical habitat or mitigate specific threats.)
- What is the genetic origin of the population(s) residing in Bonairian waters? (This information will provide policy-makers with the identity of range states with whom any management planning must be coordinated, and emphasizes the value of international conservation agreements.)

While Bonaire also provides critical habitat for juvenile green turtles, especially at Lac Bay and Lagun, the precarious status of the hawksbill sea turtle in the Caribbean region has convinced the Board of Directors of the STCB to focus future efforts on this species. Due to extensive harvests for its shell and the loss of this turtle's habitat, hawksbill populations worldwide have declined in recent decades. Bonaire is fortunate in having both a nesting population and a foraging assemblage where the species is legally protected and where there is easy access to protected habitat. Bonaire has, therefore, a rather unique opportunity to make significant scientific contributions in the study of this species.

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SPATIAL AND TEMPORAL DISTRIBUTION OF GREEN TURTLE NESTS IN TORTUGUERO, COSTA RICA

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INTRODUCTION

The spatial and temporal distribution of nests plays an important role in the biology of sea turtles. For instance, the location of nests in different zones of the beach may expose them to different sunlight levels, thereby affecting sand temperature and consequently sex ratios (Spotila et al., 1987). Nests laid over the course of the season may be subjected to variable temperatures and precipitation wich may influence offspring survival. Additionally, nests may also be exposed to different artificial light intensities, which have been shown to affect the hatchling survivorship in green turtles, *Chelonia mydas* (Raymond, 1984).

Some factors that may influence the spatial and temporal distribution of nests include ambient and sand temperatures, precipitation, lunar phase, and presence of artificial lights on the beach. We evaluated the effects of these variables on the spatial and temporal distribution of green turtle nesting and non-nesting emergences in Tortuguero, Costa Rica.

DATA COLLECTION

We conducted daily track surveys of the Tortuguero nesting beach from 9 August, 2000 to 1 October, 2000, coinciding with the peak nesting season and covering the wet (August) and dry (September) seasons. Our data were collected in the northern 5 miles of the 22 mile-long nesting beach. Nesting and non-nesting emergences in each 1/8 mile section were counted every morning at dawn. All nests were classified by zone based on the exposure of the nest to sunlight (open = complete exposure; border = partial exposure; vegetation = no exposure). Non-nesting emergences were further divided into two categories: emergence with no attempt (half moon) and some attempt to make a body pit (DNL= did not lay). Precipitation, ambient temperature, and sand temperature at 30 cm were measured daily by researchers at the Caribbean Corporation Conservation field station. We collected data during two lunar cycles, and moon phases were grouped in two categories: 1) new moon with first quarter and 2) full moon with last quarter. A light survey of the five miles was conducted and light intensity in each 1/8 mile section was classified into one of three categories: 1=total darkness, 2=light present but not falling on the actual beach, and 3= light present and illuminating the sand. To determine trends in spatial distribution, the 5 mile study site was divided into 7 equal 6/8 mile sections.

RESULTS

Of a total of 15,133 emergences, 45.7% resulted in actual nests (n=6,921), 29% in half moons (n=4,396), and 25.2% in false nests (DNLs) (n=3,816). The nests were spatially distributed in the following manner: 68.1% in the open zone (n=4,716), 29.1% in the border zone (n=2,016), and 2.7% in the vegetation zone (n=189).

The spatial distribution of nesting and non-nesting emergences varied significantly among the seven mile sections (Fig.1) (Kruskall-Wallis test; chi square=181.49, p=0 (nesting); chi-square=81.31, p=0 (non-nesting)). No significant differences were found in nesting and non-nesting emergences between some of the sections (Mann Whitney U test; p>0.05).

The number of nesting emergences, DNL's and half moons did not vary significantly between the dry and wet seasons (t-test; t=1.112, p>0.271 (nesting); t=0.689, p>0.271 (did not lay); t=-0.311, p>0.271 (half moons)). However, there was a significant difference in the open and border zones, with a larger percentage of nests in border during the second half of the data collection period, coinciding with the dry season. The vegetation zone did not vary significantly with seasonal variation (Mann Whitney U test; U=168.5, p<0.04 (open); U=210.5, p<0.04 (border)) and (Mann Whitney U test; U=228.5, p=0.093 (vegetation)) (Fig.2).

There was no relationship between the number of nesting and non-nesting emergences and precipitation (Least square regression; r^2=0.003, p=0.696, n=51 (nesting emergences); r^2=0.006, p=0.594, n=51 (non-nesting emergences)). The number of nests in the open and vegetation zones were not correlated with precipitation (Least squares regression; r^2=0.05, p=0.12, n=51 (open); r^2=0.03, p=0.25, n=51 (vegetation)). However, the number of nests in the border zone was positively correlated with precipitation (Least squares regression; r^2=0.08, p=0.05, n=51).

Average ambient air temperature varied over the course of the nesting between 25.5 and 31 °C (average temperature between maximum and minimum). There was a positive correlation between ambient temperature and number of nesting, but not between ambient temperature and non-nesting emergences (Least squares regression, r^2=0.09, p=0.03, n=51 (nesting); r^2=0.002, p=0.781, n=51 (non-nesting emergences). Significant differences were found between ambient temperature and the zonal distribution of nests (Least squares regression, r^2= 0.29, p=0, n=51 (open); r^2=0.11, P=0.016, n=51 (border); r^2=0.08, p=0.042, n=51 (vegetation). Number of nests in the open zone decreased and the number of nests in the border and vegetation zones increased with rising ambient temperatures.

The number of nests in the open zone decreased significantly with the change in sand temperature in the open zone (Least squares regression, r^2=0.241, p=0, n=51). In contrast, the number of nests in the border zone increase significantly with increase in border sand temperature (Least squares regression, r^2=0.30, p=0, n=51). The number of nests in the vegetation zone was not affected by fluctuations in sand temperature (Least squares regression, r^2=0.02, p=0.39, n=51).

Data were collected during two lunar cycles. The number of nesting and non-nesting emergences did not vary significantly between the two categories of lunar phase (Mann Whitney U test; U=271.5, p=0.313 (nesting); n=26 (New Moon-First quarter), n=25 (Full Moon-Last quarter) and (t-test; t= -0.294, p=0.77 (non-nesting emergences); n=26 (New Moon-First quarter), n=25 (Full Moon-Last quarter)).

The number of nesting and non-nesting emergences varied significantly for each category of light intensity (Kruskal-Wallis test; chi square=133.3, p=0 (nesting emergences); chi square=128.82, p=0 (non-nesting emergences)). Significant differences were found between each pair of light categories (Mann Whitney U test; p<0.05). Of the total number surveyed nests, 81.51% were in zones without any light influence, 13.61% in zones with partial light, and 4.88% in zones with direct light. 73.81% of the study beach fell into light category 1 (no light influence); 16.67% fell into light category 2 (partial light); and 9.52% fell into light category 3 (direct light).

DISCUSSION AND CONCLUSIONS

We found that the nesting and non-nesting emergences varied significantly spatially and temporally among the different sections of the beach. The nesting beach does not have the same profile over the course of the nesting season; each 6/8 mile section has distinct characteristics which seem to influence turtle emergence and nesting choice. Some influencing factors may have been the topography of the beach (width, presence and density of vegetation, beach slope) and human-related factors. The latter may have led to increased levels of artificial light on the beach. Some authors have observed correlations between beach illumination and lower sea turtle nesting activity (Mortimer, 1982 in Witherington, 1992), and changes in the nest site selection behavior (Caldwell, 1959 in Bacon, 1973). This study supported preference for nesting in zones without light influence (81.51%). However, 13.61% of nests were located in zones with partial light influence (Fig.3). Turtles nesting at Tortuguero Beach are not affected by lights located among the trees, unless they are intense (Carr, A. and Carr, H.M., 1971).

Temporal distribution was evaluated in terms of the wet and dry sesaons. Apparently seasonal variation has a greater effect on nest placement than on the number of nesting and non-nesting emergences. While the conditions which influence the nesting behavior, including nest placement, are not very well-understood, Mortimer (1982) found that green turtles picked beaches with more open zone (Mortimer, 1982 in Witherington, 1992). In our study more nests were laid in the open zone. Various factors favor the selection of this zone for nesting: lower predation risks for nesting females, eggs and hatchlings; hatchlings have a shorter distance to travel which also decreases the risk of dehydration. Additionally, the absence of roots facilitates egg chamber construction. However, nest placement in the border and vegetation zones also has its advantages: vegetation provides shade and moisture, facilitating egg chamber construction especially during the dry season. This is supported by the increase of nests in the border zone and the decrease of nests in the open zone corresponding with increasing sand temperature. No significant differences were found in the number of nests in the vegetation zone, although this zone is similar to the border zone. The increasing presence of roots and predators and the difficulties of entering into the dense vegetation probably prevented the significant increase in the number of nests in this zone. Sand temperature appears to have an important influence on nest zone selection.

In conclusion, these results suggest that several environmental factors, rather than a single factor, determine nest site selection. Many of the variables measured in this study are interrelated; for example, extended precipitation affects both ambient air temperature and sand temperature in open zone (Spotila, et al., 1987). A number of dynamic environmental variables, beach topography, and human-related factors play an important role in the spatial and temporal distribution of nests. These variables and their interactions influence nesting behavior of green turtles, which need to maintain a balance between the conditions imposed by the environment and the survival probability of the next generation.

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SEATURLECAM: LIVE INTERACTIVE VIDEO FEED OF BASKING HAWAIIAN GREEN TURTLES

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INTRODUCTION

A cooperative venture between SeeMore Wildlife, the Hawaii Preparatory Academy (HPA), and the National Marine Fisheries Service (NMFS) has led to the placement of two remotely controlled video cameras on the Kona coast of the Island of Hawaii (Balazs et al. in press). These cameras are being used by HPA and NMFS to monitor the basking behavior of green turtles in the area. The video signal is also being intermittently streamed over the internet for public viewing. Camera control is browser based and can be handled by anyone with password access.

THE SETUP

Two digital Sony video cameras are sequestered in water resistant plastic spheres containing pan and tilt servo motors as well as controller circuit boards. The cameras are hardwired to a master circuit board and to the video transmitter unit located some 75 meters from the cameras, away from tidal and wave action. Power is supplied to the unit via solar panels and 2, 12V gelcel batteries. The video transmitters and receivers are made by Primier Wirelesstm. The normal range of these transmitters is only a few hundred feet so 24 dBi parabolic antennas have been used to send the signal the 19 miles to the Hawaii Preparatory Academy Campus.

THE BENEFITS

The use of the remotely operated video cameras has allowed us to maintain a constant daytime presence at the research site. This has made research on the basking behavior of green turtles much more convenient and efficient. Work done by Quaintance et al. (this volume) has clearly demonstrated the successful use of the cameras to identify individual turtles and study their basking behavior.

A side benefit of the installation is the effect it appears to have on human behavior. The area where the cameras are located is frequently visited by tourists and locals and we believe that the cameras act as a deterrent to inappropriate human / sea turtle interactions.

Future work with the cameras will involve adding environmental data gathering and transmission capabilities. Using either broadband or microwave transmission equipment, we will be able to monitor temperature, wind velocity and direction, relative humidity and light intensity on a 24 hours / 7 days a week basis.

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EFFECTS OF LONGLINE HOOKING ON DIVE BEHAVIOR AND MORTALITY OF OCEANIC-STAGE JUVENILE LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)

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Little is known about the effects of incidental capture by longline fisheries on the subsequent behavior, health, and mortality of oceanic-stage loggerhead sea turtles. Juvenile loggerheads are captured in longline swordfish and shark fisheries in the Azores archipelago. These turtles are most frequently hooked in the mouth or esophagus and are normally released by cutting the line at or near the mouth, leaving the hook embedded in the turtle. Harmful effects, including mortality, may result from tissue damage and resultant internal bleeding, infection, and digestive tract obstruction. Symptoms may not appear for hours or days. Satellite-linked time depth recorders (SLTDR's) are useful for studying the post-hooking behavior of free-ranging sea turtles in the oceanic realm. The results of such studies will aid in the design of population models and fisheries management plans for the Azores archipelago and for other areas where sea turtle populations are impacted by longline fishing activity.

During summer 2000, we attached SLTDR's to twelve (12) turtles captured with dipnets (control group) and six (6) turtles incidentally hooked in the esophagus by longline fishing gear. We evaluated differences in maximum dive depth, dive duration, and proportional usage of the water column between control and hooked turtles during November, and differences in movement patterns from date of release through February 2001. We also examined whether SLTDR's can be used to estimate sea turtle mortality due to hooking.

ESTABLISHING REPLICABLE COMMUNITY-BASED TURTLE CONSERVATION RESERVES IN THE FIJI ISLANDS

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ABSTRACT

Fiji is a Pacific Island country located in the central Pacific area, made up of over 300 islands, of which only 1/3 are populated. Fiji is an area of high biological diversity where many communities remain highly dependent on natural resources for their sustenance. To varying degrees, many of these communities are experiencing increasing pressure to move into the cash economy and this often necessitates changing from sustainable resource use to less environmentally sustainable practices. In terms of marine ecosystems and biodiversity, the Western Pacific has the highest marine diversity in the world, and Fiji has one of the best-developed coral reef systems in the Pacific. However, there is no inventory of Fiji's marine plants and several marine species have become extinct in recent times and several others now in danger of extinction (1993 Government of Fiji and IUCN – The World Conservation Union).

World Wide Fund for Nature (WWF) South Pacific – Fiji Country Program works with communities to assist them with the design and implementation of marine reserve areas and no-take zones as a means for protecting coral reef and other ecosystems within resident landowners' customary marine areas. This community-level work is based upon the traditional practice of many Pacific Islanders in setting aside tabu areas (seasonal no-take zones), a management system which has been used successfully for generations to maintain healthy marine populations of fish and other marine life.

Turtle exploitation & conservation actions – Fiji

The main threats to Fiji's sea turtle populations are from traditional harvesting of adults for ceremonial purposes, subsistence and commercial harvesting of adults, their eggs and shell, and mortality in commercial fishing nets. However, a lack of local capacity and financial resources has meant that the extent and intensity of each of these threats is currently unknown.

Traditional Harvesting

Traditionally turtle hunting was one of the duties of the clan 'mataqali' who were called 'gonedau' with the 'tunidau' as the head (Guinea, 1993). These members of the community were well educated in natural history and traditional taxonomy of turtles, and were responsible for supplying animals at the chief's request for consumption on special occasions. Hunting was conducted by day, with nesting turtles being collected by night. During the day turtles sighted from canoes were chased till exhaustion.

In addition, if turtles were observed on reefs or in shallow areas, a large mesh (lawa ni vonu) or coconut fiber (lawa tabu) net was spread to encircle the animal at the most likely point of escape, and driven towards the net (Guinea, 1993). Turtle eggs were not traditionally harvested for special feasts.

Subsistence and Commercial Harvesting

With the weakening of traditional restrictions on who, where and when turtles could be hunted, many Fijians, Indians and Rotumans now consider turtles to be common property (Guinea, 1993). Turtles are now being targeted for general consumption as well as for sale in local markets. The eggs are also targeted for subsistence purposes. In addition, turtle shells are still being sold for both ornamental purposes and jewellery.

Mortality in Fishing Nets

Discussions with the Department of Fisheries indicate that turtles are being caught, by commercial fishermen operating in Fiji's waters. A number of these operators have requested permits to sell the turtles on domestic markets. Very little is known about the numbers of turtles being caught, how many are being released, and mortalities resulting from drowning in nets.

Legislation and Regulations

Hunting in Fiji is generally unregulated and uncoordinated, and the sale of sea turtles is dictated by demand, market price and the relative ease of obtaining other sources of income. Currently the legislation prohibits the taking of turtles and their eggs during the breeding season, December to March. Since 1990, small changes have been made to legislation in Fiji to address the conservation of turtles nationally. A ban on the export of turtle shell was imposed in 1990, though a number of exemptions have been granted. A five year moratorium was imposed on the killing of turtles, the taking or destroying of eggs, and the trade of turtle meat, eggs from 1995 to December 2000. The Department of Fisheries is hoping to extend this moratorium for a further period.

National actions for turtle conservation in Fiji

In 1998, in recognition of the "Year of the Turtle", the Fiji Government in consultation with the University of the South Pacific and other non-government organisations, developed "The Fiji Sea Turtle Conservation Strategy". The Strategy is not formally adopted by government, but it is currently being used to manage turtle conservation efforts in the country. The strategy identifies the following actions for turtle conservation:

1. Institutional Capacity building – To provide the personnel requirements for successful implementation of the strategies.
2. Limiting and regulating harvest – To manage turtles in Fiji to allow a sustainable subsistence and ceremonial harvest (of certain species) whilst enhancing population of all species.
3. Education and Awareness – To communicate with target groups about national and regional situation concerning sea turtles in order to facilitate positive decisions leading to sea turtle conservation.
4. Marine Conservation Touring workshops – To build community-based capacity for conservation management of sea turtles by means of dialogues, education and awareness and local participation in management activities.
5. Protection of nesting sites and nesting turtles – To develop key turtle nesting sites to effect conservation of eggs, protection of nesting and conservation and sustainable use of these sites.
6. Protection of foraging areas and foraging turtles – To manage the most significant foraging sites in such a way as to offer protection to foraging turtles and their habitat, and opportunity for research to be conducted that will assist management in the future.
7. Captive turtles – To ascertain numbers and location of captive turtles and consider the role of captive turtles in management of sea turtles in Fiji.
8. Pollution – To conduct research into pollution threats to marine turtles in Fiji Waters.
9. Bycatch – To gain understanding of possible by catch of sea turtles from commercial fishing vessels operating in Fiji waters.
10. Regional Strategy – To compile regional database as recommended in the Regional Marine Turtle Conservation Program.

Population & Distribution

Five of the seven species of turtle found globally are found in Fiji - green(*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), Olive Ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*) and loggerhead (*Caretta caretta*) turtles. The green and hawksbill species are relatively common and are known to nest in Fiji. No data is available on the Olive Ridley turtle.

Hawksbill turtles

Hawksbill turtles (taku) are commonly observed on coral reefs where they feed on sponges, seagrass, ascidians and soft corals. The species is considered to be less migratory than others (Batibasaga, pers. comm.), although long distance migrations have been recorded for example, between Solomon Islands and north eastern Australia. A thousand hawksbills are thought to nest in the Pacific Ocean which includes a Fiji breeding population of approximately 120-150 (Batibasaga, pers. comm.). Known nesting sites include Heemskereq reef, Ringold Reef, and the islands of Namenalala, Laucala, Leleuvia, Tavarua and Vatulele (Sue 1996; Guinea, 1993). The estimated numbers of adult hawksbill turtles for Fiji is estimated at 2-3,000. However, harvest for hawksbills has been high in recent years. Approximately 30,000 shells were exported during the 1980s with some 2,000 kg of shell exported in 1989 alone.

Loggerhead turtles

Loggerhead turtles (tuvonu) are uncommon in Fiji with recorded sightings in Nasese(Suva)Aiwa (Lau) and Taveuni (Guinea, 1993). The Department of Fisheries estimates that there are some 50-60 loggerheads in Fiji. There are no reports of nests, although there anecdotal evidence for nests on Yadua Island. They are also known to nest in Kiribati, on the Southern Great Barrier Reef and adjacent to Australian mainland coastal areas, and southern New Caledonia. Loggerhead turtles feed predominantly on shellfish, crustaceans, sea urchins and jellyfish. Their distribution in Fiji is patchy and is likely to reflect both their preferred habitat and possibly the lack of hunting pressure.

Leatherback turtles

Leatherback turtles (vonudakulaca) are the largest living species of sea turtle. They are also one of the rarest. They are not common in Fiji but there have been recorded sightings and 4 nesting attempts in Fiji (Guinea, 1993). Leatherback nesting and sightings have been recorded for Savusavu region, Qoma, Yaro passage, Vatulele and Tailevu. The number of leatherbacks in Fiji is likely to be around 20-30 individuals. Although the numbers are low in Fiji, the significance of the population is likely to be high due to the very low numbers in the region. Guinea (1993) suggested that most leatherbacks are merely passing through Fiji on westerly moving ocean currents, and may represent the remains of relic population. The threat of extinction both locally and internationally is therefore extremely high . Leatherback feed primarily on jellyfish and other soft bodied marine invertebrates.

Green turtles

Green turtle (vonu dina) according to Guinea (1993) is the most prized food of the Fijians and is an important ceremonial gift. The only known nesting sites are located on the islands of Heemskereq Reef and Ringgold reefs. The Department of Fisheries estimates that of the population of 4-5000, 30–40 green turtles nest in Fiji. The remaining ones are likely to nest in other parts of the Pacific. Green turtles feed primarily on seaweed and sea grass, and utilize the rich feeding grounds offered in Fiji waters. A tagging program by Regional Marine Turtle Conservation Program has shown that male green turtles migrate between Fiji, French Polynesia, American Samoa and Eastern Australia.

WWF – Fiji Turtle Conservation

WWF's turtle conservation program in Fiji is in its initial stage. A strategy is being developed to integrate turtle conservation into community-based marine protected areas (MPA) in the Great Astrolabe Reef, Kadavu.

WWF has carried out marine conservation awareness programs targeted at customary resource owners, and will be working with them to establish an MPA to protect hawksbill turtle nesting site at Qasibale Island. As part of establishing an MPA, WWF will be assisting customary resource owners with an assessment of their current harvesting practices (traditional and non-traditional), and developing and implementing management measures to protect and conserve turtle populations in the area.

In Fiji, WWF is helping the customary resource owners of Ono Island to set up a community-based marine protected area (MPA). Local people have acquired new skills in monitoring the health of their reefs, and the use of fish poisons, destructive fishing practices and poor land-use practices has been outlawed. In addition, there is currently a ban on the harvesting of turtles within their MPA. To enforce the rules developed by the community, a number of villagers have been appointed and trained as honorary fisheries wardens.

Ono Islanders have rediscovered the art of weaving fish traps using local vines. They plan to introduce the traditional fish trap back into their community, slowly cutting down on the use of spear guns and other destructive fishing methods. Turtles are specially regarded and looked after in Waisomo. It is perceived that involvement with turtle conservation will be particularly meaningful for the Waisomo community(managers of the Ulunikoro Marine Protected Area) as the animal is the traditional totem for the village. Turtles are specially regarded and looked after in Waisomo. It is perceived that involvement with turtle conservation will be particularly meaningful for the Waisomo community(managers of the Ulunikoro Marine Protected Area) as the animal is the traditional totem for the village.

WWF will focus its conservation efforts on changing turtle harvesting practices of customary resource owners through education and awareness. It will work with communities to develop mechanisms by which communities can have a direct role in the conservation of turtles in Fiji.

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THE USE OF HOT PEPPER EXTRACT TO CONTROL MAMMALIAN PREDATORS- A PRELIMINARY STUDY

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Gumbo Limbo Nature Center

Since 1976, cages have routinely been used in Boca Raton to protect sea turtle nests from mammalian predators. In 1997, this practice was discontinued when a 1996 study demonstrated that the cages actually attracted predators. Since this time, cages were randomly utilized on less than 1/3 of the Loggerhead nests giving the predators time to apparently relearn how to locate in situ sea turtle nests. As successful attacks by predators increased during the 2000 nesting season, alternative deterrents were sought. Infertile turtle eggs from nests excavated 72 hours after the first emergence were injected with extract of habenero pepper from a commercially available product (approximately 3 ml per egg) and these "egg bombs" were placed in pseudo-nests in areas of high predator traffic on the beach. Additionally, chicken eggs were injected with the hot sauce and placed in areas of high predator activity. Following the placement of these "egg bombs", sea turtle nests in the area were sprinkled around the nest site with a 1:100 dilution of hot pepper extract to hopefully deter predators exposed to the "egg bombs" by the smell of the hot sauce.

Initial results indicate that the hot sauce deployment resulted in fewer successful predatory attacks on sea turtle nests while an increased number of attacks were observed during this period. It is important to note that hot pepper effects only mammals and not sea birds or reptiles and is a potentially effective non-lethal method of mammalian predator control.

INTRODUCTION

From 1976 to 1996, Boca Raton routinely caged all sea turtle nests in an effort to prevent depredation of the nests by raccoons and gray foxes. When a 1996 study (Mroziack et al., 2000) demonstrated that the cages were actually attracting the predators to the egg chamber, cages were used on less than one-third of the nests from 1997 to the present. Since 1997, cage use was restricted to areas of the beach that had high predatory activity and was implemented in a random fashion to prevent habituation to the cages by mammalian predators. Historically, the areas of Boca Raton's beaches with the highest populations of predators was the City's parks which compromise more than half of the five miles of surveyed beach. Typically, some 60% of the predatory attacks occurred in a 1.5 mile area of beach that encompassed Red Reef and South Beach Parks (Florida Index Nest Beach Survey zones D, E, and F).

Methods for predator control were actively sought such as making park garbage unavailable to predators, reducing park patron feeding of predators, and removing predators from parks. These procedures are slowly being implemented in city parks, but in the interim, a new potential method of predator control came to light during an unfortunate incident suffered by one of our co-workers with a particularly potent form of hot pepper sauce known as "Da Bomb". After touching the jar, then touching her eye, the unfortunate co-worker suffered for some two hours instantly causing us to think what may happen to a mammalian predator that was similarly afflicted.

Infertile turtle eggs from excavated nests and chicken eggs were injected with the potent habenero sauce and placed in areas of high predator activity. Nest sites and predator trails were surrounded with a diluted sauce. In zones of high predatory activity, nests that were protected by "egg bombs" withstood higher attacks per nest and slightly lower numbers of successful depredations. In the future we hope to refine and improve the use of this hot sauce to protect sea turtle nests under threat of mammalian predators.

MATERIALS AND METHODS

The habenero hot sauce used in this study was "Da Bomb-Beyond Insanity" (Juan Original, Inc., Parkville, MO). This hot sauce sports over 1.5 million scovill units (scovill units measure how hot a hot sauce is) whereas a typical jalapeno sauce contains about 5,000 scovill units.

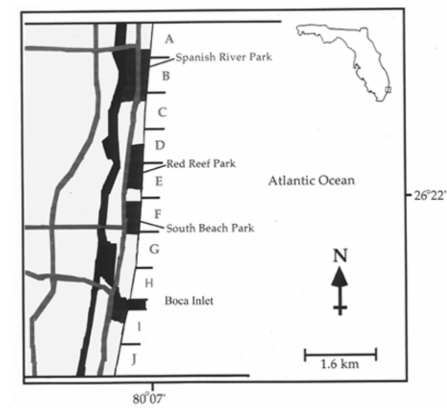
Infertile sea turtle eggs obtained from recently excavated nests and chicken eggs were used as carriers of "Da Bomb". A diluted form of "Da Bomb", dubbed "sauce" was made by making a 0.2-0.5% (v/v) solution of "Da Bomb" with water.

To create an "egg bomb", eggs are pierced with the sharp points of scissors followed by the withdrawal of 2-3 ml of yolk with a disposable pipette. A like amount of "Da Bomb" is injected into the egg with a different disposable pipette. The "egg bomb" is then sealed with candlewax resulting in the final "egg bomb". These "egg bombs" were placed at predator beach accesses or trails. Bombs were left exposed at predator trails inaccessible to beach patrons in the dune or partially buried in trails accessible to humans. Turtle nests in the immediate area (approximately 50 feet) of egg bombs are the surrounded with sprinkles of dilute "sauce" in an attempt to deter egg bombed predators from probing the nest site by the smell of the hot sauce.

The areas of high predator activity have historically been Red Reef and South Beach Parks, or zones D, E, and F (fig 1). These areas were targeted for egg bomb deployment because of high predator activity and traffic, indeed nearly 60% of the nest attacks occurred in the 1.5 mile area of these zones versus 40% of the attacks over 3.5 miles of Boca Raton's beaches. Nests in the area of egg bomb deployments were closely followed and were designated as "egg bomb" (EB) nests. Nests in these zones that were not covered by egg bomb use are referred to as non-EB nests. The fate of these nests was also closely monitored.

Predatory attacks for nest in zones D, E, and F were recorded as "dig, no predation" (DNP), or earnest digging at a nest site, and predation (P). A depredation was recorded as any dig displaying one or more turtle eggshells on the surface of the sand.

Figure 1- Map of Boca Raton's beaches. The zones involved in this study (D, E, and F) are shown in this figure. Most of the mammalian predator activity (60% of total attacks) is found in these zones which encompass the city parks of Red Reef, Red Reef Municipal Golf Course, and South Beach Park from north to south.



RESULTS

The use of egg bombs and dilute hot sauce did not begin until late in the 2000 sea turtle nesting season, the first series of egg bombs were first deployed on August 23 and continued until all nests were gone. Because of this, only predation data collected after August 23, 2000 were used in this study. During the 2000 nesting season, 1,163 attacks on sea turtle nests were recorded over the entire five miles of beach. Of these attacks 282 resulted in a successful nest predation (24% of total attacks). It is important to note that a successful nest predation does not indicate total nest destruction as predations can be as few as one eggshell removed from a nest to a predation that occurs during or soon after a successful nest emergence. The study area, zones D, E, and F recorded 689 attacks (59% of total) with 135 of these attacks resulting in a successful predation. From August 23 onward 315 attacks were recorded in Boca Raton or 27% of total attacks for the year. In the study zones, 168 attacks were recorded resulting in 28 successful predation attacks.

Because areas of high predatory activity were specifically targeted for egg bomb dispersal, attacks in these areas are referred to as "EB DNP" for unsuccessful attacks on nests in egg bombed areas of the study zones and "EB PRED" for successful predation attacks on nests in egg bombed zones. Similar nests in areas that were not subjected to egg bombs are referred to as non EB DNP and non EB PRED.

The attacks on green (*Chelonia mydas*) and loggerhead (*Caretta caretta*) in egg bomb and non egg bomb areas are shown in figures 2 and 3 respectively. Figure 2 demonstrates the attacks on 21 green EB area nests and 12 non EB area nests. Nests in egg bombed areas withstood nearly twice the attacks of non EB nests yet successful predations per nest is lower for EB nests (0.29) than non EB nests. (0.42). These data indicate that egg bombs and "sauce" in the nest areas protected green sea turtle nests in areas of high predatory activity. Similarly, figure 3 demonstrates the attacks on 24 loggerhead EB nests and 19 non EB nests showing that nests in egg bombed areas also withstood nearly three times the attacks of non EB nests. These data results in 0.46 successful predation attacks for EB nests and 0.42 successful predation attacks for non EB nests.

Again, these data indicate that nests in egg bombed areas were protected from predation because they endured higher unsuccessful attacks but demonstrated nearly identical successful predations to non EB nests.

DISCUSSION

The data presented demonstrates that sea turtle nests in the study area withstood more than twice as many attacks by mammalian predators but resulted in the same or fewer successful predations for loggerhead and green nests. This indicates that the utilization of egg bombs and dilute sauce may actually provide some protection for sea turtle nests from mammalian predators. It is interesting to note that 40% of the attacks in Zones D, E, and F were due to raccoons whereas 97% of the attacks in the remainder of the zones were by the Gray Fox. This indicates that the parks support higher populations of raccoons due to the ready availability of garbage in these parks. All other zones include parks that are located west of the major island highway (A1A) or areas of condominium development where garbage is locked away in raccoon-proof dumpsters. This indicates that restriction of garbage in the parks may help control raccoon populations and possibly reduce the number of raccoon attacks in park areas.

The use of habenero hot pepper sauce is ecologically friendly, as it is simply a biological compound that is readily broken down by common bacteria in the sand. Additionally, hot sauce appears to have no effect on reptiles and birds as shore birds such as Sanderlings and Gulls were often seen greedily devouring egg bombs. As such, there is no reason to expect that hot sauce would harm any sea turtles that inadvertently come in contact with an egg bomb. Additionally, hot pepper extract has been successfully used in Zimbabwe for two years to keep elephants from raiding farm areas (Revkin, 2000).

It is important to deploy plenty of egg bombs in areas of high predator population to ensure that all potential predators are exposed to the hot sauce. Our hope was that once a predator was exposed to an egg bomb, they would avoid areas that were sprinkled with dilute hot sauce by smell. Anecdotally, two nests that were successfully attacked in the egg bombed area remained unmolested until they hatched several days later. The only protection these nests had was the daily application of dilute hot sauce around the nest site. The actual effectiveness of the dilute hot sauce will be studied in detail during the next nesting season. Egg bombs should not be deployed on the site of an incubating egg chamber because many egg bombs deployed on predator trails and previously excavated nest were found to attract fire ants as well as shore birds and crows.

This preliminary study indicates that potent hot sauce may effectively deter potential predators from attacking sea turtle nests. Because the study was begun late in the season, there is not enough data to draw a strong conclusion but the study will continue from the beginning to the end of this year's nesting season. With good controls, the effectiveness of egg bombs and dilute hot sauce will be well quantified.

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Figure 2- Attack Results on Green Nests. This figure demonstrates the attacks on 21 green EB area nests and 12 non EB area nests. See "Results" text for further details.

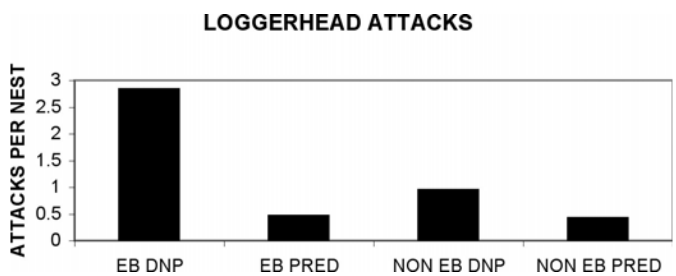
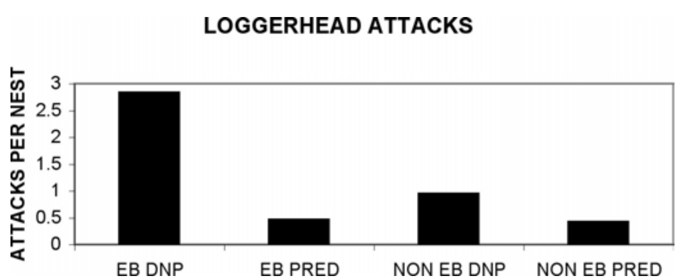


Figure 3- Attack Results on Loggerhead Nests. This figure demonstrates the attacks on 24 loggerhead EB nests and 19 non EB nests . See "Results" text for further details.



INSHORE DISTRIBUTIONS OF LEATHERBACK SEA TURTLES IN THE NEW YORK BIGHT

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Aerial and shipboard sightings surveys have been conducted in the New York Bight for leatherback sea turtles since 1996. These surveys have identified two areas within the New York region with consistent concentrations of leatherbacks on an annual basis. Both locations are within 25 nautical miles of shore. Leatherbacks have been observed between April and November with peak abundance between May through September. Mean site counts are 7.4 SD 2.6 with a range of 0 to 11. Animals were observed widely distributed throughout the region, however significantly greater numbers were observed in the two identified concentration sites. In one site a naturally marked animal has been observed in that site on two consecutive years. Repetitive sightings of individuals imply the possibility of site fidelity. The identified site locations offer the opportunity to determine the extent site fidelity might exist for leatherbacks in non-nesting regions.

DIVING AND FEEDING BEHAVIOR OF JUVENILE GREEN TURTLES, WITH COMPARISONS TO LEATHERBACKS

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North Atlantic green turtle hatchlings migrate offshore and are probably entrained by the Gulf Stream into the North Atlantic gyre. However pelagic-stage juveniles are rarely observed in the open ocean, and little is known about their behavior or ecology. We reared hatchlings in the laboratory and, at 2, 4, 6 and 8 weeks of age, transported individuals several km offshore to the Gulf Stream. Each turtle's behavior (n = 34 individuals from 5 nests) was observed in the open ocean for 35 min before it was released. Subjects towed a small data tag that recorded dive depth. Below, we summarize the results and compare their feeding and diving behavior to leatherbacks (studied the previous two years) of comparable age.

Green turtles swam continuously. The majority made repeated (mean of ~7 dives/30 min), shallow (range: 1 - 18 m; mean, ~ 4 m) dives. "Deep" dives (to depths over 10 m) were rare (n = 5), and usually made immediately after the turtles were initially released into the ocean, or when they were recaptured to retrieve the data tag (and to release each individual). The dives of younger (2-4 week old turtles) and older (6-8 week old) turtles did not differ in depth distribution, but the dives of older turtles were significantly longer. Dive profiles were typically "U"-shaped (rapid descents and ascents to a depth maintained for most of the dive).

Seven hatchlings paused to feed upon vegetation (*Sargassum*, *Thalassia* leaves), unidentified gelatinous (probably molluscan) eggs, and ctenophores in the water at the surface or at shallow depths (< 3 m) in the water column. They ignored jellyfish (*Aurelia*), even when these organisms were abundant. Thus turtles foraged at shallow depths and were omnivorous.

Leatherbacks of comparable age differed from green turtles in the following respects. (i) Dive profiles were often "V" as well as "U"-shaped. (ii) The turtles fed exclusively on gelatinous prey (including *Aurelia*), captured by dives directly toward prey below them in the water column. (iii) As they grew older, both dive depth and duration increased. Thus the two species, even at an early age, show different developmental "trajectories", indicative of niche separation within open oceanic pelagic habitats.

DETERMINATION OF FEEDING HABITS AND BEHAVIOR OF THE PACIFIC BLACK TURTLE (*CHELONIA MYDAS AGASSIZII*) IN GORGONA NATIONAL PARK, DEPARTAMENTO DEL CAUCA, COLUMBIA

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INTRODUCTION

Studies of migratory processes between nesting and feeding areas of *Chelonia mydas agassizii* have established the existence of migratory corridors between the Galapagos Islands in Ecuador and the peninsula of Baja California in Mexico (National Marine Fisheries Service, NMFS, 1998). The marine ecosystems of Gorgona Island are strategic areas for the development of diverse species of algae and invertebrates (Bula, 1982), which contribute to the settlement of higher organisms. Marine chelonians, such as the black sea turtle, are using this area for growth and development (Sánchez, in prep.). Tunicates, rhodophyte and chlorophyte algae and terrestrial vegetation form the majority of the diet of this population. Continuing evaluations seek to elucidate the spatio-temporal dynamics of these food sources and their demand by turtles.

METHODS

Behavioral monitoring was carried out during the day, on average every two hours. When it was necessary to capture individuals, this was done manually (with and without snorkel equipment) at night, at a depth of approximately six meters. Measurements of curved and straight carapace length were taken, as well as length and width of plastron, head and tail. Esophagic lavages were performed adapting the methodology proposed by Forbes and Limpus (1993). Our modification consisted of using tubes with dimensions proportional to the turtle; thus for subadults with a Straight Carapace Length (SCL) of <70 cm a tube of 15 mm diameter was used and for adults of >70 cm LRC the diameter was 17 mm. Glycerin was used on the sides of the tube to facilitate its insertion. Seawater was used to wash over the contents. The vegetative samples were fixed in 70% ethanol and those of animal origin in 10% formalin. Alimentary samples were also taken directly from the beak of the individuals. Each individual sampled by esophagic lavage was marked with a steel monel tag. Four turtles were captured by fishermen and handed to us, allowing stomach content analyses to be done.

For better comprehension of the dynamics between food sources and their spatio-temporal distribution, the dietary analysis was done comparing different study sites and seasons, and taking into account differences between sexes and individuals of differing levels of development.

RESULTS

During behavioral monitoring we observed 115 individuals, all of them during nighttime hours. We observed nocturnal feeding on algal formations (*Gelidium bulae*, *G. pusillum* y *Cladophora panamensis*), and in areas known as 'Hileros1' (Flores, pers. comm.) where large quantities of terrestrial vegetative material accumulate (e.g. *Eichornia* sp.). A symbiotic relationship was observed in sector I. where turtles appeared to be liberating themselves of parasites by allowing fish to 'clean' them.

Of the 55 individuals captured, a total of 39 samples from esophagic lavages were obtained for subadults (SCL: = 59.66 cm + 66.4 cm S.D.) and 4 for adults (SCL = 73.38 cm + 3.44 cm S.D.). The mean volume of each sample was 200 ml.

The subadults showed an alimentary tendency towards plancktonic tunicates of the genus *Salpas* in the family Thaliceae. 41% of the total sample volume for subadults was made up of *Salpas*, and occurred in 28/39 (72%) of the individual samples. In adults it made up 92.5% of the total sample volume and 3/4 (75%) of individual samples. At sample sites I and II, the tendency was defined by tunicates (60% of sample). At sample site III the red algae *Gelidium bulae* and *G. pusillum* and the green alga *Cladophora panamensis* made up the majority of the sample (50.2%). In the analysis of difference between sexes it was found that female adults and subadults preferred *Salpas* tunicates (67.1% of combined sample volume for females), however males had a herbivorous tendency, preferring red and green algae, which made up 50.2% of the combined male sample volume. In the comparison of seasons, it was found that in both sampling periods (October to December 1999 and January to March 2000) there was a tendency to consume animal material; plancktonic tunicates made up 72.1% and 68.1% of the samples respectively.

The total sample volume from the four subadult turtles obtained from fishermen was 1552.5 ml. Leaves, stalks and seeds of the terrestrial phanerogram *Ficus* sp. dominated stomach content composition (69%, 23% and 7% respectively). Tunicates of the genus *Salpas* made up less that 1% of the sample.

1. Phenomenon of currents caused by temperature differences and density of the water that do not allow their mixture, which causes the parallel displacement of the currents and the material suspended on them.

ANALYSIS AND DISCUSSION

The behavior exhibited by this population during the day is characterized by constant movement, which contrasts with nocturnal passivity. This diurnal movement pattern could be explained by a permanent visual search for food sources.

The population of black sea turtles at Gorgona Island presents an alimentary tendency towards marine tunicates of the genus *Salpas*. These organisms have a limited capacity for movement, and are typically stationary in space and time, which generates considerable abundance in some areas (Sefton, 1986) and makes them easy to find and consume. However the spatio-temporal patchiness of this resource makes red and green algae (*Gelidium bulae*, *G. pusillum* and *Cladophora panamensis*) a more consistent and complementary dietary choice. Similar tendencies towards planktonic tunicates have been reported by Mortimer (1981) and the NMFS (1998), but in minimal percentages in the samples analyzed. The existence of individuals feeding on *Ficus* sp. as a sporadic food source in "hileros" is evidence of the flow, transformation and use of energy between terrestrial and marine ecosystems, which could be complementing and/or replacing other food sources. However this behavior makes the turtles vulnerable to fishermen who frequent these areas to hunt them. Similar energy flows have been described by Pritchard (1971), such as in the consumption of red mangrove leaves (*Rhizophora* mangle). The alimentary tendency of subadults and adults towards an animal food source contrasts with reports which characterize the adults of this species as herbivores (Mortimer, 1971; Márquez, 1990 and NMFS, 1998). Knowing the dependence of age at sexual maturity (10 – 50 years) on nutrition in natural conditions (Balazs, 1982), the use of inconstant food sources (such as tunicates and terrestrial vegetative matter) could be affecting the normal development of this population.

CONCLUSIONS AND RECOMMENDATIONS

The alimentary tendency of subadults and adults in this population does not show high fidelity towards a particular resource, as in other populations of *Chelonia mydas agassizii*. It is necessary to continue evaluating the spatio-temporal availability of the identified food sources and their level of use. Until this study, the presence of this population in the Columbian Pacific has been unknown to science. It is therefore necessary to further study aspects of its biology (e.g. telemetry, genetic characterization) and implement a marking program so that its postulated sympatry with populations in the Galapagos Islands, Michoacán and Baja California can be investigated.

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GREEN TURTLE (*CHELONIA MYDAS AGASSIZII*) DIET DIFFERENCES IN TWO PERUVIAN COASTAL LOCALITIES

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ABSTRACT

Three *Chelonia mydas agassizii* (green turtle) stomach contents were analyzed in order to investigate their main feeding items. Two of them came from the inlet of San Andres (75º45' W; 13º45' S), the remaining one from the fishing port of Chimbote (78º30'W y 9º00'S). At San Andrés, the main items were the algae *Ulva costata*, *Grateloupia doryphora* and *Prionites decipiens*, whereas at Chimbote, the main items were animal parts and non-organic residues such as plastics and fishing nets. The feeding items from the Chimbote turtles were markedly different from the San Andrés turtles (SJ = 0 – 10.53%). One of the reasons of such striking differences between localities 654 kilometers apart is that the San Andres turtles are showing the feeding habits in a high quality habitat, whereas the Chimbote turtle is showing the feeding behavior in a low quality, high disturbance zone, behaving as a generalist and eating whatever the environment had to offer.

INTRODUCTION

Marine turtles feeding habits provide excellent means for obtaining information on preferred food items and the places where they are obtaining food. Indirectly, information on the richest feeding grounds in the Peruvian coast can be identified as well as the differences in their preferences based on the various feeding grounds. Information for Peruvian waters date from at least 20 years ago and current researches remain unpublished. Due to this, investigations in the Southeastern Pacific need to be emphasized.

The main purposes of this research were to determine feeding behavior similarities between two turtles from the San Andres Inlet in Pisco (75º45' W; 13º45' S) captured from April to June 2000, and a turtle coming from the Fishery Port of Chimbote (78º30'W y 9º00'S) collected in December 1999.

Feeding items identifications were made in the Faculties of Sciences and Fishery at La Molina National Agrarian University (UNALM).

BASIC INFORMATION

Chelonia mydas agassizii can be found along the entire Peruvian coast due to its richness in food items. Nesting beaches have not been reported for the Peruvian coasts nor hatchlings have been found. Subadults and adults comprise most of the captured populations. Tag recovery has provided information that part of these captures is migrating from the Galapagos Islands (Hays Brown and Brown 1982). Apparently green turtles are using the Peruvian waters as their feeding grounds and possibly as their developing grounds, according to Hays Brown and Brown, who in 1982 found juveniles in the 85% of the cases.

In their hatchling period the green turtles are carnivorous. Crustaceans and jellyfish constitute their main feeding items. Later, they change to a herbivorous diet, feeding on algae or marine grass (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1998).

Paredes in 1969 (Frazier 1979) working on the stomach contents of 20 green turtles from the San Andrés Inlet in Pisco found algae in the 100% of the cases. The main species found were *Macrocystis pyrifera* and *Gigartina tuberculosa*. Jellyfish were present in 60% of the sample and crustaceans in 50% of the sample. Later, Hays Brown and Brown (1979) analyzed 39 stomachs and found the following food items: algae (*Macrocystis*, *Rhodymenia* and *Gigartina*), mollusks (*Nassarius*, *Mytilus* and *Semele*), polychaetes, jellyfish, amphipods and fish (sardine and anchovy). From then onwards green turtle diet studies in Peru have not been published.

MATERIALS AND METHODS

Localities were selected on the basis of their high number of captures along the Peruvian coast. The San Andres Inlet, Pisco, department of Ica, has been traditionally known for its turtle meat trade for over 30 years. On the other hand, the Port of Chimbote, in the department of Ancash, represents the greatest concentration zone of artisan fishery in the northern Peruvian coast

Two stomachs from San Andrés were analyzed as well as one from Chimbote. The stomachs were collected using disposable gloves and plastic bags with a 10% formalin solution. This solution was injected to the stomach collected in Chimbote.

Curve caparace length (CCLmax) was taken from the collected individuals (Table 1). In the laboratory, the stomachs were weighed and opened by a longitudinal cut (Table 1). The stomach contents were sampled to obtain all the feeding items. Their abundance was visually estimated. Reference algae preparations were made following standard procedures. Algae found in the Chimbote stomach couldn't be identified due to the advanced level of decomposition. With the items found in all of the stomachs, a Jaccard Similitude Index matrix was constructed.

Table 1.Turtles length and stomach weights

	San Andrés turtles		Chimbote turtle
	1	2	3
Curve caparace length (CCLmax) cm	83.2	76.9	56
Complete stomach weight (gr)	1345	3580	415
Stomach content weight (gr)	875	3160	194

RESULTS

Size and stomach weights are shown in Table 1. Results of the identification of the items in each of the stomachs are shown in Table 2.

The main items found in the first San Andrés stomach were *Grateulopia doryphora* and *Ulva costata*. In the second stomach, *Prionitis decipiens* and *Ulva costata* were the most representative items. Conversely crustaceans and plastic materials were the main items found in the stomach coming from Chimbote.

Results from the Jaccard Similitude Matrix are shown in Table 3.

Table 2. Feeding items identification

	San Andrés Stomachs		Chimbote Stomach
Feeding Items	1	2	3
Prionitis decipiens	X	X	
Grateloupia doryphora	X	X	
Agardhiella tenera	X	X	
Pterosihonia dendroidea	X		
Gracielariopsis lemaneif	X	X	
Ulva costata	X	X	
Ulva sp.	X		
Cladophora sp.	X	X	
Bryopsis sp.	X	X	
n.n.1			X
n.n.2			X
goose-barnacle	X		
bivalve	X	X	
larva	X		
crustacean larva			X
crustacean eggs			X
crustacean			X
jellyfish			X
plastic			X
caoutchouc			X

DISCUSSION

The results obtained clearly show that that the diet from both the San Andrés turtles is basically the same (SJ=69.2%). The only difference is that four items more were found in one of the stomachs.

Taking into account all the items found in both localities, a similitude of 0.0% was found. This means that the feeding behavior differs markedly between San Andrés and Chimbote, as no common items were found.

Two algae species from the Chimbote stomach could not de identified due to their degree of decomposition. Some probability exists that the algae could belong to the same species as those found in the San Andrés stomachs. Taking this into account the similarity index could vary from 0 to 10.53%, which is still very low. Due to this, it can be ascertained that the feeding behavior of the turtles coming from both localities is strikingly different.

The feeding behavior of the Southeastern Pacific turtles is reported to be predominantly herbivorous. (National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998). The stomach contents from the San Andrés turtles are coincident with this, but not in the case of the Chimbote turtle. One of the reasons could be that they are 654 kilometers apart, but in order to confirm this, further investigations need to be conducted.

Another explanation could be that the San Andrés turtles are showing a normal feeding behavior. Due to the fact that their feeding grounds border the Paracas National Reserve, their habitat in not disturbed and it is also recognized one of the main feeding grounds for the green turtles in the South eastern Pacific (Marquez, 1990).

Data obtained from the stomach of Chimbote is showing the feeding behavior of a stressed individual due to the fact that it is coming from a highly contaminated and degraded area. The scarcity of food items could have conducted this turtle to ingest anything it considered as food, including crustaceans and even plastic bags (false medusa) changing from a specialist behavior to a generalist behavior.

Due to the fact that this investigation reports the behavior of only three stomachs (no more stomachs could be collected) further studies must be conducted in order to establish the feeding similarities between both localities, one considered as the main fishing area in the north of Peru and the other one exhibiting more than 30 years of commercial turtle meat trading.

CONCLUSIONS

The stomach contents of the two San Andrés turtles were essentially the same (SJ=69.2%). The only difference was that one stomach presented four more items than the other one. The most representative species for the San Andrés turtles were *Ulva costata*, *Grateloupia doryphora* and *Prionites decipiens*.

Food items from both localities were strikingly different (SJ=0 – 10.53%). Main items from the Chimbote turtle were of animal origin rather than of plant origin, as was the case for the San Andrés turtles.

Results are showing a normal and specialist feeding behavior for the San Andrés turtles due to the fact that they are coming from a high quality habitat and a stressed and generalist feeding behavior for the Chimbote turtle due to the fact that it is coming from a highly disturbed and contaminated area.

Table 3. Similitude Index Matrix.

	1	2	3
1	1	69.2	0
2		1	0
3			1

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SEA TURTLE NESTING, THREAT TO SURVIVAL AND CONSERVATION EFFORTS IN BANGLADESH

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ABSTRACT

Present study has been done since 1980 and surveys have been conducted on the beaches of more than 250 km at Cox's Bazar-Teknaf, St.Martin's Island, Chittagong-Cox's Bazar, Moheshkhali, Sonadia, Kutubdia islands, Dublar char(islet) and Katka in the Sundarbans mangrove forests and scattered offshore islands and islets e.g. Hatyia, Kukri-mukri, Dhal,.Dighol, etc. in the coast of Bay of Bengal along the southern fringe of Bangladesh.

Among these beaches Cox's bazar-Teknasf, St. Martin's Island are the longest ones. Muddy beaches are available interior of the Sundabans forests and Maheshkhali island, and stony beaches occur to some parts of St. Martin's Island and Inani, Cox's Bazar and rest of the beaches are sandy preferable for sea turtle nesting.

METHODOLOGY

Nesting grounds were studied on foot and offshore islands and water by mechanical vessels between October and February in every year. The rest of months were not worked continuously due to rough of the sea and bad climatic condition like frequent cyclone, thunder storm, tidal surge, etc.

For searching the turtle nests spotlight and torchlight were used at night during visiting the nesting beaches. While a nest was detected, measurement of. diameter and depth of nest and condition of nesting ground and distance from the seawater, etc. were recorded accurately wherever possible. The number, weight and measurement of length and diameter of eggs were taken and recorded in data sheets one for each nest. Identified nests were marked by fixing sticks with a serial number, date, time and even with number of eggs of each nest and also marked on study area maps. Usually spring balance and electric balance were used where possible for measuring the eggs and young. Soil temperature of nesting beaches was also determined in some cases. Eggs of some nests were collected and then buried in selected beach areas for estimating of incubation period, hatching date, time and breeding success. Species of sea turtles were identified on the spots in the field experiences and then confirmed from the illustrated literature and museum specimens wherever necessary. When a gravid turtle was found in the nesting ground it was observed closely from a limited distance without disturbing the turtle until she completes laying and safe returns to the sea. Noticeable activities and behavior were recorded either in a micro recorder or on a notebook according to the suitability.

RESULTS

Green turtle (*Chelonia mydas*), Olive Ridley turtle (*Lepidochelys olivacea*), Hawksbill (*Caretta caretta*), Loggerhead (*Eretmochelys imbricata*), Leatherback (*Dermochelys coriacea*) and River terrapin (*Batagur baska*) are known to occur in the offshore water of the Bay of Bengal along the southern land mass of Bangladesh. Of these, Olive Ridley is commonly bred, Green turtle and Leatherback few, River therpin seems to breed and Loggerhead is yet confirming to breed in Bangladesh coast. Leatherback is recently recorded to breed on the beach at Inani of Cox's Bazar. A dead leatherback was seen in the sea at St. Martin's Island. Batagur is only known to breeds in the brackish water areas of the Sundarbans and adjacent islets areas. Regarding nesting sites, St. Martin's Island was commonly used. The island is mostly suitable for the nesting of sea turtles because of its isolated location in the Bay of Bengal about 10 km away from the main land mass- the Teknaf Peninsula. Seaweed, living corals, less disturbance in the beach areas at night and shallow water area are also attracted the turtles for nesting there. Beach of Cox's Bazar-Teknaf is the second choice of sea turtles e.g. Olive Ridley for nesting. In 1999 one Leatherback was reported to lay about 300 eggs in a nest. Although the turtles was allowed to return to sea after heavy physical torture like riding on her by several people for many times. All eggs were collected ,sold and devoured by local people. Approximate 50 nests of Olive Ridley, 5 nests of green turtle and a few nests of hawk bills were reported and recorded from St. Martin's Island. About 35.nests of Olive Ridley, 3 nests of green turtle and 1 nest of leatherback were reported and observed on the beach of Cox's bazar-Teknaf.

About 100 nests of Olive Ridley, 10 nests of Batagur, 7 nests of green turtle and few nests of hawk bill were reported and recorded in the brakishwater areas of the Sundarbans and adjacent areas including scattered islands and islets. Nesting and species status of all sea turtles are not sufficiently known in the other beaches of Bangladesh. Further study in this regard is mostly essential.

Clutch sizes varied from 50-165 in *L. olivacea*, 90-125 *C. mydas*, and 250-375 in *D. coriacea*. Incubation period was recorded 55 days in O.*olivacea*.
Breeding season of sea turtles in Bangladesh coast is comparatively lengthy one and it varies from beach to beach due to ecological and climatic condition. Average breeding range observed six months from early October to the late April even to May in few cases. Early nesting was recorded on the beaches of St. Martin's island and Cox's Bazar-Teknaf and late nesting in the Sundarbans' areas. Reason of such variation is not clearly known. It seems that oceanic temperature, rainfall, turbidity, salinity, water depth, food availability, etc would be the main factors for such nesting periodic variation.

Threat and Problems

Both biotic and abiotic factors are responsible for destruction of nests, eggs, young and female sea turtles along the beaches of Bangladesh.

Destroying of eggs and killing of females were the major threats for the breeding of the sea turtles in the coast of Bangladesh. At night local Hindu, tribal and professional people search systematically on the beaches with the help of torchlight for nests and wait at strategic points for female turtles which come for nesting and eggs laying. On finding nest they digging out nests to collect all eggs for sale in local or mainland markets and are consumed by them.

Fishing permits are issued for random fishing particularly in the Sundarbans in winter between September to mid February and then it is stopped or limited due to bad climate. Besides, fishing is also going on in other coastal areas along the beaches except St. Martin's Island where it has been done in summer rather than winter. Fishing particulaly in winter months causes a great impact on turtles' nesting.

In coastal water along the beach of Cox's Bazar-Teknaf random fishing going on year round, fishermen throw out the young jelly fishes on the sandy beach where they died all. The jelly fish seem to cause food shortage of sea turtles. Sometimes, fishermen kept the fishing nets over night in coastal water along the beaches and it obstructing the movement of breeding turtles for nesting.

Local people use sand for collecting molluscs from sand of Cox's Bazar-Teknaf beach by filtrating through the sieves for supplying to the hatcheries and poultry farms as food and thus destroyed the nesting habitats of turtles and brake down the ecosystem there. Direct human disturbances of the turtles by day night fishing along the beaches.

Local people collect shrimp fry in shallow water areas along the beaches for sale to the shrimp hatcheries causing heavy disturbances and shortage of food of the turtles when they move in shallow water areas for nesting.

Professional collectors dive in shallow water during low tide and in winter months to collecting molluscs, corals and sea weeds for commercial purpose which create a great disturbance for nesting activities of sea turtles as well as destroy the environmental condition of nesting habitat.

Tourists also create a great concerned for turtle as they move in the beaches even at mid night and early part of dawn when the female turtles used to nests and laying of eggs. Domestic elephants and horses are used to ride by the tourists in the beaches destroy the fresh nests and eggs by heavy pressure of elephant's feet and also high speed motor vehicles.

Anchoring of commercial ships, ferry, fishing and other boats at and adjacent the nesting sites cause disturbances to the gravid female turtles from nesting there. Besides these, domestic dogs, Jackals, foxes, wild boars, gulls, birds of prey, monitor lizards, etc. also contribute a great extent in destroying the turtles eggs and newly hatched young. It is also observed that the wild boars move in batches of 2-5 individuals on the beaches of the Sundarbans and quickly dig out nests and devour eggs on their way. Development activities like construction of embankment by collecting the huge number of boulders from the offshore areas at the St. Martin's Island obstructed the turtles nesting and destroy nesting habitat.

Use of organic chemical e.g. rotenol which causing dead of fishes in certain areas along the beaches may cause certainly impacts on nesting sea turtles at least during nesting season. Oil spills from the ships and other sea going vessels cause great pollution of coastal water which threat to beaches, nests, incubation and development of embryos, eggs and young of sea turtle. Drainage of agro-chemicals and sediments from mainland and hills into sea coast may cause the same impacts.

A large number of female sea turtles is captured by professional catchers during nesting. And keep them in ditches from where they transfer to mainland and finally are sold in the local open markets at Taka 50-60 per kg.
During fishing when a turtle is entangled in the net, fishermen collect it for sale or consumption instead of releasing them to the sea.

Domestic dogs sometimes killed female turtles on beaches during nesting by repeated biting and obstructing them to return to the sea. Sometimes physical barriers like boulders, embankments, etc may cause dead of turtles due to exhaustness after eggs laying obstruction.

Conservation Issues

Conservation of nesting habitats along the coast of Bangladesh is mostly essential. Potential nesting beaches like St. Martin's, Cox's Bazar-Teknaf, Sundarbans would be declared as protected areas. Well trained patrol guards need to be posted to protect the nesting grounds to minimize all possible disturbances at least during breeding period. Circulation of sea vessels, fishing, etc in and adjacent turtle nesting areas should be stopped.

Sea turtle hatcheries should be established at nesting potential areas like St. Martin's Island, Inani and Sundarban forests for collection, incubation of eggs, hatching and releasing of young to the sea.

Local communities should be incorporated in conservation planning and management programmes so that they get economic benefit and can be deviated from to indulging anti turtle breeding activities. Creation of educational awareness would be more fruitful for protecting the sea turtle in coastal areas.

Detailed scientific investigation on the breeding biology, nesting habitat, threats, problems and conservation issues is also required for breeding success and protection of sea turtles of Bangladesh. Cooperation of international conservation organizations is mostly essential in this regard.

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SEX RATIOS OF GREEN TURTLE HATCHLINGS (*CHELONIA MYDAS*) OF SARAWAK TURTLE ISLANDS, SARAWAK, MALAYSIA

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ABSTRACT

A study on sex ratios of green turtle hatchlings incubated under different incubation conditions in Sarawak Turtle Islands was conducted from April 1999 to April 2000. The results indicate that seasonal changes in the sex ratios of the hatchlings occur, with more males being produced during the wetter and cooler monsoon season (April to September). During the dry season, in situ nests produced 60.8%, 59.9% and 51.3% female hatchlings in Pulau Talang Talang Kecil, Pulau Talang Talang Besar and Pulau Satang Besar respectively. The results also indicated that sex ratio of hatchlings incubated in the beach hatcheries were biased towards females compared to in situ nests (86% in Pulau Talang Talang Kecil, 80% in Pulau Talang Talang Besar and 96% in Pulau Satang Besar). Estimates of overall natural sex ratio and pivotal temperatures were also determined in the study.

INTRODUCTION

Turtle eggs have been exploited for consumption for more than 150 years in Sarawak. However, turtle conservation efforts have only been actively pursued since 1951. A hatchery program was established and some eggs replanted in hatcheries.

Turtle nesting in Sarawak has declined from 23,000 (1950) to 1,898 (1998) nests per year. Hatching success have fluctuated from 55.3% (1997) to 96.0% (1976) (Bennett et al. 1996). Pulau Talang Talang Besar showed that only 6.3%~13.8% male and 81.3% ~ 91.3% female hatchlings were produced under hatchery incubation (Leh, 1985). In 1998, another study conducted in Pulau Talang Talang Kecil showed that the hatchery produced 94% female hatchlings compared to natural green turtle nests (71%) (Chai, 1999).

Mortimer (1990) and Limpus (1991) recommended that egg clutches must be allowed to hatch naturally to enhance natural sex ratio. However, Chai (1999) found that 63% of the in situ nests were destroyed or disturbed by turtle nesting activities. As predation and other mortality factors are problematic, artificial incubation in the Sarawak may be necessary. Therefore, knowing the natural sex ratio production from such beaches is very important as a yardstick for conservation management.

On a natural beach, the situation is far more complex due to dynamic environmental change and location of the nests. Favourable sex ratios may be obtained from different thermal zones at the beach or from a single breeding unit comprising from different breeding nesting beaches. Consequently, a long term study is important to cover the full seasonal profile and thermal regimes to provide a conservation guideline.

STUDY SITES AND METHODOLOGY

This study was conducted at the Sarawak Turtle Islands (Pulau Talang Talang Kecil, Pulau Talang Talang Besar and Pulau Satang Besar) from April 1999 to April 2000. Throughout the study, sand and nests temperatures were measured using temperature data loggers (VEMCO Minilog-T V2.10). The beach was divided into open and shaded zone. Probes were deployed at transects 20-m apart along the beach for temperature measurements. Every month, one nest was selected from each zone and split equally. Half of the eggs were incubated as in situ nest and the other half incubated in the hatchery. One nest per month also split for open and shaded hatchery incubation. During the monsoon season, eggs were also incubated in styrofoam boxes for sex ratio studies. Temperature probes were placed at the middle of the egg chamber for temperature measurement throughout the study. After emergence, 15 hatchlings were sampled from each experimental nest for sex determination.

RESULTS AND DISCUSSION

Throughout this study, a distinct thermal difference between the open and shaded zones was observed where the average sand temperatures of the open beach was higher than the shaded zone by not more than 3^{o}C.

Figure 1. Relationship between mean middle trimester incubation temperature and percentage of female hatchlings under different incubation methods in Pulau Talang Talang Kecil.

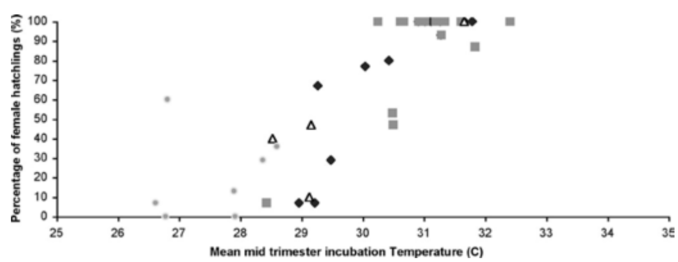
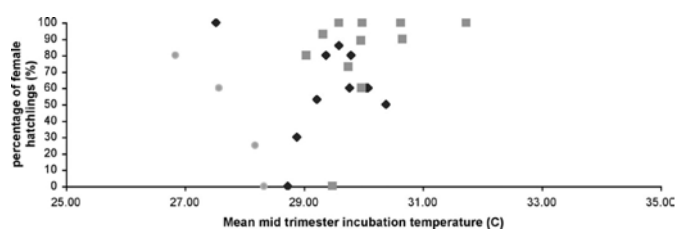


Figure 2. Relationship between mean middle trimester incubation temperature and percentage of female hatchlings under different incubation methods in Pulau Talang Talang Besar.



During the dry season (April to October 1999), the percentage of female hatchlings produced in the open beach in Pulau Talang Talang Kecil was 95% compared to 98% in the shaded zone (Table 1). Pulau Satang Besar recorded the production of 99% of female hatchlings on the open beach, while the shaded portion produced 85% females (Table 2). Percentage of females hatchlings decreased during the monsoon season. In Pulau Talang Talang Kecil, it was found that 5% of female hatchlings were produced in open beach compared with 2% in the shaded zone (Table 1). Pulau Satang Besar recorded 1% and 15% of female hatchlings produced in shaded and open beach during the wet season. (Table 2). In Pulau Talang Talang Besar, 60% of female hatchlings were produced in the open beach during the dry season. No data was collected during the monsoon season due to inundation and tides problems.

Figure 3. Relationship between mean middle trimester incubation temperature and percentage of female hatchlings under different incubation methods in Pulau Satang Besar.

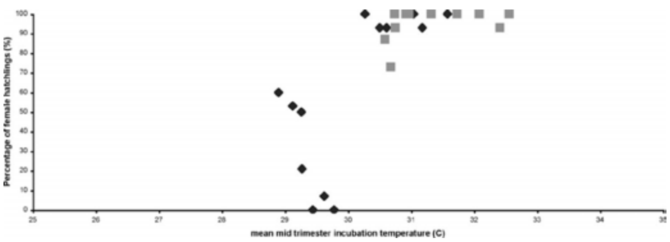


Table 3 showed the average nests temperature and sex ratios of hatchlings under different incubation methods in Sarawak Turtle Islands. The percentage of female hatchlings produced in the hatcheries in Pulau Talang Talang Kecil (Figure 1) and Pulau Satang Besar (Figure 3) were strongly female biased. In Pulau Talang Talang Kecil and Pulau Satang Besar, 87% and 96% female hatchlings were produced in the hatcheries respectively. The hatchery, shaded by plastic polymesh, produced 1:1 (female: male) sex ratios in the dry season due to insulation effect. The styrofoam box incubation produced 20% and 41% female hatchlings in Pulau Talang Talang Kecil and Pulau Talang Talang Besar respectively. No significant difference was found in female production between in situ and hatchery incubation in Pulau Talang Talang Besar (Figure 2).

Table 1. Summary of the green turtle hatchling sex ratios that would have been hypothetically produced from Pulau Talang Talang Kecil (From April 1999 to March 2000).

Season	Open beach nests (Female : Male)	Shaded beach nests (Female: Male)	Total (Female Male)
Dry Season (Apr-Oct) 62.7% from total nests	53197 : 9073 (95% : 84%)	7667 : 1924 (98% : 93%)	60864: 10997 (72% :85%)
Wet Season (Nov – Mar) 64% from total nests.	2551 : 1695 (5% : 16%)	99 : 140 (2% : 7%)	2650 : 1835 (28% : 15%)
Total 74% from total nests	55746 : 10768 (73% : 14%)	7766 : 2064 (10% : 2%)	63514 : 12832 (83% : 17%)

*Values in parenthesis represent percentage of the total.

Table 2. Summary of the green turtle hatchling sex ratios that would have been hypothetically produced from Pulau Satang Besar (From April 1999 to March 2000).

Season	Open beach nests (Female : Male)	Shaded beach nests (Female: Male)	Total (Female Male)
Dry Season (Apr-Oct) 73.0% from total nests	6093 : 5529 (99% : 99%)	755 : 975 (85% : 95%)	6848: 6504 (97% : 99%)
Wet Season (Nov – Mar) 20% from total nests.	56 : 10 (1% : 1%)	139 : 47 (15% : 5%)	195 : 57 (3% : 1%)
Total 83% from total nests	6149 : 5539 (45% : 40%)	894 : 1022 (6% : 7%)	7043 : 6561 (51% : 49%)

*Values in parenthesis represent percentage of the total.

The pivotal temperature for green turtle population nesting in Pulau Talang Talang Kecil and Pulau Satang Besar was calculated to be 29.60°C and 29.32O^C respectively. Pivotal temperature was not calculated for Pulau Talang Talang Besar due to incomplete data.

Table 3. Average nest temperature and sex ratios of green hatchlings under different incubation methods in Sarawak Turtle Islands. (Average + Standard Deviation).

Pulau Talang Talang Kecil	Duration	Hat. Succ.	Tri. T°C	% Female	% Male
In situ	55.7 ± 5.93	63.8 ± 28.3	30.50 ± 0.99	60.80	39.20
Open Hatchery	51.4 ± 2.16	70.8 ± 30.71	30.93 ± 0.87	86.69	13.31
Shaded Hatchery	60.5 ± 1.91	57.7 ± 37.3	29.62 ± 1.39	49.53	50.75
Styrofoam Box	64.5 ± 2.70	77.1 ± 10.44	27.57 ± 0.82	20.71	73.79

Pulau Talang Talang Besar	Duration	Hat. Succ.	Tri. T°C	% Female	% Male
In situ	60.2 ± 5.60	60.0 ± 33.33	29.40 ± 0.80	59.91	40.09
Hatchery	55.0 ± 2.43	63.8 ± 30.71	30.01 ± 0.76	80.46	19.54
Styrofoam Box	57.7 ± 5.68	86.6 ± 7.28	27.73 ± 0.68	41.25	58.75

Pulau Satang Besar	Duration	Hat. Succ.	Tri. T°C	% Female	% Male
In situ	58.4 ± 6.41	74.9 ± 22.37	30.04 ± 0.88	51.33	48.67
Hatchery	50.7 ± 2.05	75.3 ± 12.91	31.31 ± 0.71	95.5	4.50

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FIRST DATA ON THE NORTH ADRIATIC *CARETTA CARETTA* EPIBIONT COMMUNITY

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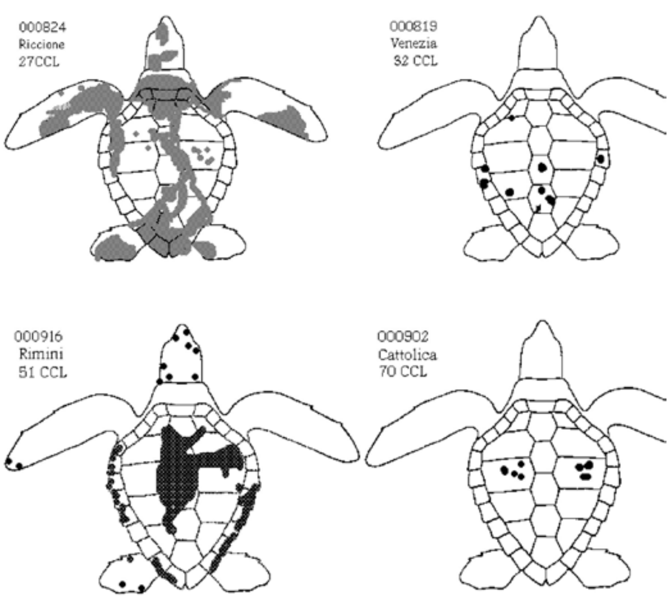
At the Fondazione Cetacea a project on the epibiont community of the North Adriatic *Caretta caretta* is ongoing. Every year some dozens of live or dead specimens are collected along the Emilia-Romagna shore and sent to the turtle hospital and research center in Riccione (Meotti et al. 1995). Currently there are two rescue points: one at the Delphinursery in Cattolica, the so-called "Turtle Hospital" with a 3600-liter pool, and a new 3-pool system (each pool measuring 200 cm x 110 cm x 80 cm) at the Delphinarium in Riccione. During the last decade, 135 *Caretta caretta* were hosted. One hundred and ten specimens have been released, and eight are currently under treatment. Each animal is treated by routine medical protocol and follows feeding schemes. Moreover, a ultrasound investigations on hosted animals are carried out to determine the different pathologies (Fedrigo et al. 1999).

After starting and discontinuous collections, in 1999 a specific research project was established in order to achieve a better knowledge of epibiont presence on the loggerheads. The epibiont form a diversified community and the main taxa are represented by barnacles with a massive presence of *Chelonibia testudinaria* (Linnaeus, 1758). Other species are *Lepas hilli* (Leach, 1818), *Platylepas hexastylos* (Fabricius, 1798), *Stomatolepas elegans* (O.G. Costa, 1838).

Chelonibia testudinaria is the most frequent epibiont found on the turtles. About the 85% of the loggerheads have a least some of these barnacles. A large number of subadults have been collected in the last three years with hundreds of *Chelonibia*, covering carapaces and heads.

Figure 1. Localization of *Chelonibia testudinaria* on some typical Adriatic loggerheads.



One turtle with a barnacle in one nostril and other two with specimens on eyes have been also recordered. We collected 12 loggerheads of 27-45 cm CCL with 120 to 165 *Chelonibia* each. The largest crustacean had the elliptical walls of about 50 x 42 mm. Favorite sites were on vertebral and pleural scutes. In some cases, when barnacles were present in large number, they also covered marginal scutes and grew in distorted way to follow the edge of the carapace. On large barnacles we found also algae, Bivalvia (*Mytilus* spp.) and small *Chelonibia* growing on the walls or in the radii.

Lepas hilli is the only Lepanidae determined in the turtle samples. The crustaceans were found in turtles of 22-85 cm CCL. The total length of collected specimens ranged from 7 to 60 mm.

One to five specimens at various growth stages were found on each turtle. There is no correlation between the CCL and length of the Lepanidae. In fact, we collected small specimens from an adult loggerhead and, for example, 3 crustacean of 53, 42 and 28 mm on a young individual of 22 cm CCL. All the specimens were located on the caudal part of the carapace or on the anal scutes, as show in Figure 2.

Stomatolepas elegans was collected on at least 12 loggerheads, with a CCL ranging from 45 to 85 cm. The specimens were typically located on throat, shoulder and flank skin, joint in groups of 12 to 40 individuals joint together, each one measuring of 5 to 9 mm. This crustacean has been already reported for *C. caretta* in central and east Mediterranean areas (Relini 1980, Frazier et al 1985) but not for Sicily channel (Gramentz 1988).

Platylepas hexastylos was also collected on about the 10% of the loggerheads. This epibionts is are localized on the skin of throat, shoulder and flanks and rarely on anal and marginal scutes (Figure 3). The maximum diameter of collected specimens ranged from 3 to 18 mm. The species was already quoted for C.*caretta* in Mediterranean (cfr. Relini 1980, Frazier et al 1985).

In comparison with other researches (cfr. Frazier et al. 1985, Dodd 1988, Gramentz 1988), the Adriatic community sampled appears to have a lower diversity. The large number of young and subadults loggerheads in the sample may be an explanation. At least 5 cases of turtles of not more than 35 cm CCL were found with the whole carapace covered by barnacles except for the second and third vertebral plates due to the temporary exposure to air and sun. Some other epibionts are currently under study. In few cases we found groups of Serpulidae on adult specimens, associated with algae and dense groups of *Chelonibia* on the posterior part of the carapace. Irudinea are very rare with two cases of *Ozobranchus margoi* as well as the presence of only two samples of Caprellidae.

Figure 2. Localization of *Lepas hilli*.

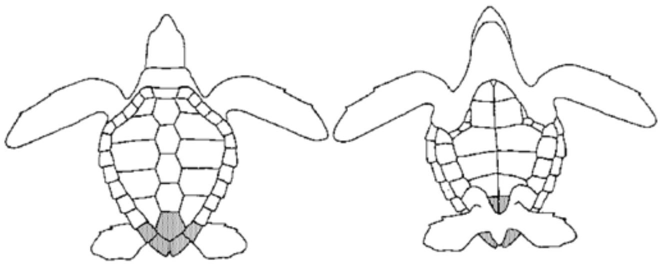
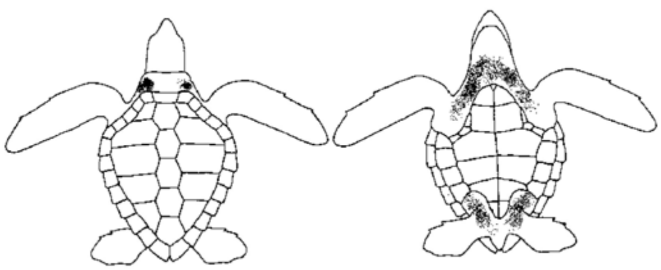


Figure 3. Localisation of *P. hexastylos* and *S. elegans*.



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FLORIDA MARINE CHELONIAN ZOOARCHEOLOGY AND ETHNOZOOLOGY

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INTRODUCTION

Marine chelonian zooarcheology is the archeological study of the remains of oceanic testaceous reptiles. It can illuminate the interrelationships of prehistoric people and chelonians, as well as provide insight into past patterns of human utilization of turtles in their diets and belief systems (Bogan and Robison, 1987; Reitz and Wing, 1999). Seasonal abundance and movement of turtles can provide a basis upon which to theorize migration of native groups and occupancy of particular sites (Rhodin, 1986; 1995). Chelonian populations or distributions and changes in the region's ecology may be extrapolated from the data obtained in zooarchaeological research. Specifically, Hawksbills apparently found commonly in prehistoric southwest Florida are not currently abundant. Primary problems inherent in this approach are: incomplete or inaccurate identifications; lack of detailed faunal analysis; loss of material through screening biases and soil acidity; submergence of early coastal sites; and inaccessibility of the data due to a terminology differences and simple lack of indexing. Many other researchers do not specify how the identification was performed (geographical range, comparative collections or morphometrics) (Baker and Shaffer, 1999). As many archaeological sites contain turtle remains (Larson, 1980), the identity and condition of the faunal material can provide information regarding past subsistence utilization and human environmental impact (Adler, 1968; 1970; Reitz and Wing, 1999). Hunting, fishing and preparation methods may be determined in many cases from the condition of the remains. Food, ornamental or utilitarian use of sea turtles was common in prehistoric Florida. Some substantial evidence, particularly as regards Hawksbills, exists for a sea turtle industry in southwest Florida (Fairbanks, 1959; Wing, 1977) with trade extending far up the coastal plain (Larson, 1993). Regional biotic factors may also have a great deal of influence on the culture of the inhabitants. Diverse cultural patterns once linked many indigenous coastal and island societies to sea turtles (Nietschmann, 1981). There are many ethnozoologic examples of this with respect to spiritual views, mythology, effigies and folklore.

MATERIALS AND METHODS

An extensive, but by no means complete survey of archeological sites in Florida was completed utilizing a formal literature search, supplemented by a manual search of unindexed journals and other publications deemed likely to contain coverage with this subject. An unusually large and complete sample of faunal material from throughout the state was located at the Florida Museum of Natural History at Gainesville. Manual examination of this material, representing a large number of sites, was performed and photographs were taken for documentation. Photographic findings from the literature were scrutinized in a similar manner. Comparison identification was accomplished utilizing a variety of osteological works.

RESULTS

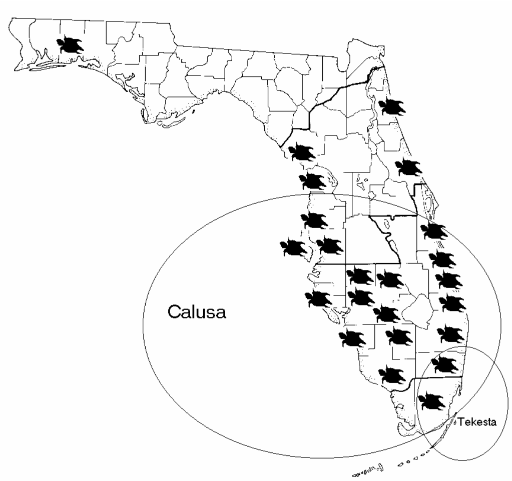
Sea turtle faunal material is found sporadically up the east coast.

The majority of sites identified were in south Florida, with intensive concentrations in the southwest area of the state. Two Florida groups, the Tekesta in a small portion of the southeast and the Calusa in a large area of the south seemed to account for these samples (Milanich, 1994; Powell, 1999) (Fig. 1). Another group, the Timucua, in northeast Florida, had access to marine turtles as a resource, yet their remains were not well represented in middens (Reitz and Scarry, 1985).

Screening biases (Wing, pers. comm.) and submergence of early coastal sites (U.S. Dept. Int., 1984) can limit accessibility to skeletal material. Terminology differences, lack of good identification texts, incorrect or incomplete identification, and simple indexing can remove finds from a researcher's reach. While the FMNH catalog was found to be accurate, other classifications are believed to be in error. Embellished early ethnographic material can lend credibility to practices where none exist (Fundaburk, 1969) (Fig. 2).

Figure 1: (right) Primary Calusa and Tekesta territory & sites with significant sea turtle remains.

Figure 2: "Their manner of fishynge in Virginia" as originally drawn by White in 1585 (left) and as redrawn by DeBry in 1590 (right).



DISCUSSION

The Calusa were a complex hunter-gatherer group in South Florida with an advanced social formation as a chiefdom or an early state (Marquardt, 1987). For them, the marine and estuarine bounty served as a proxy for agriculture. Particularly, the Calusa artifacts are significant relative to chelonian ethnozoology, attributing a strong spiritual importance to the Hawksbill as evidenced by the use of its shell and scutes in objects of religious. Ritual regalia crafted of "Tortoiseshell" in Calusa design have not only been found in their area of influence, but also as far as the Etowah site in Northern Georgia (Larson, 1993)(Fig 3). Turtles in funerary contexts are very important. They believed that a person's three souls resided in: their eyes, their reflection in water, and their body (Zubillaga, 1946). Calusa burial mounds and charnel houses (containing the bodies of the dead), located on islands in lakes (calm reflective water) within their man-made shell mounds, were always guarded with the figures of turtles. The protruding eyes of the Calusa sea turtle figurehead (Fig. 4) may be symbolic in their function as keepers of the soul and appeasing the dead (Widmer, 1988). This may aid in understanding the turtle effigies found elsewhere in Florida at Fort Center and Hontoon Island in funerary locations. The Tekesta site at the Miami Circle also included a complete sea turtle carapace aligned east to west in a practice associated with human burials (Miami-Dade Parks, 1999). Cushing also noted that the masks found at Key Marco were found in twos and that the bear mask was associated with the turtle mask (Fig. 4). Bears where thought to live in two worlds (Hudson, 1985) as they walked on two legs and four. Perhaps turtles also lived in two worlds – that of air or land and that of water.

An unresolved issue concerns the utility of zooarchaeologic analysis relative to current population demographics. Fossil, archeological and current range must be examined to determine any impact. With the two former being the best baseline indication with several caveats. Turtle shells and material may have been traded to some extent so worked turtle shells at a site are not a positive indication of the range of a species (Adler, 1968a). These artifacts may have also been introduced through trade although this is usually true of items not found in the area such as shark's teeth, seashells, flint (Adler, 1970). It is unlikely that turtles were imported as food as other game species and turtles were locally abundant (Adler, 1968a). Other literature suggests that chelonians were transported and traded as food items (Baker and Shaffer, 1999). In regard to worked shell, it does appear that *Eretmochelys* shell was actively traded at least into northern Georgia (Larson, 1993). Factors, such as burning to clear crop lands or village sites, may also have had impacts. It is difficult to evaluate the population of indigenous peoples but it is generally considered that their influence on the ecology was significant (Day, 1953).

It is clear that hawksbills were harvested with sufficient regularity to imbed them in the ethnozoology of the Calusa (Fig. 4) in an area where they are extremely rare today. Could they have been overharvested to the extent that entire nesting colonies were extirpated? While it would be naive to imagine that primitive man accomplished this to the exclusion of all other factors, clearly some significant impact was made. And Florida is no stranger to this type of cheloniocide. Prehistoric Floridians are believed to have driven the native giant tortoises, *Geochelone crassiutata* and the largest members of the box turtle family, *Terrapene putnami* to extinction. This was especially true in the case of large terrestrial species with predictable habits and no real defense against man. It continues into modern time. Some scientists estimate that the gopher tortoise, *Gopherus polyphemus*, will be extinct within twenty five years. Though not terrestrial, sea turtles have the same predictable patterns and without major changes in conservation policy may not last much longer.

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Fig 2. Fundaburk, E. L. 1958. Southeastern Indians: Life Portraits.

Fig. 3. Larson, L. 1993. Archaeological Report no. 25. Fig.

4. (redrawn from) Smithsonian Institution. Neg. no.CS852126. Fig. 5. FLMNH Cat. No. A5538.

Figure 3: Calusa pins. *E. imbricata* on left.

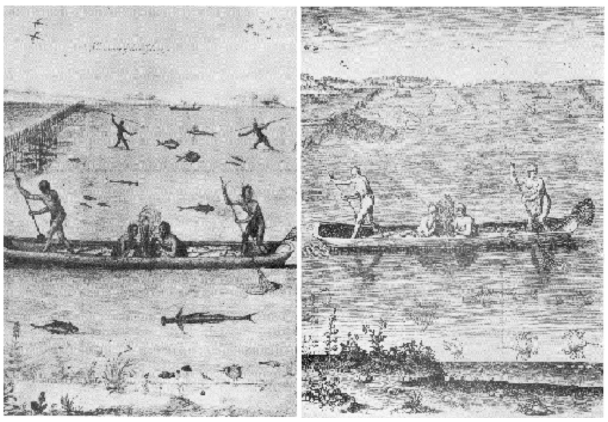
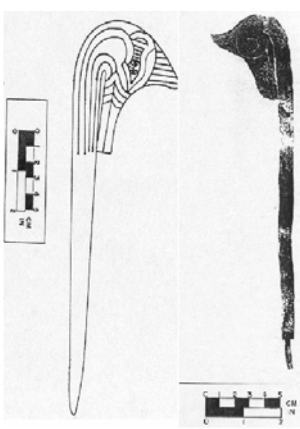


Figure 4: Calusa sea turtle figurehead (left) and Hawksbill Man Mask (right) from Marco Island.



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BEACH DENATURALISATION - THE EFFECTS ON NEST SITE LOCATION AND NESTING SUCCESS

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INTRODUCTION

One of the most complex challenges to long-term conservation of sea turtles is the changing habitat of coastal areas, via natural and anthropogenic processes. Threats to such habitats can be defined as any action or process that can alter sand substrate of a nesting beach, injure or kill sea turtles or their eggs and/or disrupt behaviour (Witherington, 1999). Worldwide research has proved that certain substrates (fine sand; silt and clay sediments; mixed sand sorting co-efficient) can negatively affect nesting and incubation success of nests. Furthermore, beach erosion, and sediment deposition can cause prime nesting areas to deteriorate.

Daphni is one of the six loggerhead nesting beaches in Laganas Bay, which are a part of the National Marine Park of Zakynthos. Daphni annually holds the second largest number of nests laid within the rookery. In order to calculate nesting value of Daphni over the last six years, these factors were assessed:

1) Nesting density and consistency (1984-2000)
2) Overall nesting success (all years) and on specific sub sectors (2000 only)
3) Nest location trends, for a particular subsector and between subsectors (1995-2000) on Daphni beach

CURRENT STATUS OF DAPHNI

Legislation protects 200 metres of land behind the beach (on a horizontal transect), prohibiting construction or land alteration. Since illegal human development has occurred on Daphni, its suitability as a nesting beach has been greatly reduced because soil and stones that are washed down on to the beach alter the beach substrate. The land has high levels of erosion due to shallow soils (of high silt and clay content), high rainfall intensity and steep slopes. This is further aggravated by deliberate fires and over grazing causing root loss, which has resulted in a mosaic landscape of low scrubs and medium height grasses with intermittent areas of denuded eroded ground.

In 2000, the beach perimeter was bulldozed, flattened, reshaped, native flora uprooted, shrubs and small trees cut, non native flora planted, and beach furniture were placed in lines from 1 (A-C, F-O, S-W) to 5 rows (O-S). All are activities against current legislation. Between sunset and sunrise it is prohibited to enter the beach or to use lights, yet the bars opened illegally at night, whose customers used lights and were encouraged to walk on the beach. The removal of vegetation camouflaging the illegal buildings also lit up the beach. Furthermore on the beach, beach furniture, boats, vehicles and rubbish are forbidden. Yet the beach was bulldozed in 2000 to clear sea grass, which was dumped with rubbish rendering 20 metres of beach futile for nesting.

METHODOLOGY

Since 1984, ARCHELON - the Sea Turtle Protection Society of Greece, annually collects monitoring information on the six major loggerhead nesting beaches in Laganas Bay. The data collected for Daphni included daily early 'morning surveys' from June to September. Since 1995, all hatched nests have been mapped with respect to 10-20 metre subsector poles concealed within the beach vegetation line. During the 2000 nesting season, the positions of all adult female emergences were also recorded with respect to these subsectors. Essential, observational material is also collected with respect to illegal development, illegal taverna operation, sun umbrella numbers on the beach and beach perimeter, tourist numbers, and areas of sediment deposition on the beach.

ANALYSIS AND CORRELATIONS OF THE COLLECTED DATA, 1995-2000

The data collected on Daphni suggest that it's value as a nesting beach is declining. Emergence success, nesting success and nesting density data depict a marked fall for Daphni from 1993-2000. The data further support the hypothesis that turtles are moving to alternative beaches to nest. Detailed data collected on Daphni beach between 1995 and 2000, indicate that on Daphni areas that the turtles used to nest have altered, and that this change has occurred in parallel with the destruction of prime areas of nesting beach as a result of human activity (Katselidis & Dimopoulos, 1999). The data also indicate that the 'new' areas used for nesting, prove to be of poorer quality producing poorer hatching success rates and greater embryonic mortality rates. Illegal human activities on the beach, on the beach perimeter and on the land behind the beach are believed to be responsible for these changes.

Between 1984-2000, the annual nesting number of the rookery maintained an overall plateau, whereas the number of nests held on Daphni is annually declining. Until 1993 Daphni annually held the second largest number of nests (on average 12%) with respect to the total number of nests laid within the rookery; in subsequent years (1994-2000) Daphni has held between 5th and 3rd position only. The data imply that turtles, in recent years, have begun using alternative nesting sites within the rookery. Except for Daphni, all other beaches in the rookery require an average of 3,5 emergences to successfully nest. Annually Daphni holds the lowest nesting success of the rookery, with turtles requiring an average of 6 emergences to nest. On Daphni between 1984-1992, an average of 5 emergences were needed to nest; between 1993-2000, this rose to an average of 6.5 emergences. The data indicates that while Daphni may have already been a difficult beach to nest on, development on the beach in the 1990's appears to have further affected nesting success rates.

The data clearly indicate that turtles 'preferentially' emerged in specific subsectors (i.e. AD, PS, SW). Some subsectors, like A-D held high emergence rates but low nesting success in 2000. Such regions until 2000 held significant numbers of nests, however in 2000 were heavily subjected to human activities. This table also shows that turtles are still emerging in formerly 'preferred' subsectors but with negligible success. A strong positive, negative or neutral correlation was noted between different subsectors, with markedly negative correlations arising in adjacent areas. Nest site location analysis between 1995-2000 revealed a significant shift away from subsectors: AD, OP, QR The data clearly indicate that turtles, over subsequent years have started nesting in new areas, including DE, GI, TW; in other words areas of beach which to date have received the least disturbance.

SUGGESTED MANAGEMENT METHODS FOR DAPHNI BEACH

To date, Daphni has fallen under the protection of several National Government Presidential Decrees. The formation of the National Marine Park should ensure that current legislation is enforced. It is suggested that the following environmental factors are monitored annually to establish and re-adjust management measures on Daphni:

· Develop programmes to monitor and control fire, grazing, trampling etc.
· Develop programmes to assist natural regeneration of affected land.
· Management of surface erosion to decrease the level erosion and land slides.
. Monitor effects of eroded material deposition on the beach.
o Maintain erosion control works of the 2 roads leading to Daphni.
o Continual re-assessment of vegetation cover of the beach & perimeter: beach front shape (at sea and vegetation line), beach profiles, clay and silt content, sediment inflow and outflow of the beach, dune system and land.
· Expansion of scientific monitoring and conservation. orientated research of the flora and fauna; in the hills, dunes, beach and surrounding reefs.
· Continual assessment of sea turtles: number of nests, nest distribution, nesting success, incubation time and hatching success and to define the boundaries of breeding aggregations.
· Public awareness & education liaison initiatives to involve the locals and alter their impact on the beach.
· Implement night curfew (7pm- 7am) as required by the NMPZ and ensure effective wardening.
· Implement effective beach cleaning so as not to lose nest sites.

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A BRIEF HISTORY OF SEA TURTLE COMMUNITIES, CONSERVATION AND CONSUMPTION IN BELIZE

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INTRODUCTION

The use of flipper tags and satellite transmitters has led to an increased knowledge of sea turtle migration patterns throughout the Caribbean. Numerous green turtles tagged while nesting in Costa Rica have been harvested in Belize waters. Turtles tagged in Cayman, Mexico and Florida have also been recaptured in Belize waters. Zenit, a green turtle that nested in Costa Rica in July 2000, was affixed with a satellite transmitter and migrated to Belize in less than one week. A hawksbill turtle tagged with a satellite transmitter in Antigua also migrated to waters offshore Belize. It is clear that the coastal waters and beaches of Belize play an important role in providing habitat for migrating sea turtles. Once these migratory sea turtles reach Belize what is there fate? Only by compiling detailed descriptions of sea turtle distribution, abundance and use can Belize begin to work with other nations in conserving sea turtle populations throughout the Caribbean.

METHODS

In October 2000, research began on the status and distribution of sea turtles in Belize. Literature reviews, interviews and market surveys were conducted. Literature that focused on countrywide surveys of distribution and use were examined. Informal interviews were conducted with divers, resort managers and fishermen. Surveys were carried out at two fish markets in Belize City during the open sea turtle season from November 1, 2000 through March 31, 2001. Information recorded included species, curved and straight carapace length and width, and sex.

RESULTS

Communities

Belize's beaches, sea grass beds, coral reefs and open ocean provide suitable nesting and foraging grounds for hawksbill, green, loggerhead and leatherback turtles. Surveys conducted by Miller (1984) and Gillett (1987) for the Western Atlantic Turtle Symposiums confirmed that sea turtles nest throughout Belize's coast and offshore cayes. In the late 1980s to early 1990s Greg Smith conducted seasonal surveys of nesting beaches and identified a key nesting beach for hawksbills at Manatee Bar and one for loggerheads on northern Ambergris Caye. Green turtle nests are occasionally observed in Belize, but not in the quantity in which they were once recorded (Smith, Eckert & Gibson 1992). There have been no recorded observations of leatherbacks nesting in Belize.

Fishermen, divers and offshore resort managers are important sources of information on sea turtle distribution and behavior. One fisherman reported seeing small turtles travelling at the surface inside the barrier reef. Another fisherman reported finding juvenile hawksbills in lobster pot funnels, getting trapped themselves while trying to feed on the lobster. Fishermen also describe an area that supports large populations of sea turtles that lies southeast Belize City. In fact, this is the same area where turtle fishermen capture most of the turtles that are sold at markets in Belize City and Dangriga. Most of the tags collected from fishermen are from turtles captured in this area, which indicates that the area may be an important foraging ground for migrating sea turtles. Leatherback turtles are rarely observed, but are occasionally sighted outside the barrier reef in deep water during blue water fishing tournaments. A juvenile about 25 cm long was found stranded on Ambergris Caye in February 2001, apparently succumbing to injuries from a propeller. About a decade ago an adult was reported to have been captured in a shrimp trawler that operates inside the reef along the Victoria Channel.

Divers often observe hawksbills, loggerheads and green turtles resting or cruising in 10-15 meters near the drop-off outside the barrier reef and atolls. Sea turtles are also often sighted floating at the surface, only to dive when approached. Divers also report certain dive sites where the same turtle can been encountered on a regular basis.

A resort manager at northern Blackbird Caye documented hawksbills that hatched in June 2000. The manager said he has seen turtles that attempt to nest, but since the beach is also made up of conch shells, the turtles are often unable to nest successfully at this site. Another manager on Tobacco Caye says that he witnessed 3 sets of hawksbill hatchlings during June 2000. The last time he observed hatchlings on Tobacco Caye was in the late 1980s.

Conservation

Centuries of unlimited harvest officially came to an end when sea turtles first received protection under the 1977 Fishery Regulations. The Government of Belize enacted a closed season from June 1 through August 31, prohibited the taking of eggs, banned the export of sea turtle products, and established the first size limits. Hawksbills and greens had to be greater than 50 pounds, while loggerheads had to be over 30 pounds.

In 1981 sea turtles were included in the draft Wildlife Protection Act, which would have given sea turtles full protection against harvest. Unfortunately, sea turtles were removed from the draft when it was noticed that they were listed and protected under the Fisheries Regulations of 1977.

During the early 1990s when the Sea Turtle Recovery Action Plan for Belize was being compiled, several local and international non-governmental organizations (NGOs) lobbied the government to improve legislation that conserved sea turtles. While a moratorium on sea turtle harvest was the preferred conservation measure, lobbyists settled on key changes that would halt the continued depletion of hawksbills, and offer protection to mating and nesting green and loggerhead turtles. In 1993 the Fisheries Regulations were amended. It was now illegal to capture hawksbills at any time, the closed season was extended by four months, and reproductive turtles gained protection. Under the amended legislation the season was now closed from April 1 through October 31, and only greens and loggerheads under 60 cm ccl could be harvested. These new size limits were completely opposite of the 1977 Fishery Regulations.

Current sea turtle conservation activities are carried out by individuals, NGOs, government departments, and national and regional networks. A veterinarian living on Ambergris Caye rehabilitated a loggerhead sea turtle and examined the stranded leatherback.

The Gales Point Manatee Project has conducted annual surveys of sea turtle nests at Manatee Bar since 1998. The nests are protected with cages and moved to higher ground if laid too close to the water line. During the 2000 nesting season 110 nests were recorded (Andrewin 2001). Data collected includes nest depth, clutch size, incubation period, and survival rate.

SYMBIOS initiated their Save A Sea Turtle (SAST) program in 2000. Supporters can make donations in order to purchase and release captured sea turtles. The turtles are tagged and measured prior to release. During the 2000-2001 turtle season five large female green turtles were saved. SYMBIOS is currently raising funds to use in saving sea turtles during the 2001-2002 season. SAST is also distributing Sea Turtle Sighting sheets to all resorts and dive shops in efforts to learn more about the current nesting and foraging activities of sea turtles in Belize.

In efforts to determine migration patterns of nesting hawksbill turtles, the Belize Fisheries Department, in conjunction with the United States National Marine Fisheries Service, affixed a satellite transmitter to a hawksbill turtle in September 2000. The hawksbill was found nesting at Gales Point and was later recorded near the Belize-Honduras border. The Fisheries Department will tag another hawksbill turtle during the 2001 nesting season. Public service announcements regarding turtle regulations are also made at the opening and closing of turtle season. The Bacalar Chico National Park and Marine Reserve which borders Mexico is scheduled to commence with beach surveys of nesting sea turtles during the 2001 season.

The National Sea Turtle Working Group has plans to implement the recommendations of the Sea Turtle Recovery Action Plan that was published in 1992. It is expected that they will form alliances with local NGOs to carry out objectives set forth in the plan. In October 2000 the 4th Regional Workshop for the Conservation of Sea Turtle in Central America was held in Belize. During the workshop participants visited the beach at Gales Point and prepared an action plan for the area.

Consumption

Hawksbills, loggerheads and green turtles are all consumed in Belize. Interviews and observations indicate that green turtles are preferred since they taste best. Presumably they taste better since they are herbivorous, as compared to loggerheads and hawksbills that eat crustaceans and sponges.

During the 2000-2001 market surveys the largest turtle measured 110 cm ccl and the smallest was 60 cm ccl. The size class range of landed green turtles during 2000-2001 reveal that 86.6% were greater than 80 cm ccl and 62.2 % were greater than 90 cm ccl. Of those assessed for sex, over 82% were females. Some turtles slaughtered at the market in December 2000 and January 2001 had small yellow eggs 2.5 cm in diameter.

Turtle harvest is dependent on weather since fishermen do not go out during storms or high wind. When they do return to Belize City with their catch they bring as many as six turtles to sell. Fishermen who harvest turtles then sell them to merchants at the market who sell them to consumers. One merchant said that he used to sell turtle meat to a freighter captain from Florida. Turtle meat is also sold illegally during the closed season as are other fishery products.

It appears that demand for turtle meat may have decreased, since market surveys revealed it would take several days to sell the meat from one large turtle. The Belizean people are divided about eating sea turtle. One older Mayan woman at the market said turtles belong in the sea. Some older members of the Creole and Garifuna cultures however feel the opposite. Catching and eating turtles has been an important part of their culture and as such they are reluctant to give it up. The majority of young Belizeans do not eat sea turtles.

DISCUSSION

Literature review indicated that the majority of studies on sea turtle nesting were conducted during the mid to late 1980s. Therefore, the data is over ten years old, and while an accurate estimate of sea turtle communities at that time, countrywide surveys of sea turtles need to be coordinated again to determine current population trends. Additionally, much of Belize's coastline remains uninhabited and no surveys have been conducted along some coastal areas and offshore cayes. The islands of Turneffe Atoll and coastal areas north of Manatee Bar and Belize City remain primarily uninhabited. The area southeast of Belize City where large numbers of green turtles are captured may prove to be invaluable for migrating turtles. If surveys could be done in these areas perhaps more key nesting beaches and foraging grounds for hawksbill, loggerhead, green and leatherback turtles could be identified. In order to determine how important and to what extent sea turtles utilize Belize's beaches and waters, the recommendations outlined in Gillett (1987) and Smith, Eckert and Gibson (1992) should be reevaluated and implemented.

One of the major problems facing sea turtle conservation in Belize is that fishermen and consumers are not knowledgeable of current regulations that govern sea turtle harvest. It appears that no significant educational campaign to inform the public about the change in size regulations was conducted after the Fisheries Regulations were amended in 1993. Most fishermen still believe that it is the smaller turtles that should not be harvested. In efforts to raise awareness about sea turtle legislation, an educational campaign should be conducted.

Additionally, enforcement of fishery regulations is a problem not only with turtles, but other species of commercial fishery products as well. Hawksbills are captured opportunistically, and landed sea turtles are often larger than the legal allowable size limit. Since there are only a few turtle fishermen who harvest sea turtles, they should be the focus of a special awareness campaign. When sea turtle legislation is reviewed turtle fishermen and merchants should also be included so they do not feel left out of a process that could have a significant effect on their traditional income.

Miller (1984) estimated country wide sea turtle landings in Belize during 1982 as 1005, and 250 for Belize City markets, or 25% of total landings. Gillett (1987) estimated country landings during 1986 as 979, with 308 turtles landed in Belize City markets, or 32% of total landings. Market surveys conducted at Belize City markets during the 2000-2001 sea turtle season estimated that 83 green turtles were landed (Searle 2001). If this figure is 25-32% of total landings, then an estimated 259-332 turtles were landed throughout Belize during the 2000-2001 season. This would represent a reduction of between 27-33% of the 1980 landing estimates.

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ANALYSES OF BLOOD CHEMISTRY IN LOGGERHEADS AND KEMP'S RIDLEY TURTLES DURING YEAR 1 OF SCDNR INDEX STUDY OFF SE USA

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During the summer of 2000, the South Carolina Department of Natural Resources completed the first of a three-year effort to inventory sea turtles in the coastal waters off South Carolina, Georgia, and northern Florida. Standard processing of each captured turtle included taking 10 length measurements, weight, and drawing blood to analyze for mtDNA, natural toxins, contaminants, immune response, and testosterone analyses. Additional blood samples were collected from 43 *Caretta caretta* and 2 *Lepidochelys kempii* for a comprehensive reptilian profile by ANTECH laboratories in Southaven, MS. Both phlebotomy slides and refrigerated 10-ml samples preserved with lithium heparin were taken. Data on 26 blood parameters from these turtles are compared with data from the International Species Information System and with published data from cold stunned turtles during the 1999-2000 winter. Variation in blood with size and weight appears minimal within the size range sampled.

The South Carolina Department of Natural Resources (SCDNR) completed the first of a three-year NMFS funded project to establish a scientifically valid index of abundance for the threatened loggerhead turtles and to collect data on the endangered Kemp’s ridley and green sea turtles that occur in the Atlantic Ocean off the southeastern United States. The project is being conducted utilizing shrimp trawlers towing two 20-m four seam nets with 16-cm mesh, without turtle excluder devices, at speeds of 1.3-1.5 m/s (2.5-3.0 knots). Tow times are limited to 30-minute bottom time with a maximum of 42 minutes doors in/ doors out of water. A 5-m trynet with 1.8-cm mesh is towed (15 minutes) in conjunction with each sampling effort to evaluate corresponding community biota. Sampling efforts are continuous on working days beginning one hour after sunrise and ceasing one hour before sunset. Fishery dependent (2) and independent (3) research vessels worked an area from Winyah Bay, SC to St. Augustine, Florida in nearshore waters 4.6-12.2 m deep. Total tows (851) over the study area resulted in a catch of 253 total turtles (including 7 observed escaping net); 218 loggerheads, 25 Kemp's ridleys and 3 greens were brought onboard for evaluation and work up. Geographical, meteorological, hydrological and community biota data were collected in conjunction with each sampling effort and turtle work up.

Collection efforts provided collaborating scientists at 10 cooperating institutions with opportunities to analyze sex ratios (testosterone levels), population structure (mtDNA), toxicant burdens (natural and anthropogenic), immunological responses and general health parameters (CBC and blood chemistry). Results of these data are described elsewhere in these abstracts (see Arendt et al. and Stender et al.).

Apparently healthy animals were then placed in a ”bleeding chair” for blood collection. The sampling site was prepared with Betadine solution and 20-30 ml of blood was collected from the dorsal cervical sinus. Blood was collected using 22 ga, 3.8 cm needles and 5 or 10 ml vacutainer tubes (serum, lithium heparin). Blood tubes were immediately placed upright in an ice bath and transported to the onboard lab. Onboard lab work for all animals collected included total protein analysis of plasma utilizing hand held refractometers (Westover RHC-200ATC) and hematocrit values using capillary tubes and an onboard microhematocrit centrifuge (5 minute centrifuge time).

Immediately after collection, whole blood (5 ml) was mixed in a lithium heparin vacutainer tube via gentle inversion (5x) and refrigerated. Prior to clotting, a blood sample from a serum tube was utilized in making blood smears for CBC; slides were air dried, dipped in fixative and stored at room temperature.

Turtles were selected for blood chemistry sampling based on ANTECH recommendations limiting samples to those animals collected during last 24 hours of cruise. Blood samples were submitted to ANTECH Diagnostics for Comprehensive Reptile Profile (biochemical analysis and CBC) from 43 loggerheads and 2 Kemp’s ridleys collected during year one of project.

ANTECH blood chemistry results were obtained utilizing Hitachi 747/711 instruments (colorimetric); CBC values were developed with manual evaluation of blood smears by ANTECH technicians to produce WBC and differential values.

Length-weight comparison of turtles selected for blood study (ANTECH) with the other turtles collected in year one demonstrates the ANTECH samples are representative of the group as a whole. Too few Kemp's ridleys were sampled to develop comparisons. In general, turtles appeared healthy both upon physical exam and in comparison to existing International Species Information System (ISIS) blood parameters. Variations in hematocrit values are noted when comparing SCDNR and ISIS data; SCDNR and NEAQ hematocrit values exhibit comparable values. Differences in total protein were noted when comparing SCDNR and ISIS values (Smith et al. 2000; Turnbull et al. 2000). New England Aquarium (NEAQ) turtles upon arrival more closely parallel ISIS values and NEAQ animals upon release aligned more closely with SCDNR values. ANTECH normal range for Blood Urea Nitrogen appears consistently lower than values reported for apparently healthy animals in SCDNR and ISIS studies.

Several factors must be considered when comparing values: captive vs. wild trawl-caught animals, sample size in database, and different techniques in processing samples. All of these factors can impact valid data comparisons. ISIS values were based on data from 2-38 loggerheads (Table 1) and 1-5 Kemp’s ridleys (Table 2). Increased samples will refine standard values. Designation of a standard procedure to process sea turtle blood may eliminate some of these problems. Comparison of field vs. ANTECH values for hematocrit and total protein are comparable, with few exceptions. Lower ANTECH hematocrit values may be due to hemolysis of red blood cells prior to processing. Of note, no eosinophils were recorded by ANTECH in any of samples submitted. One loggerhead sample was excluded from the values chart due to conflicting reported values in biochemical profile producing numerous extremes (excessive hemolysis reported).

Sampling in the second year will continue efforts to build a database of blood parameters for wild trawl-caught sea turtles. Time restrictions on blood sampling were problematic during year one. SCDNR and ANTECH will collaborate in year two to compare blood chemistry values of plasma stored for 1, 2, and 4 weeks in liquid nitrogen to samples submitted within 24 hours of collection.

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SEA TURTLES AND THE SERI TRIBE: BENEFITS OF THE PARA-ECOLOGO SEA TURTLE PROGRAM IN THE INFIERNILLO CHANNEL, GULF OF CALIFORNIA, MéXICO.

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The Seri, or Comáac, of the Sonoran coast and islands of the Gulf of California are one of the last groups able to withstand integration into western-derived cultures. The tribe has traditionally relied on sea turtles as both the food and cultural foundation of their communities (Felger and Moser 1985). The center of the Seri territory is the Canal Infiernillo, a narrow channel separating Tiburón Island from the coast of northwest Sonora. Populations of sea turtles, particularly green turtles, were historically abundant and the focus of organized turtle hunts and traditional ceremonies (Felger and Moser 1985, Felger and Moser 1987). Such events served to strengthen the cultural bond within Seri communities and provided opportunities for the teaching of traditional knowledge to the younger generation. However, over the last four decades, sea turtle populations in this region have experienced tremendous declines. The result has been a gradual shift away from reliance on sea turtles. Though ceremonies and tribal activities that embrace sea turtles continue on occasion, there has been a breakdown in the information exchange between elders and youths and a gradual loss in the wealth of Seri knowledge of sea turtles.

Concurrent with this decrease of sea turtle populations and loss of knowledge has been an increased threat to other components of the natural environment. Irresponsible and illegal fishing practices of external origins have led to a cascade of environmental impacts that are changing the seascape within this once pristine area. In response, there has been increased desire on the part of community members to protect and manage the natural resources within the Infiernillo Channel ecosystem.

In May of 1999 Seri elders and youths took part in a workshop encouraging information exchange between three generations of Seris and scientists from the United States and México (Nabhan et al. 1999). This program was designed to educate Seri youth about traditional sea turtle knowledge and current scientific information on sea turtles of the Gulf of California and provide a framework under which conservation measures could begin. This event was met with great enthusiasm and served as a launching point for the Para-Ecologo Program.

Para-Ecologo Program Goals

The overall goal of this collaborative program is to increase the awareness and participation of Seri Tribal members in Mexico's sea turtle conservation efforts. To achieve this goal there are four primary program activities:

1. Determine current status of sea turtles in the Infiernillo Channel
2. Identify human impacts on local sea turtle populations
3. Promote Seri participation in the collection and analysis of scientific data
4. Increase communication of tribal members with biologists and other conservation personnel in México.

Summary of Activities

Activity 1: Determining current status of sea turtles in the Infiernillo Channel

Field excursions were made during March, June, September, and December of 2000. Inclement weather prevented in-water capture efforts during both the March 2000 and June 2000 research trips. During the September and December we were successful at capturing a total of four turtles at the Campo Viboras seagrass pasture. In addition, we were able to see congregations of turtles at several of the imme or 'home' sites. The capture of an adult female green turtle bearing flipper tags from Michoacán Mexico was an especially exciting event during netting activities. This success was met with enthusiasm in the town of Punta Chueca and instigated the return of one additional Michoacán flipper tag that had been recovered from a green turtle during the previous year.

Activity 2: Identifying human impacts on local sea turtle populations

During our efforts to locate discarded carapaces in the Infiernillo channel study area we encountered 71 carapaces. This includes carapaces from 63 green turtles (*Chelonia mydas agassizii*), four loggerheads (*Caretta caretta*), and three hawksbills (*Eretmochelys imbricata*). Mean CCL of *E. imbricata* was 48.5 cm, mean CCL of *C. caretta* was 72.5 cm, and mean CCL of C. m. *agassizii* was 59.2 cm. Several of the carapaces bore scars consistent with capture by harpooning methods.

Activity 3: Seri participation in the collection and analysis of scientific data

Para-Ecologo team members have become proficient in all aspects of this research including measuring, weighing, photographing, data recording, and searching for discarded carapaces. In addition, group members organized data and created presentation materials for the Third Annual Conference of the Baja California Sea Turtle Group in Loreto, Baja California (January 2001; Lopez et al. unpubl. data).

Activity 4: Increased communication with biologists and other conservation personnel in México

To date, team members have visited research projects located in Bahía de los Angeles (J.A. Seminoff, PI) and Bahía Magdalena (W.J. Nichols, PI) on the Baja California peninsula. While at these sites participants learned about specific research strategies for different study sites and gained a wider perspective of how research in the Infiernillo compares to that in other areas of México. Seri community members have traveled to two sea turtle conferences in Loreto, Mexico (Nichols and Arcas, 2000; Nichols pers. comm.). The information exchange was highlighted by a formal presentation on the Current Status of Sea Turtles in the Infiernillo Channel by team members at the Third Annual Conference of the Baja

California Sea Turtle Group.

Future Conservation Goal

In the near future a primary goal of the Para-Ecologo Program will be the formation of a committee for the protection of sea turtles in the Seri territory. Nichols et al. (2000) and Bird and Nichols (this symposium) describe a landmark accord among community members in Baja California Sur that provides an ideal example of committee development for the protection of sea turtles. We hope to use the methods of this group as a template for the creation of a committee with similar goals in the in the Infiernillo Channel.

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DIVING PATTERNS OF GREEN TURTLES (*CHELONIA MYDAS AGASSIZII*) IN THE GULF OF CALIFORNIA

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Green turtles (a.k.a. black turtles), *Chelonia mydas agassizii*, use an assortment of coastal habitats in the Gulf of California, México (Seminoff 2000, Nichols 2001). Bahía de los Angeles of the north central Gulf is important as a developmental habitat for large immature turtles and as an adult feeding ground (Seminoff 2000). While resident to this area, green turtles are generally thought to move between specific foraging sites along shallow peninsular shores and resting sites in deeper offshore habitats. The foraging and movement patterns of turtles at this temperate habitat have been discussed (Seminoff 2000); however, the diel dive trends, diving depths, and time allocated to particular behaviors by green turtles are poorly understood.

In recent years there has been increasing use of Time-Depth Recorders (TDRs) for the study green sea turtle diving behavior (e.g., Hochscheid et al. 1999, Davis et al. 2000, Hays et al., 2000). By affixing these data logging devices to wild turtles researchers can monitor diving behaviors as animals interact with their natural surroundings. Use of TDRs depends largely on the ability to retrieve them after a prolonged interval so that data can be offloaded and analyzed. A great deal of dive information has been gathered in this manner at nesting sites and foraging areas where researchers maximize the likelihood of retrieval by carefully choosing animals and time periods for study. However, in many regions animals are very difficult to recapture thus hindering the utility of TDRs. Such is the case in the Gulf of California where decades of human impact and exploitation have resulted in sea turtles that are very difficult to approach and virtually impossible to target for recapture.

Mounting technology that automatically releases data recording systems from wild animals enables deployment without the need of recapture. This technology has been successfully used with carapace-mounted video cameras (Marshall unpubl. data, Seminoff et al. 2000) and appears promising for use with TDRs. This report describes the first use of automatic detaching TDR drogues and the first study of green turtle diving behavior in wild habitats the Gulf of California.

MATERIALS AND METHODS

Between June 1999 and August 2000 we deployed TDR systems on 9 green turtles at the Bahía de los Angeles. TDRs (MK-7, Wildlife Computers, Redmond, Washington) were seated in tubular-shaped syntactic foam drogues (20-cm length, 7-cm diameter). Data collection intervals were programmable and initiated by a salt-water switch. TDRs logged time-of-day, depth (resolution = 0.5 m), temperature (C), and light levels (lumens). All devices had integrated Very High Frequency radio (MOD 050, Telonics, Inc. Mesa, Arizona) and sonic (DT-96, Sonitronics, Tucson, Arizona) transmitters to enable recovery. Units weighed 0.5 kg out of water, but were slightly positively buoyant in water.

Because of a low likelihood of recapturing green turtles in this study, we used an automatic release mechanism consisting of two interlocking plates; one fixed to the turtle's carapace with a 5-minute quickset epoxy and the second attached to the TDR drogue with hose clamps. A screw-and-groove assembly linked the anterior portion of these plates. The rear portion was connected with a galvanic (Mg) link that, upon immersion in seawater, dissolved at a constant rate. Upon dissolving, a spring mechanism forced the rear of the top plate upwards, thereby disengaging the front portion. The slight buoyancy caused the units to float to the surface, thus enabling retrieval by conventional telemetry techniques.

RESULTS

Of the nine TDR deployments during this study, two devices were not recovered and one device detached prematurely. Here we report on the six remaining deployments.

Diurnal versus nocturnal dive duration and dive depth

For analysis of dive depth and dive duration, data are summarized by day (0500-1859 h) and night (1900-0459 h) periods of activity (Table 1). The maximum depth observed was 48.5 m. Mean dive duration was consistently greater during night hours. These differences were significant for all but Turtle 5 ($Z1=4.94$, $P<0.0001$; $Z3=4.80$, $P <0.0001$; $Z4= -2.56$, $P=0.01$, $Z5=1.31$, $P=0.19$).

Relationship between day and night dive depths was variable. The difference between mean day and night dives was significant only in the case of Turtle 1 ($Z1 = 5.59$, $P < 0.0001$; $Z3 = 1.21$, $P = 0.22$; $Z4 = 0.26$, $P = 0.78$, $Z5 = 1.87$, $P = 0.06$).

Resting dives

Data on resting dives are summarized in Table 2. We observed a mean of 38.8 (SE=3.81) resting dives per day. The mean time allocated to resting behavior per 24-h period was 8.59h, SE=0.72 (35.8%, SE=3.01). The mean resting depth mode was 10.35, SE=1.36 m (range = 7.5 – 13.5 m). There was no correlation between turtle size and mean resting mode ($R2 = 0.06$, $P >0.05$).

Daily surface activity

We define surface activity as the proportion of time that a turtle spent less than 2 m from the surface. We used the following equation to calculate this value for each dive cycle: Tsurface/(Tsurface + Tsubmerged) with a dive cycle defined as the time at surfacing from dive n to the time of surfacing from dive n+1. The mean time allocated to surface activity per 24-h period was 1.41 hours, SE=0.21 (5.87%, SE=0.88).

DISCUSSION AND CONCLUSIONS

Bahia de los Angeles provides habitat for large immature and adult green turtles. The range of water depths in this region enables a variety of diving behaviors. We saw all dive types during all periods of the 24-h cycle. However, the shorter length of day dives vs. night dives suggests that turtles are more active during day periods. Shorter dive duration is associated with foraging as opposed to resting dives (Lutcavage and Lutz 1997). Seminoff (2000) described bi-modal foraging and corresponding shuttling behavior that occurred during the early morning and late evening hours that would account for the shorter day dive duration observed here. Similarly, Bjorndal (1980) and Ogden et al. (1983) report that foraging and movements were more common during day periods for Caribbean green turtles.

Our assessment of daily time allocation for specific dive types was hindered by our inability to accurately distinguish foraging and shuttling dives. Thus we only quantified resting behavior and surface activity. In this study green turtles rested for a mean of 8.59 h d-1 (35.8 %). This is within the range reported for green turtles in both foraging (Davis et al. 2000) and inter-nesting (Hays et al. 2000) habitats.

Time allocated to surface activity likely included surface basking, surfacing intervals between dives, and shallow water foraging. We measured a surface activity proportion (5.87%) that was greater than that found for hawksbills (van Dam and Diez 1996), but considerably less than that reported for leatherbacks and loggerheads (see Lutcavage and Lutz 1997 for review).

As conservation of green sea turtles in the Gulf of California begins, data on dive behavior and time allocation can assist in our understanding of these endangered reptiles. By learning the dive depths achieved by these animals we can more adequately determine the potential effects of trawl fisheries and those that utilize bottom-nets. Further, our understanding of surface activity can help guide data analysis of future aerial survey techniques. Future study will involve longer deployments on a greater range of size classes to establish size-, sex-, and seasonal differences in green turtle dive behavior.

Table 1. Comparison of dive duration and depth for 4 green turtles. Diving data are grouped by day (0500-1859 h) and night (1900-0459 h) periods.

		Dive Duration (min)			Dive Depth (m)		
Turtle	Period	Mean (SE)	Range	n	Mean (SE)	Range	n
1	Day	11.3 (0.8)	1 - 24	112	9.5 (0.6)	5 - 46.5	112
	Night	19.5 (1.7)	4.5 - 42.5	25	19 (1.2)	5.5 - 37	25
3	Day	10.21 (0.2)	0.3 - 34.5	1026	10.3 (0.2)	5 - 48.5	1026
	Night	13.47 (0.7)	1.8 - 30.0	86	10 (0.7)	5 - 22.0	86
4	Day	11.3 (1.6)	1.5 - 28.0	17	27.5 (2.9)	9 - 45	17
	Night	16.2 (1.2)	5 - 30.5	32	27.1 (2.1)	7 - 47.5	32
5	Day	17.6 (0.5)	5 - 26.5	77	10.6 (0.5)	3 - 30.0	77
	Night	18.9 (0.6)	5 - 22.5	52	13.2 (0.6)	12.5 - 26.0	52

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Table 2. Summary of resting depth mode, mean time allocation to resting, and mean time allocation to surface activity for four green turtles.

		Resting Dives			Surface Activity	
Turtle	Mass (kg)	Depth Mode (m)	Mean % Time (SE)	Range (%)	Mean % Time (SE)	Range (%)
1	50.0	7.5	29.3 (8.94)	16.4 - 46.5	3.0 (0.04)	0.5 - 28.6
3	84.1	13.5	42.0 (1.65)	38.7 - 43.7	8.1 (0.02)	0.4 - 35.2
4	39.5	12	39.1 (10.7)	28.3 - 49.3	6.2 (0.01)	1.3 - 15.0
5	35.2	12	33.2 (5.30)	27.9 - 38.5	5.3 (0.01)	5.9 - 21.3

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A REVIEW OF SPECIES CONCEPTS: IDEAS FOR A NEW CONCEPT AND IMPLICATIONS FOR THE GREEN – BLACK TURTLE DEBATE

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INTRODUCTION

One of the central paradigms of biology has been the concept of a species. The debate has centred largely around whether species are arbitrarily designated taxonomic units forced upon nature by biologists to facilitate his understanding of the natural world. Alternatively, are species biologically and ecologically meaningful units as opposed to other taxonomic classes. In marine turtles, the most contentious species debate has centred around the taxonomic status of the black turtle, *Chelonia mydas agasizzii*. I suggest a new concept, called the "inclusive species concept" which may be defined as a group of individuals or population that has a finite probability of contributing to a common gene pool of two or more traditionally classified species. In species, geographical and reproductive isolation are two of many variables that affect gene flow between populations. Rather than use a binary method (based so far on reproductive isolation) to divide species, ecologists and evolutionary biologists should attempt to evaluate the degree and effect of isolation between related populations. Bayesian methods could provide a useful tool to assess relationships between populations and a framework where models can be updated with new data. Methods can be devised to graphically represent relationships between populations, which would enable managers and policy makers to make appropriate conservation decisions. This offers a framework to understand the evolution of the black turtle and other populations of the green turtle and their relationship with each other, and to understand evolutionary processes in marine turtles where diverse species can in fact hybridise.

SPECIES CONCEPTS OF THE PAST

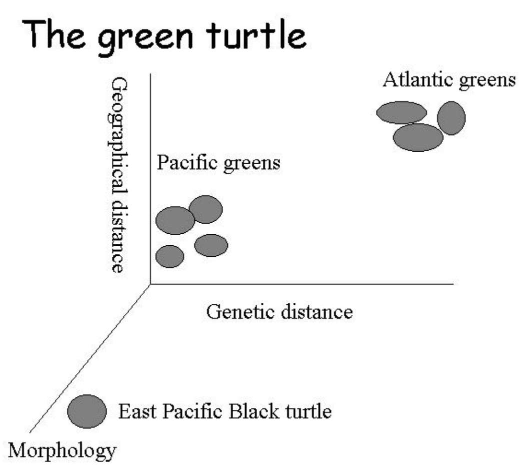
The primary questions with respect to the definition of species have been: Are species real units in nature? Can they be defined objectively? Can real organisms be assigned to one of the non overlapping species? Or "Is there a special class of discontinuities that delimits units (Biological species) whose definition and description should be attempted because they play a significant role in evolution or in understanding it?" Linnaeus's classification viewed species as discrete units of phenetically similar groups. Since, several other concepts have been proposed. These include the Phenetic species concept, Biological species concept (Ernst Mayr, 1963), Evolutionary species concept (Simpson; Wiley, 1978), Phylogenetic species concept (Eldredge & Cracraft, 1980), Recognition species concept (Coyne et al., 1988), Geopolitical species concept (Bowen et al., 1998) and the Cohesive species concept (Templeton, 1987). Darwin considered species to be arbitrary units, not differing in essential features from variety. The Biological species concept (Mayr, 1963) defines species as groups of actually or potentially interbreeding populations that are reproductively isolated from other such groups. In the BSC, species are defined by distinctiveness (reproductive gaps) rather than by (phenetic) difference. Species consist of populations rather than unconnected individuals. Species are more unequivocally defined by their relation to non conspecific populations (isolation) (Sokal & Crovello, 1970).

However, for defining species within this concept, one has to find: Some individuals which lack distinctiveness from each other - these are grouped into populations, a group of populations which interbreeds and a group that doesn't interbreed with other such groups. This last raises the questions: What is interbreeding? How does one find out single evolutionary taxonomic unit, two or more ETUs or a collection of ETUs that are not monophyletic. Sokal and Crovello (1970) ask "Are well circumscribed species the exception rather than the rule ?"

CONSERVATION & SPECIES CONCEPTS

Since species concepts have been closely linked to assigning conservation priorities, other concepts and terms have been introduced into the field. Some of these are:

The Geopolitical species: the maintenance of a taxonomy based on geographic and political considerations.
Management units: populations with significant divergences of allele frequencies regardless of the phylogenetic distinctiveness of those alleles.
Evolutionary significant units: a category above the management unit, describing a population or a group of populations that may comprise a novel evolutionary trajectory, as indicated by a long term isolation or a significant divergence in ecological, morphological or genetic traits. There has been heated debate over the status of the Green turtle & East Pacific green turtle. While they are morphologically very different , all molecular studies show a Pacific - Atlantic dichotomy in Greens. Black turtles are not genetically distinct. However, they may however be an incipient evolutionary lineage. This leads to the question "How should they be conserved?".



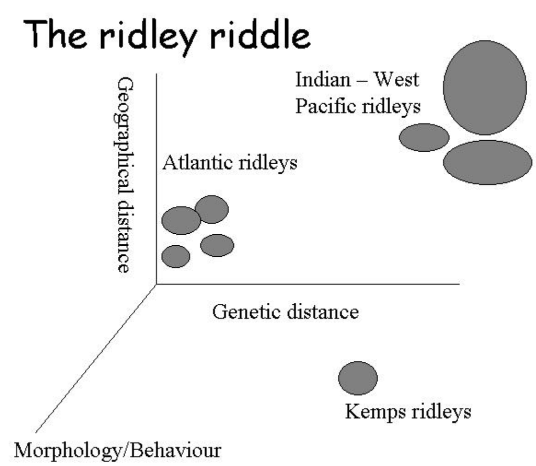
A GRAND UNIFIED THEORY OF SPECIES

In this definition, "A species is that inclusive group of individuals that have finite probabilities of contributing to a common gene pool." These may belong to one or more traditionally classified species. The probabilities of belonging to a particular gene pool may vary by individuals or populations. Historically, this borrows from Hamilton's inclusive fitness theory which demonstrates that fitness (genes) is passed on not merely from parents to offspring but to a varying degree through all related individuals. While all species concepts model geographic and reproductive isolation, traditionally, populations (or subspecies) are geographically separated and species are reproductively separated. In the arbitrary or non arbitrary designation of some populations units as species, there is loss of information. Instead, one can model the probabilities of exchange of genes or gene flow between populations. For example, reproductive isolation will be affected by sterility genes, reproductive incompatibility, behavioural differences and seasonal isolation and geographic isolation by vagility of the organism, distance between populations and barriers provides useful tools whereby the relationships between populations can be assessed. It provides a framework where species models can updated as new data becomes available. Molecular and morphological data, which are now available in abundance can be used for these evaluations.

Populations can be compared with each other on appropriate criteria (genetic distance, geographical distance, morphology, behaviour, cultural value). Distances can be calculated between populations in any number of dimensions. Visual representation of populations would make their conservation importance immediately clear to managers (Figures 1 and 2). Hence, the species status of Kemps ridleys or East Pacific green turtles can be delinked from the issue of their conservation. While the new framework enables an understanding of evolutionary processes, it also provides a tool whereby conservation decisions can be made. The understanding of speciation, diversity and species concepts need no longer impinge on conservation evaluation.

Acknowledgements:

I would like to thank: for listening to me rave and rant periodically about species concepts, Meera; for his inputs, particularly in applying Bayesian theory to this field, Dr. Jagdish Krishnaswamy; for the photograph of hoomalu and the cartoons, respectively, Peter Bennet and Ursula Keuper-Bennet & Gary Larson; friends and colleagues and the scruffy dog who have helped discussions along on many a difficult evening; and the Packard Foundation for a travel grant to attend the symposium.



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ORISSA - THE SOURCE OF THE WORLD'S OLIVE RIDLEY POPULATIONS

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INTRODUCTION

Many sea turtle populations have already been driven to extinction and several others have declined drastically (Ross, 1982). Leatherback turtles in the Pacific may go extinct in less than 50 years (Spotila et al. 2000) and Kemp's ridley sea turtles are barely out of danger now (Pritchard 1997). Olive Ridley turtles *Lepidochelys olivacea* are the world's most abundant sea turtles, largely due to the presence of a few exceptionally large aggregates in Pacific Mexico and Costa Rica and on the east coast of India. Several hundred thousand turtles have been reported to nest at one to three sites in Orissa since the 1970s (Pandav et al. 1998). Molecular data supports biogeographic theory which suggests a divergence of the ridleys with the formation of the isthmus of Panama and a recent recolonisation of the Atlantic via southern Africa (Bowen et al. 1998). In this paper, we show that the origin of olive ridley turtles is likely to be in the Indian ocean region, with this large population serving as a source for (re)colonization of populations in both the Pacific and Atlantic oceans.

SAMPLING AND MOLECULAR ANALYSIS

Nesting olive ridley turtles were sampled at all three mass nesting sites - Gahirmatha, Devi mouth and Rushikulya - in Orissa (Figure 1). Samples were also collected from mating pairs, which were captured at sea off the Gahirmatha coast, using a locally designed net. In Madras, samples were collected from hatchlings from nests relocated at a local turtle hatchery. Muscle and skin samples were collected from the shoulder of adults and from dead hatchlings and stored in 90 % ethanol. After DNA extraction, a 350 base-pair sequence of the mitochondrial d-loop region was amplified using turtle specific primers, HDCM 1 (Allard et al, 1994) and TCR5 (Norman et al, 1994) for 35 samples. PCR amplifications and sequence reactions were modified from standard protocols and automated sequencers (ABM prism 377 and ABM prism 3700) were used for sequencing.

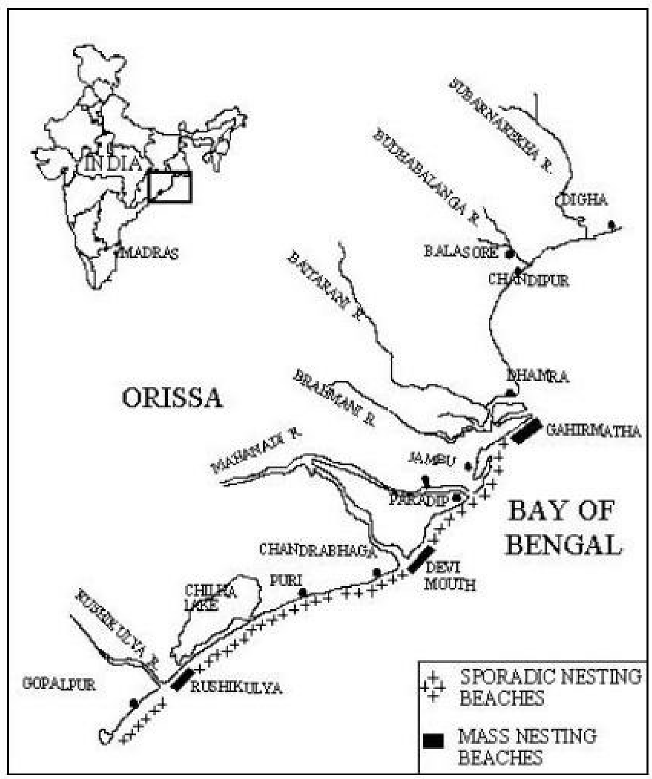
DATA ANALYSIS

The Genbank database (National Center for Biotechnology Information, USA: NCBI Home page http://www.ncbi.nlm.nih.gov) was searched for similar sequences using a BLAST search. Kemps Ridley sequences and other olive ridley sequences were also downloaded for comparisons. Population analysis was carried out using ARLEQUIN and a maximum likelihood tree (with bootstraps) was generated using PHYLIP (3.6).

RESULTS

Out of a total of 35 samples, 5 haplotypes were found of which two corresponded to haplotypes J (previously found in Sri Lanka, Malaysia and Australia) and K (Sri Lanka) (Table 1). Haplotype K was predominant in the sample, being found in 29 (87.3 %) individuals. Three new haplotypes were found, all variants on haplotype K. Haplotype diversity (0.3046) and nucleotide diversity (0.003 +/- 0.002) were low, as has generally been observed in ridleys. Haplotype K differs significantly from other haplotypes described so far, and the closest haplotypes to K discovered thus far are those described in this study (Figure 2).

Figure 1. Map of India, showing the principal mass nesting sites at Orissa. Solitary nesting occurs along both the east and west coast of India. Samples were collected at the three mass nesting sites in Orissa and Madras.



DISCUSSION

To summarise the available information, Haplotype K and the new haplotypes form a distinct cluster that is most closely related to the Kemps Ridley (Figure 3). Haplotypes K is the deepest lineage within olive ridleys, representing half the divergence with kemp's ridleys (Bowen et al., 1998) and is dominant in the Indian olive ridley turtles

The repeated colonisation theory

Populations of ridleys in the Atlantic and Pacific may have been frequently extirpated by unstable climatic conditions (Bowen et al. 1998). The size of the Orissa population (possibly close to a million turtles even in recent times) supports the view that this population may have been least susceptible to extinction, especially since these have been also the warmest bodies of water in the past 20 million years, providing a stable climate for marine turtles. The kemp's ridley may be one of the early remnants of an ancestral ridley migration from the Indian ocean region and may have diverged by the migration and subsequent isolation of ridleys by the formation of the isthmus of Panama.

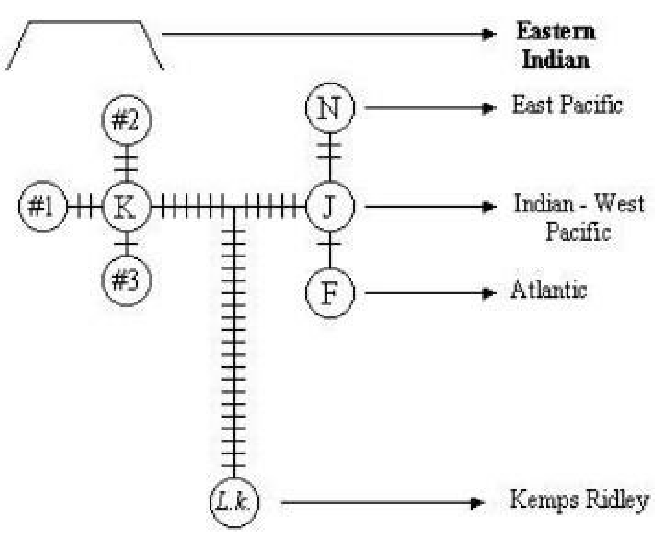
Table 1. Comparison of Indian ridleys with other global populations of ridleys and Kemps ridleys

	Fst	Nm
Brazil	0.93	0.04
Surinam	0.94	0.03
Sri Lanka	0.5	0.5
Australia	0.9	0.05
Costa Rica	0.92	0.04
Kemps Ridley	0.96	0.02

A distinct Indian source population

There was no difference in the haplotype frequencies in Orissa and Madras, further south along the coast. The Indian population is distinct from the Sri Lankan population which is its closest geographical neighbour (Table 2). The fact that Haplotype K is clearly the most dominant (85. 7 %) of the haplotypes in the Orissa, the size of the population and the region's stability suggest that this population is the ancestral source for global ridley populations.

Figure 2. Haplotypes J and K and the 3 new haplotypes were sequenced in this study, while other sequences were retrieved for reference from Genbank. All dashes indicate sequence changes between haplotypes. Haplotype K differs from New 1 by 2 transversions and one insertion, from New 2 by two tranversions and from New 3. Haplotype K differs from J by 9 transitions, 1 transversion and a 7 bp indel.



Conservation priority

The molecular genetic evidence shows that this large population could be the source for contemporary global populations, and hence of immense conservation importance. However, this population currently suffers severe trawling mortality, with over 70,000 turtles counted dead over the last 5 years (Pandav & Choudhury, 1999). The loss of this population from the Indian region may thus have significant consequences for the conservation of this species. There are other important populations of marine turtles, particularly leatherbacks and Hawksbill turtles in the Indian region and these may be globally significant populations as well.

Acknowledgements:

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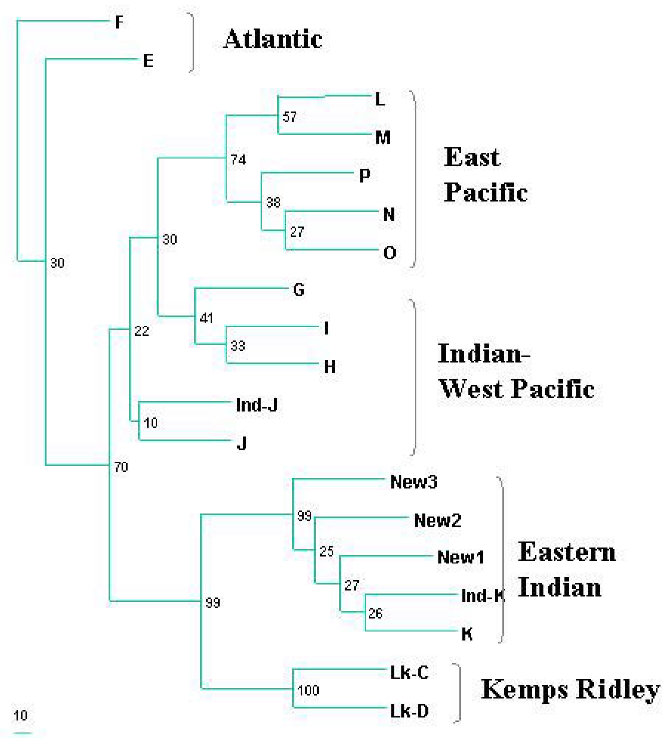
Figure 3. A maximum likelihood tree with bootstraps showing the Indian haplotypes a distinct cluster, which is most closely related to the Kemps Ridley turtles.



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HOW PRECISE IS NATAL HOMING - SPECULATION ON THE NESTING MIGRATIONS OF OLIVE RIDLEYS ON THE EAST COAST OF INDIA ?

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INTRODUCTION

Olive ridley sea turtles (*Lepidochelys olivacea*) nest all along the east coast of India. Most of the nesting is sporadic with three mass nesting sites at Gahirmatha, Rushikulya and Devi mouth in Orissa. Nesting migrations have been observed along the east coast on the coasts of Tamil Nadu and Andhra Pradesh. Feeding and nesting olive ridleys have also been observed in the Gulf of Mannar and off the coast of Sri Lanka. However, since there have been no studies thus far involving satellite telemetry, nor any intensive studies on the east coast apart from Orissa, little is known about the post nesting migrations or about remigrations of these turtles.

METHODS AND STUDY AREA

Tagging

Over three years, 10,000 nesting females were tagged at the three mass nesting sites in Orissa, Gahirmatha, Rushikulya and Devi mouth. At Gahirmatha, 1,500 mating pairs were captured using a locally designed fishing net and tagged. All animals were double tagged using monel tags

Molecular studies

Tissues were collected from mating pairs and nesting females in Orissa and from hatchlings at Madras, further south on the east coast of India. Microsatellite analysis was carried using the following primers - Cc7, Cm3, Cm72, Cm84 and Ei8 - on 34 samples from Orissa and Madras. Standard PCR conditions were followed (Fitzsimmons, 1995). Following amplification, polymorphism was studied by running the PCR products on 4% polyacrilamide gels on ABM prism 377 automated sequencer. Alleles were identified using Genotyper 3.0.

RESULTS

Tagging

Of 19 turtles recaptured in Sri Lanka, only two were recaptured during the non breeding or feeding period ie. 90 % of the recaptures were between December and April, which is the nesting season on the east coast of India. All, except one (13247/8) were females.

Microsatellite analysis

Two of the five alleles showed high degree of polymorphism. Cm 84 had substantial variation with 11 alleles and Ei 8 also showed varation with 12 alleles. In many instances, amplifications were found 20 bp beyond the range which were not included in the analysis.. Heterozygosity ranged from 0.09 (Cm 3) to 0.56 (Cm 84) with an average of 0.37. A pairwise comparison of individuals showed that no two individuals had the same allele complex. Heterozygosity was not different between Chennai and Orissa. Allele frequencies varied between populations, but population subdivision was not significant (Figure 2)

Table 1. Long distance recaptures of Olive ridley sea turtle (*Lepidochelys olivacea*) tagged in the coastal waters as well as in the nesting beaches in Orissa between 1996 and 1999. A total of 19 recaptures outside Orissa has been made till January 2001.

TAG NO. Left	TAG NO. Right	Recapture Date	Place of recapture	Tagged on	Place of tagging
WG22081	WG22082	27.04.97	Kalmunai, Sri Lanka	13.03.97	Devi River mouth
WG03019		15.12.98	Poonagari, Sri Lanka	13.11.97	Gahirmatha
WR26559		Dec. 98	Ruwanthika, Nainamadama, Sri Lanka	22.03.98	Rushikulya
WR27619	WR27620	Jan. 99	Trincomalee - east coast of Sri Lanka	23.03.98	Rushikulya
# 855		Jan. 99	Chilaw, Norht West Sri Lanka		Gahirmatha
WR25087		15.12.99	Keelamanakudi, Thoothikudi, Kanya Kumari district, Tamil Nadu	02.02.97	Rushikulya
WR30084	WR30085	31.08.99	Tamil Nadu in the Gulf of Mannar	23.03.98	Rushikulya
WG09385	WG09386	22.09.99	Kanegodalla, Kottegoda, latitude N7°43' and longitude E83°35', Sri Lanka	29.03.99	Gahirmatha
WR26203	WR26204	12.01.00	Galle, Sri Lanka	22.03.98	Rushikulya
WG13247	WG13248	Jan. 2000	Nainamadama, Sri Lanka	23.12.98	Gahirmatha
WG17375	WG17376	10.01.00	Tamil Nadu, 52 km NE of Kanya Kumari, Gulf of Mannar	25.03.99	Gahirmatha
WR29834		01.02.00	Negambo, Sri Lanka	23.03.98	Rushikulya
WG01891	WG01892	07.02.00	Negambo, Sri Lanka	14.04.97	Gahirmatha
WR28131		15.01.00	Poonagari, Sri Lanka	23.03.98	Rushikulya
WG17563	WG17564	01.04.00	Poonagari, Sri Lanka	25.03.99	Gahirmatha
WG17805		15.03.00	Galle, Sri Lanka	25.03.99	Gahirmatha
WR30398	WR30399	18.03.00	Galle, Sri Lanka	12.03.99	Rushikulya
WR27677	WR27678	Jan. 2001 ?	Kalpitiya, Sri Lanka	23.03.98	Rushikulya
WG15045		Jan. 2001 ?	Kalpitiya, Sri Lanka	08.01.99	Gahirmatha
WR26135		Jan 2001 ?	Kanyakumari, Tamil Nadu	22.03.98	Rushikulya
WG14805		Jan 2001 ?	Kudankulam, Tamil Nadu	06.01.99	Gahirmatha

Table 2. Summary of information on five microsatellite loci for olive ridley sea turtles on the east coast of India.

Microsatellite Locus	Number of alleles	Range	Heterozygosity
Cc7	2	162-164	0.88
Cm3	4	160-166	0.38
Cm72	3	236-240	0.09
Cm84	9	326-346	0.56
Ei8	12	190-212	0.47

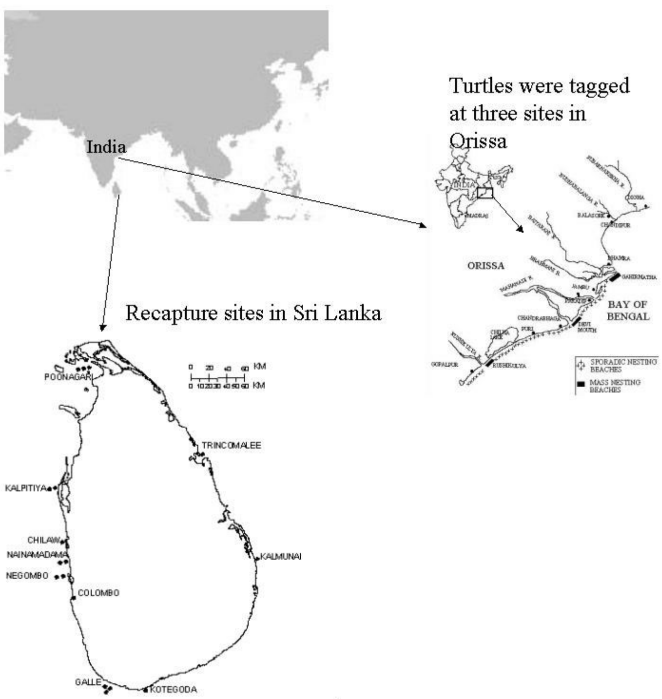
DISCUSSION

Multilocus fingerprinting, RAPD analysis did not reveal any population structure in olive ridley populations along the east coast of India (Shanker et al. 2000). Mitochondrial DNA analysis did not reveal population structure along the east coast of India (Shanker et al. 2000) Turtles tagged in Orissa in the 1970s have been observed nesting in Madras, more than 1000 km south along the coast (Harry Andrews, pers. comm.)

Sporadic nesting along the east coast is roughly correlated with mass nesting events in Orissa (Kartik Shanker, unpubl. data) .In Orissa, turtles have been recorded nesting at more than one nesting beach (320 km apart) within and between seasons(Pandav, 2000).

While olive ridleys are believed to breed annually, most other species are known to breed at intervals of three to five years. Sea turtles have to lay down their fat reserves and yolk stores in preparation for the breeding migration during the interbreeding period. Hence, the remigration interval in turtles may be determined by the diet during the interbreeding period. This is supported by the fact that the annual green turtle nesting intensity in Australia is correlated to El Nino events (Limpus et al., 2000).

Figure 1. Map showing sites of tagging in Orissa on the east coast of India and recapture sites in Sri Lanka.



Firstly, the data may be explained by imprecise natal homing in olive ridley turtles. However, recaptures at nesting beaches in Orissa (Pandav, 2000) suggest that this is not true. Other species of marine turtles may vary their remigration interval based on the fat reserves accumulated during the interbreeding period. Perhaps ridleys off the Indian coast (and elsewhere) simply choose to travel a shorter distance to nest rather than not nest at all. Hence turtles that would normally nest off the Orissa coast may choose to nest in Andhra Pradesh or Tamil Nadu when they run out of reserves. Though these hypotheses need validation by field and genetic data, we suggest them here as viable alternatives to the now well entrenched paradigm of natal homing, in the hope that future studies might address them.

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We thank the Ministry of Environment and Forests and state Forest Departments of Orissa and Tamil Nadu for permits. We would like to thank all the assistants in the field and Ramesh Aggarwal and Rama for their support in the lab. We would also like to thank Turtle Conservation Project and the fishermen of Sri Lanka for tag returns. We would like to thank the Packard Foundation for a travel grant to attend the symposium.

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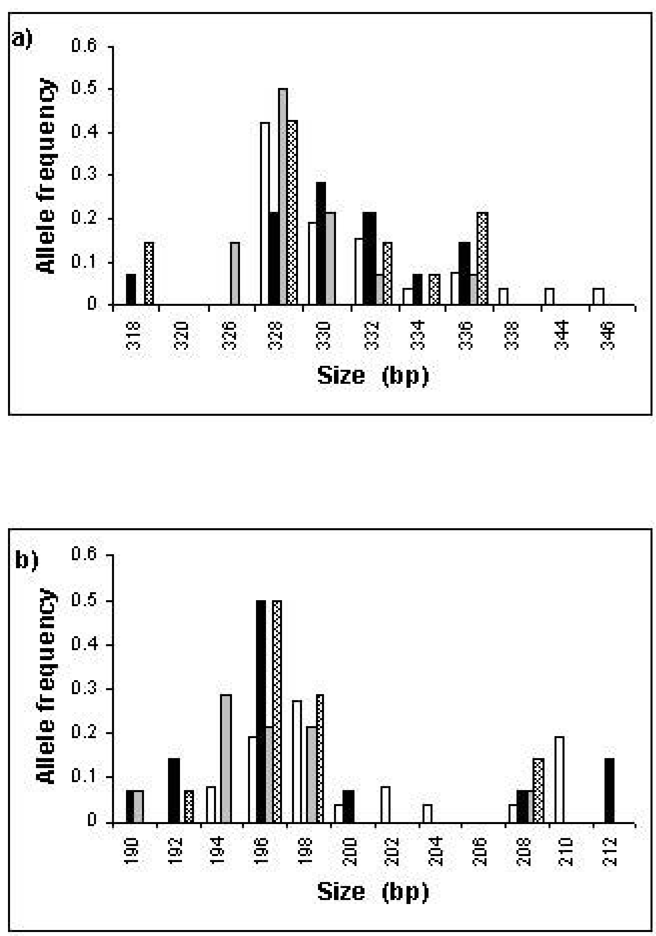
Figure 2. Allele freqeuencies of microsatellite loci for Gahirmatha (white bars), Devi River Mouth (black bars), Rushikulya (grey bars) and Chennai (patterned bars) for (a) Cm 84 (b) Ei 8.



INCIDENTAL FISHERIES OF SEA TURTLES IN THE SOUTHEAST PACIFIC

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Incidental fisheries in Peru and Ecuador, absence of its monitoring, together with the socio-economic and cultural background of coastal communitites are the main conservation problems for turtles in the Southeast Pacific.
Official numbers from IMARPE of turtle catch in Peru during 1997-99, were 4.4, 3.04 and 0.58 tons respectively. Besides, our monitoring towards turtles and cetaceans bycatch, estimated 520.2 turtles caught during 1999-early 2000 (MDC=1.3 turtles/day) in one port. Green turtle *Chelonia mydas agassizii*, olive ridley *Lepidochelys olivacea*, leatherback *Dermochelys coriacea* and hawksbill turtles *Eretmochelys imbricata*, were affected. IMARPE Statistics showed that in 1997-99, 3/4 of turtles were entangled in drift gillnets (43.5%) and trammelnets (33.0%).The remainder, were caught in longlines (7.8%), purse-seine (4.3%), during diving (3.7%) and others (7.7%).
INP-Ecuador reported for 1989-early 2000, bycatch of 366.3 tons of olive ridley, green and hawksbill turtles off Ecuador. There is none information of bycatch by shrimp trawling, where the use of TED's is compulsory.
Reported turtle bycatch should be considered minimum as capture, trade and consumption, are forbidden since 1990/1995 in Peru and Ecuador respectively. Bycatch is considered illegal. Although information suggests that capture of turtles for human consumption persist at moderate levels in both countries. Most turtles are captured alive and virtually never released, their captures should not be dismissed as an unavoidance bycatch problem but regarded as active, albeit illegal, fishery and should be managed accordingly. An extended programme of research and conservation on turtles along the Peruvian-Ecuadorian coast is highly recommended, involving fisheries communities and stakeholders.

ASSESSMENT OF LOGGERHEAD (*CARETTA CARETTA*) REPRODUCTIVE SUCCESS ON HUTCHINSON ISLAND, FLORIDA; SUMMER 2000

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INTRODUCTION

Hutchinson Island is an important loggerhead (*Caretta caretta*) nesting beach that annually ranks as the second most productive in Florida (Meylan et al., 1995). During the last 10 years of index nesting surveys, the island averaged 6436 loggerhead nests (B. E. Witherington, unpubl., 2000). In order to identify the reproductive characteristics of a nesting population, careful records on clutch survival are needed (Miller, 1999). While nesting surveys have been conducted since 1971, there has never been an attempt to randomly sample loggerhead reproductive success on the northern half of the island.

Assessments of nest productivity have been carried out on the island's northernmost beaches, but these studies were in an urbanized area subject to renourishment projects (R. G. Ernest, and R. E. Martin, unpubl., 2000). In addition, previous projects were biased towards specific areas and did not encompass the entire north end. The objective of our study was to provide an estimate of loggerhead reproductive success on the northern 16.5 km from a random sample of insitu nests. Ultimately, our goal was to obtain an unbiased estimate of clutch survival from which future comparisons could be made.

METHODS

Hutchinson Island is 36 kilometers long and situated in St. Lucie and Martin counties on Florida's southeast coast. Index Nesting Beach Survey (INBS) zones (one km long) divide the island and are part of a state-wide program to monitor long term sea turtle nesting trends. The study area for the present research included the northern 16.5 km of the island beginning approximately 2.5 km south of Ft. Pierce inlet.
From the 15 of May through 12 of August, every 45th loggerhead nest deposited the night before was verified and marked during morning surveys. A white survey stake was placed behind the nest perpendicular to the water line and near the top of the dune where it could be easily seen from the beach. A green survey stake was placed at least 2 meters behind the white stake and in dune vegetation. Yellow survey flags were conspicuously placed at an angled distance from the nest. Beach section, nest location, landmarks and initial nest disturbances, if any, were recorded.

Marked nests were monitored during nesting surveys for depredation, tidal inundation, erosion and removed markers. Nests were excavated three days after detectable hatchling emergence or 70 day's post-deposition. The contents of the egg chamber were removed and counted as either hatched eggs, unemerged stragglers, pipped, damaged eggs or whole eggs. Whole eggs were opened and placed in the following categories: infertile, addled, early embryo or late embryo. Live stragglers found in the nest were released and allowed to crawl back to the water. Emerging success was used as the best measure of overall reproductive success (Ehrhart and Witherington, 1987). We defined emerging success as: [(hatched eggs - unemerged hatchlings) / the total number of eggs] X 100.

RESULTS AND DISCUSSION

A total of 85 loggerhead nests were marked throughout the summer. Nesting was higher in the southern end of the study site, which accounted for more nests marked in these areas (Figure 1). The spatial distribution of nests was probably influenced by biotic and abiotic factors that affect emergence patterns on the entire island (Williams-Walls et al., 1983). High surf washed out two nests in late September. The remaining 83 nests were evaluated for reproductive success. Throughout incubation, nests were either left undisturbed (2.4%), or suffered tidal inundation (38.6%), ghost crab (Ocypode quadrata) depredation (83.1%) and/or plant root invasion (8.4%).

The mean number of days to emergence was 52.2 ± 3.1 (n = 69). The distribution ranged from 47 days to 63 days and was skewed to the right (Figure 4). Mean clutch size was 111.1 ± 25.4 (n = 83, range 45 -165) and similar to mean loggerhead clutch sizes reported at Cape Canaveral, Florida (Ehrhart, 1979) and Melbourne Beach, Florida (Ehrhart and Witherington, 1987). Mean emerging success was 65.5 ± 25.7% (n = 83, range 0 - 98%). The majority of unhatched whole eggs were addled and exhibited no discernible development (Figure 2). Tidal inundation early in incubation may have reduced oxygen exchange in these eggs and suffocated them (Herren and Cross, 1995).

Ghost crabs invaded most of the nests and destroyed 10% of the total number of eggs. Crabs have typically been minor nest predators (Ehrhart and Witherington, 1987), yet in our study they destroyed more eggs than any other animal. This was largely because raccoon (Procyon lotor) depredation was not observed in this study. Raccoon depredation was much higher 25 years ago, but since 1979, it has not exceeded 10% of the nests on the island (Quantum Resources, 1999).

We feel confident that our results were representative of reproductive success on the northern half of Hutchinson Island. However, our marked nests accounted for only 2% of the total nests in this area. It is possible that sampling error could have confounded our data. Nevertheless, we plan to continue monitoring reproductive success on this important nesting beach to provide a long-term dataset for the future.

Figure 1. The distribution of loggerhead nests marked in the one km Index Nesting Beach Survey zones, Hutchinson Island, Florida, 2000.

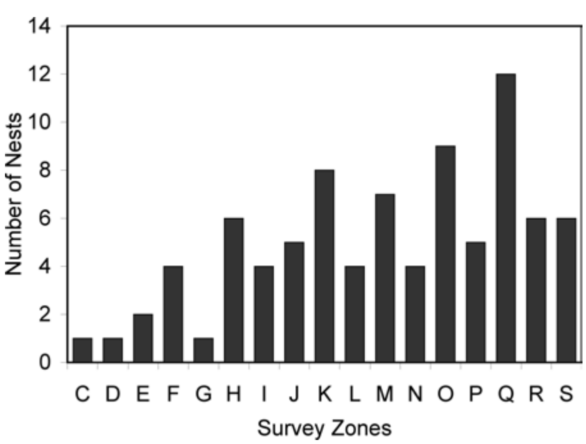

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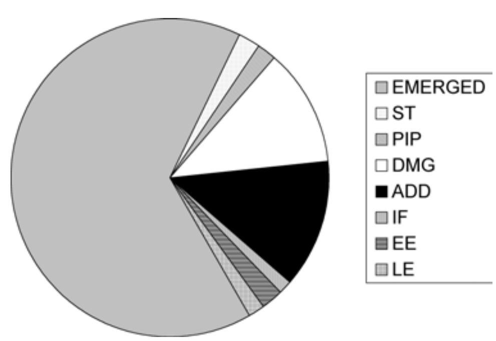
Figure 2. Mean Egg fate percentages for marked loggerhead nests. ST = stragglers (dead and alive); PIP = pipped (dead and alive);DMG = damaged eggs; ADD = addled (discernable early development); IF =infertile; EE = early embryo; LE = late embryo.



DOES GENDER MATTER? AN EXAMINATION OF THE LINK BETWEEN GENDER AND VOLUNTEERISM IN TORTUGUERO, COSTA RICA.

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Numerous environmental nongovernmental organisations (ENGOs) are working with communities in developing countries on conservation initiatives. ENGOs often rely on volunteers for physical and financial assistance with conservation projects, and reliance can be expected to increase as long as government downsizing remains in vogue. Understanding the characteristics and motivations of volunteers can aid in both recruiting participants and determining a sense of their satisfaction with programs, but to date little research has been done on volunteers involved in ENGOs. This research examines the Turtles of Tortuguero Research Participant Program operated by the Caribbean Conservation Corporation (CCC) at its research station in Tortuguero, Costa Rica. Established in 1959, the CCC is a not-for-profit membership organisation based out of Gainesville, Florida, that is dedicated to the conservation of sea turtles through research, training and natural education. In-depth interviews with 34 volunteers, comprised of both research assistants and participant researchers, were conducted during July of 1999 and 2000. In addition, 135 volunteer exit surveys administered by the CCC from 1996-1999 were analysed. Interviews probed a range of issues, including general motivations and expectations of participant researchers, while surveys provide volunteer evaluation of specific elements of their experiences. Results presented here focus on the role of gender in influencing volunteer motivations and expectations.

SKELETOCHRONOLOGICAL ANALYSES OF HUMERI FROM CODED WIRE TAGGED (CWT) KEMPS RIDLEYS: INTERPRETATION OF EARLY GROWTH MARKS

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We received humeri from five Kemp's ridleys (*Lepidochelys kempii*) that are wild, known-age animals, tagged as part of a bi-national program managed by NMFS Galveston for the purpose of applying coded wire tags (CWT) to mass numbers of hatchlings. Two of the animals were recovered by the STSSN-NMFS, Galveston, TX in 1998, two were recovered as dead strandings by the Massachusetts Audubon Society in Wellfleet, MA during the cold stun event of 1999, and the third was recovered by the Virginia Marine Science Museum Stranding Program in 1998. The animals range in age from 1.27 to 2.37 years old. We prepared histological thin-sections from cross-sections of the humeri and observed the growth marks. Settlement marks (diffuse skeletal marks that represent the transition from pelagic to benthic habitat utilization) are visible in each of these bones, including the 1.27 year old, providing evidence that this mark represents one year. The 1.72 year old animal revealed an extra layer outside of the settlement line which is frequently observed in unknown-history animals, demonstrating that this is likely an accessory layer. The two 2.37 year olds both show growth layers near the edge of the bone, indicating that there may be little bone growth during the summer and fall of the third year. We observe a double-layer pattern in unknown-history animals that the findings here suggest may represent years 2 and 3. The first line of arrested growth (LAG) is laid down at year 2 or 3. These 5 CWT animals provide evidence of the applicability of skeletochronology for age estimation in Kemp's ridleys. They also highlight the need for validation to correctly interpret the growth marks, particularly in very young animals before LAG's are deposited. The acquisition of additional CWT animals will provide further support for our interpretation of the growth marks.

I gratefully acknowledge that my participation at this symposium was funded by the 21st Annual Symposium on Sea Turtle Biology and Conservation.

A COMPARATIVE APPROACH IN DETERMINING HEALTH STATUS OF CHELONIIDS WITH RESPECT TO AVIAN AND MAMMALIAN MEDICINE

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While sea turtles exhibit a multitude of pathologies both in captivity and in the wild, there exists little data on accepted health status standards for reptiles. Sea turtle biologists and veterinarians have very little research to reference in regards to clinical profiles of cheloniids when presented with parasitic challenge, fungal infections, nutritional deficiencies, bacterial infections and fibropapillomatosis. By convention, packed cell volumes are utilized to determine general health status and whether the turtle has a competent immune system. This research focuses on trends exhibited by wild *Chelonia mydas* with regard to conventional methodology as well as serum protein electrophoresis and in vitro lymphocyte proliferation. Clinical chemistry values and leukocyte differentials are compared to provide an overall profile of sea turtle health. The results will provide baseline data with which to compare health standards of avians and mammals and address future standards with which to gauge sea turtle health.

INTRODUCTION

Debilitating diseases threaten sea turtle populations worldwide. Most recently, seemingly healthy looking loggerheads (*Caretta caretta*) have been washing up on Florida's beaches moribund or dead. Populations of green sea turtles (*Chelonia mydas*) in Hawaii, Australia and Florida are afflicted with fibropapillomatosis, another disease that can be fatal. And captive Kemp's ridleys (*Lepidochelys kempii*) and greens are inundated with lung, eye and tracheal disease (LETD). Possible facilitating causes include natural stressful changes in their environment (such as extreme temperature changes and harmful algal blooms) and anthropogenic related insults (such as pesticide exposure). The sea turtles' environment predisposes them to these diseases and to harmful anthropogenic conditions that burden overall sea turtle health. However, health standards for sea turtle populations with respect to diseased individuals are inadequately defined. One difficulty lies in comparing sea turtle health standards with those utilized in avian and mammalian medicine. Mammalian health standards are the most extensive and have been studied since the turn of the 20th century. But while the healthy mammal appears to regulate most blood chemistry parameters within normal ranges making it simple to identify abnormal (unhealthy) excursions, these criteria might not apply to ectotherms. Healthy ectotherms may accommodate much wider ranges in such parameters as blood glucose, blood urea and PO2 than birds and mammals. Thus baseline data is needed in wild populations. The objective of this study was to compare healthy sea turtles with unhealthy populations in the wild.

MATERIALS AND METHODS

One hundred juvenile green sea turtles (*Chelonia mydas*) from three separate populations were sampled. The populations included: The Port Canaveral Trident Basin where there is zero prevalence of fibropapilloma disease (n=30), a group from south of the Sebastian River Inlet where there is a 5% prevalence of GTFP (n=38) and another group from the Indian River Lagoon in Brevard County where ~67% of all the turtles evidence external fibropapillomas (n=32). Two to 5mL of blood was drawn from the dorsal cervical sinus of each turtle and transferred to a sodium heparin 3cc vacutainer. Serum protein gel electrophoresis, clinical chemistries and packed cell volumes were performed at the Department of Comparative Pathology, University of Miami School of Medicine for all turtles taken at each site. The Trident Basin turtles were utilized as health standard controls with which to compare the Indian River Lagoon and Sebastian Reef turtles, as they have no known history of fibropapilloma disease.

Serum protein values were obtained by the Beckman Paragon Electrophoresis System including SPE II protein electrophoresis kit and dryer. Each gel was evalutaed by densitometer yielding values for total protein: albumin %, alpha-1 globulin %, alpha-2 globulin %, Beta globulin %, gamma globulin % and albumin/globulin ratios.

Clinical chemistries were performed as a UM Advanced Reptilian Panel on the Kodak Ektachem System with total protein assessed by refractometer. Glucose (Glu), calcium (Ca), phosphorus (P), uric acid (Uric), alkaline phosphatase (ALKP), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), creatine kinase (CK) and gamma-glutamyltransferase (GGT) were assessed for each turtle. Packed cell volumes (PCV) were obtained by centrifuging blood in microcapillary tubes and read as a percentage pf the total blood volume.

RESULTS

Trident Basin turtles exhibit the highest levels of albumin and the lowest levels of gamma globulin for the three groups (P=0.002). Papilloma turtles expressed higher gamma globulin percentages and lower albumin percentages than non-papilloma turtles.

Non-papilloma turtles have statistically higher glucose levels than papilloma turtles (P<0.001). Differences in Glu levels between the three locations are also statistically significant (P=0.028). Both papilloma and non-papilloma turtles exhibited normal values for Ca, however there is a statistically significant difference between locations for Ca levels (P<0.001).Phosphorus levels were not statistically different between papilloma and non-papilloma turtles, however there is a statistically significant difference between the three locations (P<0.001). Uric acid levels were not statistically different between papilloma and non-papilloma turtles. Papilloma turtles had statistically significant lower levels of ALKP (P=0.001), AST (P=0.005) and LDH (P=0.006) compared to non-papilloma turtles which may be biologically significant. There were no significant differences in CK between papilloma and non-papilloma turtles (P=0.154). Papilloma turtles exhibit lower levels of GGT (P<0.001).

DISCUSSION

This study investigated whether current diagnostic tools are useful in determining health standards for sea turtles. Our results indicate significant differences in clinical chemistry values, which may indicate that diseased animals are physiologically challenged. Turtles from the lagoon and reef exhibited higher levels of gamma globulin and lower levels of albumin. In avian and mammalian medicine these levels indicate possible liver disease, myeloma or malnutrtion (Kanecko, 1980). Within this spectrum there is no differentiation between the immunoglobulin superfamilies thus making it difficult to determine if the animal is stressed or carrying a parasitic load. Trident Basin turtles exhibit normal avain levels of albumin at 34% and lower levels of gamma globulin. Non-papilloma turtles have statistically higher glucose levels than papilloma turtles (P=0.001). While glucose levels were significantly different, this does not necessarily indicate a biological difference as glucose levels can vary widely under normal conditions. Normal plasma glucose levels in reptiles varies with species, nutritional status and environmental conditions, but is considered normal within the range of 60-100mg/dL (Campbell, 1996). There were no statistically significant differences in calcium, phoshorus or uric acid levels between papilloma and non-papilloma turtles. ALKP levels were significantly lower in papilloma turtles than non-papilloma turtles (P=0.001). Papilloma turtles exhibit lower levels of AST which may be biological significance (P=0.005). Non-papilloma turtles exhibit significantly higher LDH levels (P=0.006). There is no significant differnce in CK levels between papilloma and non-papilloma turtles (P=0.154). Papilloma turtles exhibit lower levels of GGT.

ALKP and GGT levels were significantly lower in papilloma turtles. This may be of biological significance due to the presence of visceral nodules found in papilloma turtles' liver; however, it is more likely a function of enzymatic uptake or release. AST in conjunction with CK are useful as an index of hepatic or muscular cell damage in mammals (Kramer, 1980). Great caution is necessary in the interpretation of the data. But it can be seen that the normal range of sea turtle serum chemistry values is far greater than those observed in avian and mammalian standards. The cause of variability could be related to a greater tolerance for internal changes and the influence of environmental factors. For example, the body temperature of ectotherms, like sea turtles, conform to ambient temperatures and many physiological and enzymatic processes are strongly influenced by temperature (Somero, 1997). For instance, normal plasma pH and bicarbonate levels vary with temperature in sea turtles, as temperature decreases, plasma pH increases (Lutz, 1996). Therefore, much more baseline data is needed to accommodate natural variation if we are to successfully assess sea turtle health. We need to determine the normal range for blood chemistries in healthy animals under such conditions as season, temperature, location, age, sex and size before blood chemistry values can be utilized as successful diagnostic tools to assess sea turtle health.

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OVERVIEW FOR 1ST OF A 3-YEAR STUDY TO DEVELOP AN IN-THE-WATER INDEX OF RELATIVE ABUNDANCE FOR SEA TURTLES OFF SE USA

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Sea turtles off the southeastern United States have been listed as threatened or endangered species since 1973. Numerous estimates have been made to assess their abundance based upon nesting females and to enhance the survival of the young (Schroeder and Murphy 1999). Regulations have been enacted to minimize their incidental catch, such as the incorporation of Turtle Excluder Devices (TEDs) in shrimp nets. In recent years, researchers have noted an increase in the number of strandings (TEWG 2000). To understand the effect of strandings on the population, it is important to monitor all life history stages, not just the mature females that first lay at age 25-30. The purpose of this NOAA/NMFS three-year study is to develop an in-the-water index of relative sea turtle abundance, incorporating adults and juveniles, males, and females.

A fishery independent survey was conducted for the coastal area from Winyah Bay, SC, to St. Augustine, FL, using strata by depth (4.6-9.1 m; 9.1-12.2 m) and latitude. Three vessels were utilized to complete the sampling during 13 summer weeks. Each vessel was equipped with paired 18/20 m (60'/65') turtle nets without TEDs (with 20 cm mesh), a 5 m try-net, and a surface thermister. Tows with the turtle nets were limited to 30-min bottom times to minimize stress on the turtles. Try-nets were towed for 15 min to give a sample of co-occurring organisms. The catch of each net was identified and weighed, with measurements taken on priority species caught while sampling for turtles.

All turtles were measured (10 standard measurements; see Arendt et al. herein), weighed, photographed, videotaped (some), and carapace and plastron markings drawn. An Inconel 681 external tag was placed in the axil of each front flipper proximal to the first scale and a Dextron (134 kHz) PIT tag was inserted in the front right shoulder. A total of 20-30 ml of blood was drawn from the dorsal cervical sinus and used to determine the blood chemistry (see Segars et al. herein), total protein, packed cell volume (PCV), testosterone level (radioimmunoassay), mtDNA karyotype, and contaminants (natural & anthopogenic). Immunoassays were conducted on a few turtles caught on final day of each week's sampling. Fecal samples, if produced, were examined for parasites.

A fishery dependent study was conducted using commercial shrimp boats, one in Brunswick, GA, and one in Mt. Pleasant, SC, for 14 days each. Observers rode with the shrimpers during their normal trawling operations, without TEDs and with tows limited to 30 min on the bottom. Turtles were processed as described above, with a reduced blood workup (primarily for mtDNA and testosterone).

A total of 253 turtles were taken on 5 vessels at 851 stations. Sampling took place between 17 May through 17 August 2000. Seven of the 253 turtles swam out the mouth of the net while cod ends were being brought onboard to workup the catch.

No turtles tagged as a part of this study were recaptured by any of the vessels in this effort. Five loggerheads that had been previously tagged, all orginally tagged off the SE USA, were captured. Two turtles tagged on this study have been recaptured by other programs, one moving 15.4 km to the SW in 4 months and one stranding within 5.6 km after a shark bite one month after release. There were also two loggerheads that may have live tags. The fishery dependent efforts did not recaptured any turtles tagged as a part of this study, even though sampling was continued in the same area for 14 consecutive days.

Loggerheads varied in straight carapace length (notch-notch) from 44.7-97.5 cm while Kemp's ridleys (24.6-62.0 cm) and green turtles (27.7-29.2 cm) were smaller. There was no apparent pattern in turtle catch or size for any of the three species with depth nor temperature.

The catch rate of turtles was highest when vessel speeds were 1.3-1.8 m/s (2.5-3.5 kt). Reduced catches at slower towing speeds may be because of escapement by the turtles. Lower rates at faster speeds may indicate changes in the gear configuration and efficiency because of increased tension on the doors, and hence on the net, at faster speeds.

Testosterone radioimmunoassays showed sex ratios for loggerheads with females outnumbering the males for most strata, the exceptions being the offshore strata off South Carolina.

For loggerheads, haplotypes for the mitochondrial DNA indicated the presence of turtles whose natal beaches were in the Gulf of Mexico, including Mexico. The Gulf turtles occurred primarily in the inner depth strata. Generally, haplotype A (occurring in a high percentage of nesting females from the northern subpopulation) dominated most strata. Haplotype B (found most frequently in nesting females from the south Florida subpopulation) was most abundant in the offshore southern-most strata.

Assays for contaminants indicated no natural toxins. These samples are being used as negative controls for studies on Pacific turtles. Fecal samples from five loggerheads and 1 Kemp's ridley contained few parasites, containing the eggs of four species of nematods and one fluke. Preliminary experiments with B and T cell mitogens indicated corticosterone as a potential suppressor of proliferation for cultured white blood cells.

The catch-per-effort (CPUE) was estimated at 0.3 turtles for paired nets towed for 30 min. Similar CPUE have been reported as 0.5 in the Charleston Harbor Channel by Van Dolah and Maier (1993) and 0.3 off SC and GA by Whitaker (unpubl.), with other reports as low as 0.02 off SC (Kaiser 1976). It is unknown if catches in year one are typical for coastal waters with these trawls. During summer of 2000, the Gulf Stream intruded further inshore than is normal for summer conditions. After additional sampling in years 2 and 3, future analyses will include the development of an index of relative abundance.

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VARIABLES DETERMINING JUVENILE KEMPS RIDLEY COLD STUN EVENTS IN CAPE COD BAY, MASSACHUSETTS

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Juvenile pelagic Kemp's Ridley sea turtles are carried north along the east coast of the United States by the Gulf Stream until they reach a size of approximately 20-30 cm SCL, at which point they actively migrate to neritic developmental habitats along the coastal United States (Morreale and Standora 1993). Chesapeake Bay and Long Island Sound are well-known developmental habitats for juvenile Kemp's Ridleys during the summer months (Morreale and Standora 1993). Increased numbers of juvenile Kemp's Ridleys can also be found in New England waters, such as Cape Cod Bay, during years when offshore water temperatures are above average (24°C) in late spring and summer (Fisheries and Oceans Canada 2000).

Juvenile Kemp's Ridley cold stun events occur on the bay side beaches of Cape Cod, Massachusetts annually during the months of November and December. These events vary in severity from year to year ranging from 3 to 220 Kemp's Ridley sea turtles in the past 20+ years (Still et al. 1999). Years (1995, 1999) with the highest number of stranded Kemp's Ridleys (100, 220 respectively) had unusually warm nearshore/offshore water temperatures during the summer months, and numerous fall storm events characterized by high winds and dramatic drops in air temperature (Still et al. 1999). We hypothesize that by comparing sea turtle stranding events in Cape Cod Bay with weather data from the summer and fall of each stranding year, trends in the severity of sea turtle cold stun events in Cape Cod will become evident.

MASS MARINE TURTLE STRANDING DUE TO COLD STRESS IN ST. JOSEPH BAY, FLORIDA

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In late December of 2000 and early January of 2001, northern Florida experienced a prolonged period of unusually cold temperatures. Water temperatures in St. Joseph Bay (Gulf County, Florida) dropped as low as 6 C, eventually stunning at least 403 sea turtles (389 *Chelonia mydas*, 10 *Lepidochelys kempii*, and 4 *Caretta caretta*). All of these turtles were found stranded along the shorelines or floating in the shallow waters of the southwestern corner of St. Joseph Bay from 31 December 2000 to 12 January 2001. Sixty-one turtles died and were necropsied. The 342 live turtles were held in heated saltwater tanks at Gulf World in Panama City, Florida. Thirty-four of them were judged to need rehabilitation beyond simple warming and were transferred to other facilities in Florida. The turtles that were behaving normally and that did not appear to have any lingering problems from the cold-stunning (n=308) were marked with inconel flipper tags and PIT tags. Beginning on January 7th, these turtles were released into the warmer waters of the Gulf of Mexico just south of St. Joseph Bay (Indian Pass Beach, east of Cape San Blas, 29 41.1N, 85 17.8W). All turtles were measured and carefully inspected for any anomalies. The mean curved carapace length of the green turtles was 39.1 cm (SD=9.43, 26.2-80.0), of the Kemp's ridleys was 35.4 cm (SD=6.72, 28.5-49.1), and of the loggerheads was 49.2 cm (SD=9.71, 40.4-60.9). Two of the green turtles had tumors characteristic of green turtle fibropapillomatosis. This was the first recorded occurrence of tumors in green turtles from the Florida Panhandle. Samples of blood, skin, or muscle (the latter from dead turtles) were taken for determinations of genetic identity. To our knowledge, this is the single largest cold-stunning event of sea turtles ever recorded in the U.S. Because St. Joseph Bay is long and narrow (21 km X 9 km) and open only at its northern end, sea turtles in the southern end of the bay may become cold-stunned when the water rapidly cools before they are able to escape to the warmer waters of the Gulf of Mexico. This type of trapping effect is also believed to occur in the northern Indian River Lagoon System, the only other place in Florida where sea turtle cold-stunning events of such a large scale have been reported.

SEA TURTLE CONSERVATION IN FRENCH GUIANA ACTION PLAN

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Since the discovery of important leatherback turtle - *Dermochelys coriacea* - nesting sites in French Guiana in 1967-68 (Pritchard, 1969), various studies and conservation programs have been developed along the whole French Guianan coast : the Kawana campaign started in 1985 on the western beaches with J. Fretey (Fretey, 1998) and the eastern beaches have been monitored by the association Kwata since 1998 (Talvy et al., 2000). At the same time, the number of stakeholders involved in sea turtle conservation in French Guiana has been increasing: NGOs (WWF, Kwata, SEPANGUY, Kulalasi, GRID), scientific organizations (CNRS, Paris XI University), French Government (Ministry of Environment, ONCFS) and the Amana Natural Reserve.

Being aware of the major conservation stake for sea turtle populations, on the international level for the leatherback (Spotila et al., 2000) and on the Guiana shield for the olive Ridley - *Lepidochelys olivacea* - (Fretey, 1999 ; Talvy et al., 2000), all the involved local stakeholders have joined to set up a common long-term conservation strategy.

To this end the WWF France started a participatory process - called Project Cycle Management (P.C.M.) - in 1999 to assess the limited human, technical and financial resources. This permitted the identification of the needs and problems of the different partners, and the establishment of a joint action plan. This strategy is part of the regional sea turtle conservation program for the Guianas (Reichart et al., in press). This participatory approach has allowed all the Guianan stakeholders to work in concert on sea turtle conservation. Identified priority actions will be implemented through a restoration plan elaborated by the Ministry of Environment in French Guiana (financial resources and coordination during a five-year period).

NATURAL HATCHERY ON MONTJOLY BEACH IN EASTERN FRENCH GUIANA

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Kwata, a Guianan NGO, has been implementing a sea turtle monitoring program in East French Guiana for two years. Along this study, we observed that more than 2000 clutches have laid during the nesting periods and an important part of them was destroyed either by dogs or by erosion and even by humans. Furthermore, people's interest in sea turtles has been increasing. That's why we decided to create a natural enclosed hatchery. The hatchery has been built with three purposes: (1) educating, through environmental awareness, (2) designing an eco-tourism program, (3) relocating threatened nests into a protected area to a conservative end.

The activities in the hatchery can be summarised in the following way: first, fieldworkers collect endangered clutches on the beach and rebury them in the hatchery. Then, they release new sea turtle hatchlings, helping to keep predators away. Hatchlings reach the sea without any assistance, in order to keep the natural imprinting. These two first activities provide us with educational sessions. Finally, volunteers also present an exhibition including biological equipment illustrating every aspects of sea turtles biology and threats, encountered.

We relocated 29 nests: 16 nests of olive ridley turtle (63.5% emergence rate) and 13 nests of leatherback turtles (8% emergence rate). The relocation success is satisfying for the olive ridley turtles, whereas it turns out to be quite less important for the leatherback turtles.

About 100 people per week visit the site. Furthermore, the media contributed to the hatchery's popularity and its significance to the population's eyes.

POST-NESTING MOVEMENTS OF THE GREEN TURTLE, *CHELONIA MYDAS*, NESTING IN THE SOUTH OF BIOKO ISLAND, EQUATORIAL GUINEA, WEST AFRICA

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INTRODUCTION

Sea turtle research in the Gulf of Guinea is quite recent. Therefore, the developmental, nesting and foraging habitats, as well as, the migratory routes of most populations have not yet been identified or evaluated. Integrated knowledge of the different habitats used by a sea turtle population is essential to elaborate conservation programs (Eckert, 1999). Conservation efforts in the Gulf of Guinea are absolutely necessary due to several serious anthropogenic pressures threatening population survival (Dontaine & Neves, 1999; Formia, 1999; Formia et al. 2000).

Although the presence of four sea turtle species nesting in Bioko Island, Equatorial Guinea, has been known for a decade (Butinsky & Koster, 1989), their populations were not evaluated until now. The Spanish NGO Asociación Amigos de Doñana, in collaboration with the University of Valencia, developed a tagging program in the beaches of the south of Bioko (between 8º 23'E-3º 16'N and 8º 40'E-3º 13'N) from October, 1996 to March 1998, for two nesting seasons. Tagging focused mainly on the green turtle, *Chelonia mydas*, the most abundant of the four species, with 400-600 female turtles estimated per season (Tomas et al., 1999; 2000). Although further analysis will lead to more precise estimates, South Bioko should be classified as one of the most important nesting areas for the green sea turtle in central Africa, and surely the most important in the Gulf of Guinea (Tomas et al., 1999).

Between 1997 and 1999, various recaptures of turtles tagged in Bioko were reported from other countries in the region. Based on these recaptures, we formulate hypotheses concerning the migratory movements of green turtles to their feeding habitats after nesting in Bioko. This is the first study on this subject for the green sea turtle in the area.

MATERIALS AND METHODS

During the nesting seasons of 1996/1997 and 1997/98, we tagged 211 green sea turtles, 196 and 15 respectively. We applied yellow plastic ear tags in both front flippers of 168 turtles, and in one front flipper in the rest of the 211 turtles. In the entire Gulf of Guinea, this type of tag was used only in Bioko. Tagged turtles were measured using the CCLn-t (Curved carapace length notch to tip) (Bolten, 1999). Recaptures were reported by one of the authors (AF), by other researchers and sea turtle conservation organizations in the area, or directly by fishermen.

RESULTS AND DISCUSSION

Table 1 summarizes data for at least 12 recaptured turtles. With respect to the tag recoveries from Cap Esterias and Cameroon, we were not notified of the total number of captured tagged individuals, so we include the minimum estimate of one recapture per site. In addition, we know of 4 tags, corresponding to 2-4 Bioko turtles, which were captured by fishermen in Corisco waters for sale in Bata (E.G.) or Libreville (Gabón), but we were unable to examine these tags. Four of the 12 turtles migrated westward, one remained close to Bioko and the others migrated to the south, 6 to Corisco Bay and the north of Gabon, and one further away, reaching southern Gabon. Migration distances ranged from 130 km to 920 km (distances measured directly on the map assuming an error of ±10 km) (Table 1, Figure 1.). Based on migration rates reported in other studies for this species (Cheng & Balazs, 1998; Luschi et al., 1998), times to recapture appear too long to be the times taken for the journeys from Bioko to the recapture places. In addition, since satellite tracking studies have shown that sea turtles often migrate following straight trajectories (references in Lohmann et al., 1997), it is possible that either the turtles were in the area for some time before being captured or that they used non straight-line trajectories.

Based on number of recaptures and the additional information collected, we suggest that Corisco Bay is a frequent destination, probably the main foraging ground for the green turtles nesting in Bioko. The area harbors extensive beds of seagrass and algae, forming a suitable feeding habitat for this species (Formia, 1999). However, the recaptures in Ghana and southern Gabon suggest that dispersal occurs from Bioko nesting beaches to more than one area, possibly other feeding grounds on the continental shelf of the Atlantic coast of Africa, as occurs in other parts of the world (Solé, 1994; Cheng & Balazs, 1998).

Some of the recapture information obtained from fishermen was imprecise, probably because they lacked the means to effectively communicate tag data or because of conflicting interests. In fact, fishermen may be reticent to admit capturing a tagged turtle, keeping a tag for months, until they see the opportunity of obtaining economic benefit from it. Nonetheless, our data are useful as a basis for future work in the area. Genetic research by A.F. is currently underway to further elucidate the distribution of the Bioko nesting population throughout the region and its contribution to the feeding grounds in Corisco Bay.

Table 1. Recapture data for 12 turtles tagged in the south of Bioko Island (Equatorial Guinea). Includes carapace length at the time of tagging (CCLn-t), minimum straight line distance from the tagging place to the place of recapture, time between tagging and recapture, location, capture method and final destination of the turtle.

Tag number	CCLn-t (cm)	straight line distance (km)	time to recapture	location of recapture	recapture method	destination of the turtle
392-393*	98	900	n.r.	Kengen (GHANA)	fished	n.r.
451-452	103	920	8 months	Ada Seas (GHANA)	fished	released
107-108	101	890	9 months	Lekpongounor beach (GHANA)	captured near the beach	n.r.
329-330*	103	900	45 days	east coast (GHANA)	n.r.	n.r.
337*-338	100	760	3 months	Nyanga (GABON)	fished	released
201*-202	97	350	4 months	Libreville (GABON)	stranded dead	-
503-504	92	280	9 months	Mbanye Island (G) (Corsco Bay)	fished	sold for human consumption
475-476*	99	280	18 months	Mbanye Island (G) (Corisco Bay)	fished	slaughtered for human consumption
248-249	84	270	n.r.	Corisco (EQUATORIAL GUINEA)	fished	n.r.
473*-474	92	270	n.r.	Corisco (EQUATORIAL GUINEA)	fished	n.r.
n.r.	-	280	n.r.	Cap Estérias (GABON)	probably fished	sold for human consumption
n.r.	-	130	n.r.	south coast of CAMEROUN	probably fished	sold for human consumption

The green sea turtle is seriously threatened throughout the Gulf of Guinea due to capture for human consumption both at nesting beaches and in foraging habitats. We recommend the implementation of efficient educational programs, as well as the establishment of compensatory funds to obtain the collaboration of local people in conservation efforts throughout the population range. In addition to local fisheries, oil exploitation is becoming a major threat to turtles in the Gulf of Guinea, particularly offshore Bioko and Rio Muni (continental E.G.), and even in the Corisco area.

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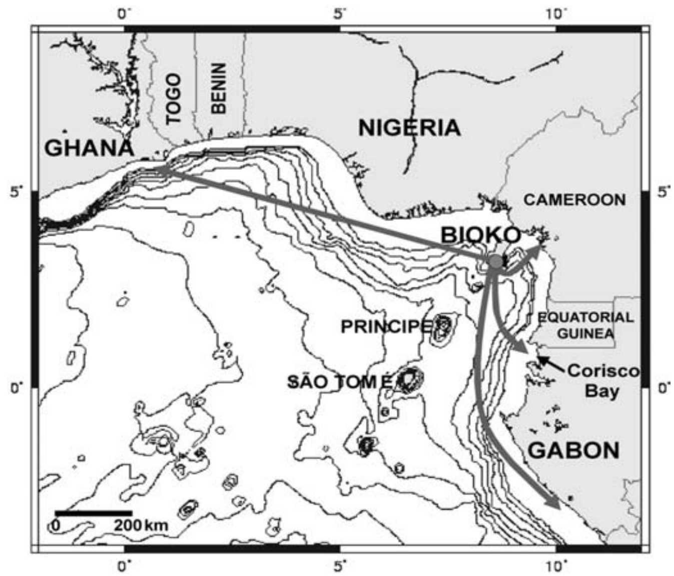
Figure 1. Hypothetical trajectories of the tagged turtles between South Bioko and their recapture place.



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NESTING BIOLOGY AND CONSERVATION OF THE LEATHERBACK SEA TURTLE *DERMOCHELYS CORIACEA* IN THE STATE OF ESPÍRITO SANTO, BRAZIL

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The leatherback sea turtle (*Dermochelys coriacea*) is a critically endangered species worldwide. In Brazil, the only place where regular leatherback nesting is known to occur is located on the north coast of the State of Espírito Santo, eastern Brazil, around latitude 19*40'S. Nesting occurs mainly on Comboios beach, about 60 km north of Vitória, the State capital; part of that beach is a federal biological reserve and the remaining part is an Indian reserve. Nesting also occurs to the north of Comboios, although in smaller numbers.

Projeto TAMAR-IBAMA, the Brazilian Sea Turtle Conservation Program, was created in 1980 by IBAMA (the Brazilian Institute for the Environment and Renewable Natural Resources), a federal government agency, and is co-managed by Fundação Pró-TAMAR, a NGO. Projeto TAMAR has been working in the State of Espírito Santo since 1982, initially on Comboios beach and gradually extending its activities northward. Nowadays, Projeto TAMAR maintains six stations in that region, monitoring 240 km of nesting beaches and conducting environmental conservation and educational activities with the coastal communities.

In this poster we present data gathered from the year 1988/1989 to the year 1999/2000 regarding 286 leatherback nests: nest spatial and temporal distributions, nesting data (clutch size, incubation time, hatching success, etc.) and size distribution of the nesting turtles. Finally, a review of the conservation status of leatherbacks in Brazil is presented. A complete report will be published elsewhere.

DECLINE OF HAWKSBILL TURTLES *ERETMOCHELYS IMBRICATA* IN CARIBBEAN COSTA RICA

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INTRODUCTION

The objective of this presentation is to summarize existing information about hawksbill turtles in Caribbean Costa Rica.

Historical Information

Historical information about hawksbill turtles in Caribbean Costa Rica is scarce and limited to anecdotal accounts. Fishing of hawksbills along the coast has occurred at least since the end of the Eighteenth Century (Palmer 1993). In 1881, a Swedish explorer observed approximately 20 hawksbills turned on their backs on the beach of Cahuita (Bovallius 1888). At the time, hawksbill shell was said to be the most valuable fishery resource available. In 1923, the U.S. Consul in Port Limón estimated an annual take of approximately 750 hawksbills (Consular Report by J.J. Meily cited in Tressler 1923). An active fishery for hawksbills off the beach at Tortuguero continued until 1973 (Carr and Stancyk 1975).

Hawksbill Encounters During Night Patrols

Data collected during green turtle monitoring at Tortuguero show a considerable decline in hawksbill encounters per unit of patrol effort for 4 four- year periods between 1956 and 2000. Linear regression of ln (hawksbill encounters per unit effort) shows an average 3.9 % annual decline between 1956-1959 and 1997-2000 (Carr and Stancyk 1975, Bjorndal et al. 1993 and CCC Unpublished Data).

Tag Returns

Data from metal tags and satellite transmitters indicate that Tortuguero hawksbills feed in Nicaraguan, Panamanian and

Honduran waters where more effort is invested in turtle fishing than in Costa Rica.

mtDNA-analysis

Maximum likelihood analysis was employed, using SPAM32 software (Anon. 2000), to compare mtDNA haplotype frequencies for Tortuguero and other nesting beaches throughout the Caribbean with feeding ground samples from Mexico, Cuba and Puerto Rico. Nesting ground samples used in analysis were Belize, Mexico, Mexico*, Puerto Rico, Puerto Rico*, US Virgin Island, Antigua, Barbados, Brazil (Bass 1999), Costa Rica (CCC Unpublished Data), Cuba –Breeding Center, Doce Leguas –1994 and Doce Leguas –1997 (Díaz-Fernandez et al. 1999) and feeding ground samples used in analysis included Cuba - Zones A, B and D, Mexico and Puerto Rico (Díaz-Fernandez et al. 1999). The analysis indicates that Tortuguero hawksbills are present in all these feeding grounds (in Cuba it is estimated that Tortuguero hawksbills made up 4.6% of the feeding ground sample, in Mexico 5.5% and in Puerto Rico 6.3%) where they may be subject to further human induced mortality.

Threats

Illegal fishing of hawksbills at low levels still occurs in Costa Rica (pers. obs.). However, Tortuguero hawksbills may be more affected by human induced mortality outside of Costa Rican borders. Taking into consideration legal hawksbill fishing in many Caribbean countries and illegal fishing elsewhere in the region, the future of the Tortuguero hawksbill population appears bleak.

Acknowledgments:

Anne Meylan provided useful comments on a draft version of this poster. Anna Bass kindly, rapidly and without charge analyzed tissue samples from Tortuguero hawksbills. The satellite transmitters were attached as part of an international research and capacity building project organized by the US National Marine Fisheries Service. Costa Rica is one of seven nations where this project is being carried out. George Balazs and Barbara Schroeder provided training in transmitter attachment and technical advice on satellite tracking. Maps detailing the migrations of the satellite tagged hawksbills (Miss Tomasa and Mamoi) are available at http://www.cccturtle.org.

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CONTINGENT VALUATION OF GREEN TURTLES *CHELONIA MYDAS* IN CARIBBEAN COSTA RICA

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Contingent valuation was used to estimate use and non-use values of green turtles. Use values include consumptive value, non-consumptive value and option value. Non-use values include bequeath value and existence value.

Consumptive value (income from sale of meat and eggs) averages US $97.5(net) or 198.7 (gross)/female turtle. Non-consumptive value of green turtles (income from turtle based tourism in Tortuguero) equals US $139-US $297.9/year/nesting turtle. The option value (income from annual tourism growth of 12%) equals US $16.7-US $35.7/year/nesting female. Our option value estimate should be considered very conservative because future uses and values of green turtles are unknown and hence not included in the analysis. Option value will increase each year if income from tourism grows. Bequeath value (funds invested in sea turtle protection) equals US $14.1-30.2/year/nesting turtle.

Existence value could not be quantified in monetary terms but annual contribution in terms of energy from sea turtle eggs deposited on the nesting beach averages a minimum of 34,000-73,000 kJ/year/nesting turtle. Green turtles killed by jaguars contributed a minimum of 13,711,000 kJ to the beach and adjacent ecosystems in 2000. In addition, green turtles grazing on sea grass beds throughout the Caribbean may increase production and contribute positively to stocks of commercially valuable species such as lobsters.

In summary, the consumptive net value of green turtles equals

US$97.5/female turtle but non-consumptive value, option value and non-use values total US $169.8-363.8/year/nesting turtle (not including energy contribution to terrestrial and marine ecosystems). Although based on several assumptions this study indicates clearly that a green turtle in Costa Rica is economically more valuable alive than dead.

PROCOSTA PROJECT: FOR THE CONSERVATION OF THE SEA TURTLES IN THE BARLOVENTO COAST, MIRANDA STATE, VENEZUELA

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The Integrated project of Conservation and Development of the coast Barlovento (PROCOSTA) was established in 1999 for PROVITA, with the contribution of Petroleum's Venezuela (PDVSA). This project attempts to establish awareness for the conservation and recuperation of sea turtles, environmental conservation, and sustainable development in the central coast of country to promote better management of natural resources that improves the quality of life of local communities.

The project has three principal objectives: 1.- realizes a monitoring of beaches nesting of sea turtles in the Chirimena coast for conservation of the species. 2. Sensibilities the local communities and visiting that they contribute to the generation of conscience and attitudes for involve them in the activists of conservation of sea. turtles 3. Establishment of small businesses as alternative economic for the local communities, for that they do not depend on the sea turtles directly.

In the first phase of the project (November 99 a march 00) problems were identified that affect several sea turtles species (*Dermochelys coriacea*, *Eretmochelys imbricata*, *Chelonia mydas* and *Caretta caretta*) in the area: nest robbing (80% approx.) for sale and local consumption of eggs, intentional capture of turtles for commercialization of meat and other products, degradation of nesting beaches by construction projects, mining of sand and gravel for construction, contamination by sewage and solid waste, and disorientation of turtles by artificial lighting.

Also, were studies the environmental situation, social and economic of the region. Were began a campaigns to divulge the project objectives to the communities, visitors, and both government and nongovernmental organizations, were identified strategic alliances with other institutions. As result of this study, Chirimena was selected as the pilot communities of Barlovento region for the project activities.

In the second phase de PROCOSTA we constructed a hatchery in the beach El Banquito. Daily morning surveys (from 4:30 am) between June and December 2000 were conducted in 7 beaches of the Chirimena area (El Banquito, Maspano, Sale, La Virgen, Diablo y Capino), to record nesting activities and protect nests. The process of nest relocation and transportation to the hatchery were conducted to ensure the surviving and prevent poaching.

In the 7 nesting beaches that were monitored, 22 nests were identified and registered, 13 for hawksbill (*E. imbricata*), 8 for leatherbacks (*D. coriacea*) and 1 for loggerheads (*C. caretta*). No nesting activities for green turtles (*C. mydas*), where reported for the area in this period. From the total of nests (22), 9 where reported poached, representing the 41%.

According to the results, El Banquito is the most important nesting beach of the area with 13 nests. Maspano and Playa Grande reported 3 and 2 nests respectively. The remaining 4 beaches reported 1 nest per beach. This information is in according to data of previous years presented by The Oscar O. Palacios Foundation (FEOOP) and local people.

A total of 517 hatches were released at sea, from 9 nests from the hatchery and 1 in natural staged. The hatchery success in natural stage was 57.5 % and 4.3% for the nests at the hatchery.

Environmental education activities were very important for the project implementation. Community, educational centers and local government meetings were performed with the goal of informing the objective of the project.

Different activities as summer camp for local children, Beach cleanups, creation of environmental clubs and distribution of coloring books about the sea turtle conservation. Special event was taken place in the International Beach Day, were it was a massive beach clean up in the nesting beaches by the local community. The 1rst. Sea turtle conservation Festival was taken place with the objective mental of creates environmental awarenest true the cultural traditions. A newsletter was established with the coordination of the Chirimena community association.

The success of this project was because of the strategic alliances with other local institutions both government and nongovernmental, local community and news media. Actually were realized the necessary studies for development the small businesses, to taking in consideration the community interest.

Acknowledgements:

PROVITA y PDVSA thank the many contributions that have been made Oscar Ochoa Palacios Foundation, ASOVECHIR, Chirimena community, PROFAUNA, INPARQUES. Barlovento Cultural Groups, British Embassy in Venezuela, Miranda State Government, Municipal government of Brion and Chirimena elementary school.

ENVIRONMENT OF NATURAL AND HATCHERY NESTS OF THE OLIVE RIDLEY SEA TURTLE (*LEPIDOCHELYS OLIVACEA*) AT NANCITE BEACH, COSTA RICA

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The environment of olive ridley nests was examined at Nancite beach, Costa Rica, during the nesting season of August to October 1999. The concentrations of oxygen and carbon dioxide, as well as nest temperatures, were measured in natural and "clean sand" hatchery nests throughout the incubation period. The conditions in the hatchery resulted in significantly higher hatching success (83%) than the hatching success in natural beach nests (22%). The higher egg mortality and the reduced hatching/emergence for the beach nests when compared to the hatchery nests, were probably due to the higher CO2 and lower O2 nest concentrations during the first 40 days of the incubation period. The decline of the olive ridley sea turtle population, nesting at Nancite beach, could be attributed to high biological O^2 demand from old and decaying nests, which could generate a build up of CO^2 and a reduction in O2 causing high rates of egg mortality. The existence of a "clean sand" hatchery on arribada beaches is an important alternative that could insure the production of larger numbers of hatchlings.

SEAFINDING ORIENTATION OF HATCHLINGS EXPOSED TO FILTERED LIGHTING: EFFECTS OF VARYING BEACH CONDITIONS

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INTRODUCTION

With increasing coastal development, more sea turtle nesting beaches are exposed to artificial lighting. This form of "photopollution" repels nesting females. Hatchlings that emerge from nests on illuminated beaches crawl toward light sources on land ("misoriented") or are incapable of crawling on straight paths ("disoriented"). The outcome is often fatal as hatchlings may be taken by terrestrial predators, or may die from dehydration or exposure (Mrosovsky, 1968; Hayes and Ireland, 1978; Witherington, 1992). This problem is particularly acute where nesting beaches are located near streetlights, used to illuminate coastal roadways.

The Florida Department of Transportation (FDOT), in an attempt to reduce this problem, is exploring the use of streetlight "filters". These are colored acrylic sheets interposed between the light element (typically, a high-pressure sodium vapor lamp) and the environment. Filters exclude the shorter light wavelengths that attract turtles. The hope is that by eliminating these wavelengths, the behavior of females and their hatchling will be unaffected.

In this study we determined how hatchlings (*Chelonia mydas* L and *Caretta caretta* L) responded under laboratory conditions to light that passes through two types of filters (#2422 and NLW filters). Responses were measured when horizon elevation and background illumination were varied. Differences in these variables affect how turtles perceive (and respond to) artificial lighting (Salmon and Witherington, 1995).

Objectives

Our goals were to determine: (i) if hatchlings ignored filtered lighting, (ii) if species differed in how they perceive filtered light, and (iii) how hatchlings responded to filtered lighting at beaches when orientation cues (dune/vegetation elevation) and background illumination (from moonlight) varied.

METHODS

Hatchlings. Hatchlings were obtained from nests in the afternoon of the day they were scheduled to emerge. They were stored in a dark room exposed to ambient temperatures (27º - 30º C) until evening tests began. All hatchlings were released later that night at a dark beach (by standard methods, W.A.T.S. Manual, 1982).

Arena. All experiments were performed in a 1.2 m circular arena (see Salmon et al., 1992). The arena floor was made of rough-textured plywood, painted flat black (1.1 m in diameter). The arena wall was made of white styrene screening (1 mm thick). The top of the arena was marked in 5º increments.

"Streetlight" Surrogates. Miniature book lights ("itty bitty" vol. 2 Model 10050) were used to simulate poled "cut-off" streetlight fixtures on a coastal roadway. Light intensity (4.5_1012 photons/cm^2/sec), elevation (35º) and fixture separation (90º) was the average of several measurements at local nesting beaches. Lamps were placed at the arena periphery.

One of two colored acrylic filters (# 2422 filter, transmits wavelengths above 530 nm; NLW filter, transmits wavelengths above 570 nm) was inserted in the pair of book lights during each experiment. Black plastic electrical tape formed a lip around the shade to control light scatter. Light transmission from the book lights matched the manufacturer's (G. E. lighting) specifications.

Hatchling Orientation. During experiments, hatchlings were tethered to the center of the arena by a short (8 cm) monofilament line. Tethered hatchlings crawl continuously, can orient in any direction, but are restricted to a fixed distance from the arena walls and lights.

Each turtle was allowed one min to select an orientation direction; its orientation was then recorded every 10 s for ten readings. The turtle was then removed and replaced by another tethered hatchling (placed in the arena at a 90* angle to the right of the previous hatchling's placement). Each hatchling was used in only one trial. Hatchlings that failed to crawl within one minute were not included in the data. Turtles from at least two nests were used in each experiment.

Silhouette Elevation Experiments. We placed dark silhouettes, extending 180* around the horizontal visual field, on the "landward" side of the arena. These simulate vegetation on a dune behind a natural beach. Silhouettes were made of flat-black (Widestone Seamless) paper, cut into a crescent shape. Silhouette elevation (in degrees) was measured from the hatchling's head to the top of the crescent. Responses were measured with two lights on when (i) no silhouette was present, or (ii) when turtles were exposed to 2*, 4*, 8* or 15* high silhouettes. Different silhouettes were used after testing 3-6 hatchlings so that turtles from single clutches were exposed to all elevations.

Lunar (Background) Illumination Experiments. Lunar illumination levels measured in the field were duplicated inside the arena by weak overhead lighting (7.5 W bulb; intensity reduced with a rheostat), transmitted through a 1.22 m2 diffusing screen.

The following "lunar illumination" tests were performed: (i) streetlights on with lunar illumination; (ii) streetlights on without lunar illumination, and (iii) streetlights off with lunar illumination.

Data Analysis. The ten readings for each turtle were averaged to estimate its mean orientation and dispersion. Rayleigh tests were performed to determine if the groups of turtles were significantly oriented ($p < 0.01$) toward or away from the lights (Zar, 1984).

RESULTS

I. Responses to filtered lighting alone: Hatchlings of both species were significantly attracted to both sources of filtered lighting.

II. Responses to #2422 filtered lighting and silhouettes: Loggerheads showed no significant orientation in the presence of 2º, 4º, and 8º silhouettes. They crawled away from filtered lighting ("seaward") in the presence of a 15º silhouette. Green turtles failed to show significant orientation in the presence of any silhouette.

III. Responses to NLW filtered lighting and silhouettes: Loggerheads failed to show significant orientation in the presence of any silhouette. Green turtles showed significant orientation only when exposed to a 15º silhouettes.

IV. Responses to #2422 lighting and "moonlight": Loggerheads (tested in the presence of a 4º silhouette) and green turtles (tested in the presence of an 8º silhouette) failed to show significant orientation when exposed to only streetlight illumination. Both species showed significant "seaward" orientation in the presence of moonlight with the streetlights on or off.

V. Responses to NLW lighting and "moonlight": Loggerheads and green turtles showed significant "landward" orientation when exposed only to streetlight illumination. Both species showed significant "seaward" orientation when exposed to moonlight with the streetlights either on or off.

DISCUSSION AND CONCLUSIONS

1. Both loggerheads and green turtle hatchlings are attracted to #2422 and NLW filtered lighting. Filtered lighting is not "turtle-friendly", as claimed by GE! However, turtles might be less attracted to filtered than to unfiltered lighting of the same intensity. Experiments (by Kristen Nelson, FAU Masters student) to test that hypothesis are underway. Results will be reported next year.

2. Dark, elevated silhouettes provide important natural cues for hatchling seaward orientation (Limpus, 1971; Salmon et al., 1992). If silhouettes are sufficiently high (15º), they can reverse the attraction of loggerheads to #2422 lighting, and green turtles to NLW lighting. But 15º silhouettes (which are at the upper extreme of dune/vegetation elevation behind South Florida nesting beaches) are insufficient to reverse the attraction of green turtles to #2422 lighting, and of loggerheads to NLW lighting.

3. Since the responses of loggerheads and green turtles differed, additional experiments are required to establish how each species of sea turtle responds to filtered lighting.

4. Removal of additional wavelengths may benefit some species, but not to others. Green turtles exposed to 15º silhouettes could orient seaward in the presence of NLW lighting, but not #2422 lighting (which contains more light energy at shorter wavelengths). But for loggerheads there was no such "benefit". These results suggest that responses of hatchlings to single wavelengths (e.g., Witherington, 1992) cannot be used to predict responses by turtles to arrays of wavelengths.

5. As reported earlier (Salmon and Witherington, 1995), attraction to filtered lighting is diminished when background (lunar) illumination increases. We now document this effect experimentally. Results support the hypothesis that artificial lighting causes abnormal orientation by its "directivity" (extreme contrast with background; Verheijen [1985]; Witherington [1997]).

6. We conclude that the "best" strategy for protecting turtles from artificial lighting remains turning off the lights. When that option can't be used, then light control (by shielding or lowering fixtures; by reducing wattage) remain the best alternatives (Witherington and Martin, 1996). Filtered lighting is a potentially useful management technique. But before this method can be adopted, new filters must be developed, then tested using several sea turtle species.

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PUBLIC AWARENESS AND EDUCATION PROJECT ON SEA TURTLE CONSERVATION IN HILABAAN AND TIKLING GROUP OF ISLANDS, EASTERN SAMAR, PHILIPPINES

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INTRODUCTION

The importance of sea turtle conservation needs to be understood and appreciated by the local residents of Hilabaan and Tikling group of islands to gain their support towards the program's sustainability. Recognizing this, a public awareness and education project is an essential component of Sagip Pawikan Philippines (SPP). The objectives of this project are: (a) to improve the level of awareness of and educate the local people on the importance of sea turtles and their habitats; (b) to mobilize the local people to participate in the conservation project; and (c) to ultimately change their practices and actions threatening the sea turtle populations and their habitats in the area.

Based on Knowledge, Attitude and Behavior (KAB) survey conducted, appropriate IEC activities and strategies were identified and are now employed. They are designed to be a continuing process that is highly participatory, integrative and connective in order to produce an environment conducive to social transformation. Initial monitoring and evaluation of the project showed that the activities and strategies being utilized are effective although certain modifications are to be incorporated (e.g. use of dialect).

PUBLIC AWARENESS AND EDUCATION ACTIVITIES

Film Showing

It serves as a venue to reinforce existing knowledge on sea turtle and the concept of conservation. This activity utilizes documentary films on sea turtle biology and conservation and the protection of their habitats. These are shown in public places several times to accommodate a large viewing audience. Every after showing, an interaction between the viewers and a researcher follows to make sure that the message of the film is clearly conveyed. At present, SPP is translating these films into Filipino language for the audience better understanding.

Coastal Clean-up

This adopts the strategy of the International Coastal Clean-up of the International Marinelife Alliance (IMA) in order to relay to the local communities the importance of a clean and healthy coastal environment for the protection of sea turtles, the marine ecosystem and humans as well. Local volunteers conduct this during the month of May (Ocean Month in the Philippines and 3rd Saturday of September (ICC Day). Most of the participants of this activity are the youth, ages between 10-20.

Group Discussion

Through this activity, SPP was able to gather information on the current status of the local sea turtle populations and their habitats. It also allowed the team to document and understand indigenous knowledge and practices of the local communities on sea turtles. Discussions also allow the group to jump from one subject to another that were considered important by the local people, e.g. sustainable use of their coastal/marine resources. This also served as a venue for the team to immerse with the local communities to experience the way of life in the islands and establish rapport with them. Also, it enabled the team to learn the language used by the local communities thereby communicating with them more effectively.

Brochure and Newsletter

The purpose of the brochure and newsletter is to (a) disseminate information about the project and the activities being conducted, thereby increasing the awareness of the people, and (b) forge linkages and solicit support from institutions and individuals. These are prepared in English and Filipino versions and distribution locally and abroad.

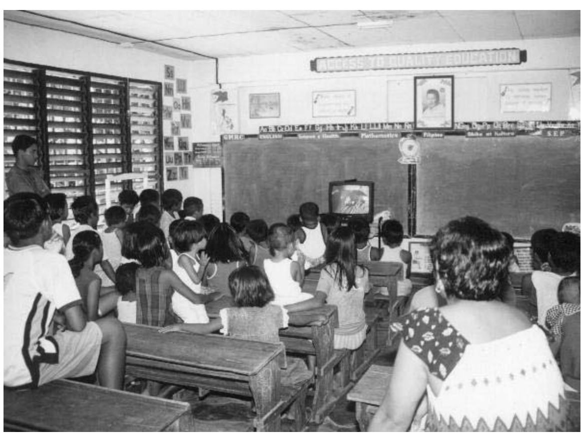
The brochure contains information about the project's importance, role and the different components. A portion of the brochure is devoted for those individuals who are willing to support the project in one way or another. Dadhikan, the official quarterly newsletter of SPP, gives its readers an update of the activities of the project. It also contains relevant and useful information intended to reinforce the public awareness and education project.

Information, Education and Communication Campaign

This activity is directed at elementary and high school students in the islands. This includes contests such as drawing, poster-making and role-playing among others. The activities were designed to (a) disseminate to the students information on sea turtles, their habitats, and the issues related to their conservation; (b) make the children recognize and appreciate the role they can play in the conservation process; and (c) set a venue for the children to creatively express their ideas and understanding of such issues. To note, this was the first activity of its kind held in the school. The SPP team commends the principal, teachers, students, and parents for their efforts, active participation, and support.

Billboards

These were erected in each of the three villages of Hilabaan and Kaybani Islands with the assistance of the communities. These are used for posting information materials such as posters, pertinent laws and regulations, and activities of SPP. A portion of the billboard is provided for the use of the local communities.



Exhibits

Photos showing the activities of the program and its progress are exhibited in schools and the communities in the islands. These are also exhibited in the University to gain support from donors and would-be volunteers.

Media Coverage

Through press releases and interviews, information about the project and the volunteers has been reported in newspapers and magazines.

Distribution of Posters and Tokens

Posters are distributed in schools and community centers to serve as reminder on the need to conserve the sea turtles and their habitats. Tokens such as t-shirt are given to individuals who are supporting the program as volunteers, by surrendering sea turtle for tagging and/or for release and reporting nests found.

Acknowledgements:

This project is supported by Project AWARE Foundation of PADI. We are also thankful to Pawikan Conservation Project, Coastal Resource Management Project, George Balazs, Pamela Plotkin, Tries Razak, Christien Ismuranty and Jeff Canin for sharing with us IEC materials. Sagip Pawikan Philippines also acknowledges the travel support provided by The David and Lucile Packard Foundation.

Dadhikan

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IEC Campaign at Hilabaan Elementary School

In celebration of the National Science and Mathematics Month last September, SPP launched a series of IEC activities in Hilabaan Elementary School with the theme "Ako, ang Pawikan, at ang Karagatan" (Me, the Sea Turtle, and the Sea). The activities, which formally opened with a parade on the 11th of September, culminated on the 15th with a role-playing contest and awarding of prizes to the winners of the different contests held. Among the activities conducted were a slogan contest, quiz bee (grades 4 to 6) on the sea turtles and issues related to them, drawing contest for grades 1 to 3, poster-making contest for grades 4 to 6, and essay writing contest for grades 4 to 6. The activities were designed to (a) disseminate to the students information on sea turtles, their habitats, and the issues related to their conservation; (b) make the children recognize and appreciate the role they can play in the conservation process; and (c) set a venue for the children to creatively express their ideas and understanding of such issues. The primary schools of Botnga and Tiking, which are under the administration of the HES, also participated in the activities.

The slogan contest was won by the grade III class while Grade V-1 represented by Gladys Bascuniana and Jessielyn Roncales bagged the 1st place for the quiz bee with 38 pts. The pairs of Ritchel Tegio and Aurelio Cortez and John Bernard Acebuche and Jesica Tabuena, all Grade VI students, won the 2nd and 3rd places with 35 and 34 pts, respectively. The following are the winners of the drawing contest arranged from 1st to 3rd places: Ronald Tabuena, Rose Bea Catuday, and Vincent Bitalo of Grade 1; Joebert Batula,

Some of the winners receiving their prizes from Ms. L. Tegio, the School Principal

Mac Jonathan Albajera, and Kechelle Madeja of Grade II; Jason Batula, Jhanie Padil, and Marivic Acebuche of Grade III; and Marynold Cadalin, Merasol Rebot, and Marilyn Balagbis tied with Bernadeth Catuday from Tiking Primary School. For the poster-making contest, the following students (arranged from 1st to 3rd) took home the prizes: Noe Roncales, Jhun Baragbis, and Joey Roncales of Grade 4; Francisco Albajera tied with Joel Nable, Raymund Rapada, and Tammy Catuday of Grade 5; and John Bernard Acebuche, Aurelio Cortez, and Anthony Nable of Grade VI. A Grade 4 student from Tiking Primary School, Maylin (no family name was written on the entry), was also awarded 1st prize for her poster. Ritchel Tegio, Marianne Catuday, and Jessielyn Roncales bested the essay writing contest.

IEC Campaign/ p.3

'Dadhikan' is a Waray-waray (language of Samar) term which means 'nesting beach.' Incidentally, it is also the name of the beach in Kaybani, Hilabaan where the Sagip Pawikan team first found a sea turtle nest on May 2000.

Contents:

SAGIP (SAVE) PAWIKAN (SEA TURTLE) PHILIPPINES: A COMMUNITY-BASED SEA TURTLE CONSERVATION PROGRAM IN HILABAAN AND TIKLING GROUP OF ISLANDS, EASTERN SAMAR, PHILIPPINES

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INTRODUCTION

Sea turtles in the eastern part of the country (Western Pacific side) still remain vulnerable to a variety of anthropogenic threats. One particular area of concern is the Hilabaan and Tikling group of islands in Dolores, Eastern Samar, Philippines (Fig. 1). In the absence of conservation efforts on these local populations of sea turtles, Sagip Pawikan Philippines (SPP) envisions to address this need through a community-based sea turtle conservation program which shall serve as flagship for a holistic and sustainable management of the coastal resources. This is in response to realizations that despite conservation measures, exploitation of sea turtles continues due to lack of support for or understanding of conservation initiatives since the local people who are affected the most by these measures are not consulted or involved.

The success of the program depends on the participation of the local communities who, being the direct users of the coastal resources, are potentially the best managers. Local communities often have the rights to the local resources, the indigenous knowledge about how to manage their resources, and the power to implement and sustain natural resources management activities over the long term. In adopting a community-based approach, the program will build upon these attributes to extend community involvement beyond being mere sources of information to a more active participation in designing and implementing management strategies with the end-view of benefiting the communities concerned while protecting the sea turtles.

PROGRAM OBJECTIVES

The Program intends to develop and implement community-based conservation strategies for sea turtles and coastal habitats in Hilabaan and Tikling Islands. Specifically, the program aims to:

1. Assess the status of sea turtles and coastal habitats in the area;
2. Evaluate the local socio-economic conditions, cultural settings and political structure; and
3. Develop the capacity of the local communities in the sustainable management of coastal resources.

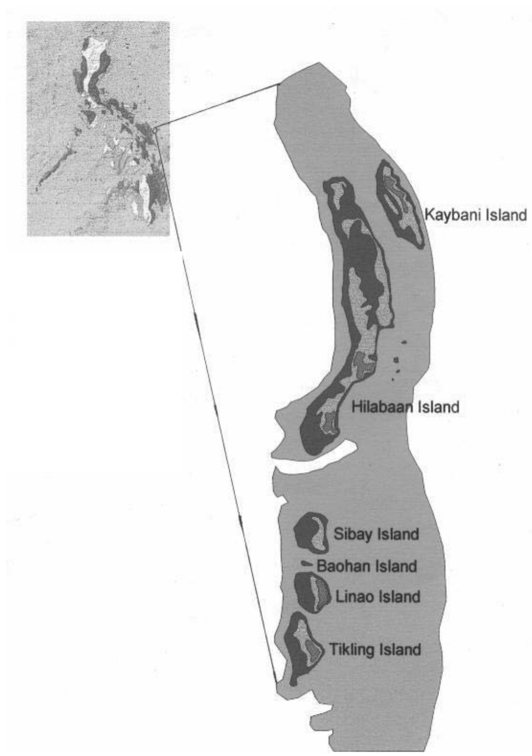
PROGRAM FRAMEWORK

The component on research and monitoring seeks to generate baseline information on the coastal environmental profile (biophysical, socio-cultural & economic) of the islands and an accurate assessment of sea turtle populations in the area. The information gathered will be utilized by the resource management component in the formulation of community management strategies for the conservation of sea turtles and the sustainable management of the coastal environment. Activities to support the conservation program will be implemented to complement the resource management component. The component on public awareness and education intends to enhance the awareness and participation of the local communities on sea turtle conservation and the sustainable management of the coastal environment by using the strategy of community organizing. Since the program has implications on both national and international level, linkages with international and local conservation groups and national and local government agencies will be established and gain support for the Program (Fig. 2).

Research and Monitoring

Aims to establish a coastal environmental profile of the islands and a database on the sea turtle's biology and ecology. Its activities are focused on:

1. Participatory Coastal Resource Assessment (PCRA)
· Habitat Assessment; Resource Mapping; and Socio-Demographic and Economic Survey
2. Social Assessmen
· Knowledge, Attitude and Behavior (KAB) Survey and Policy Research
3. Sea Turtle Assessment and Monitoring
· Population Studies (i.e. Status and Distribution, Genetic Characterization, etc.)



Resource Management

Aims to formulate and implement community management strategies and action plans for the conservation of sea turtles and the sustainable management of the coastal resources.

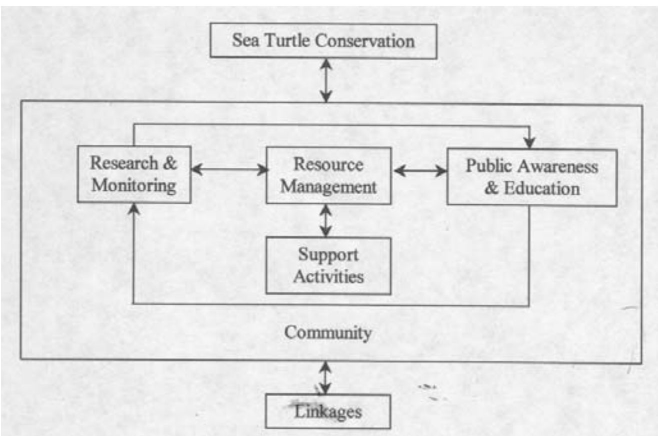
1. Participatory Planning Workshop

2. Implementation of Resource Management Plans and Interventions (i.e. Coastal Rehabilitation Projects, Policy Formulation and Reforms, Coastal Law Enforcement, etc.)
3. Participatory Monitoring and Workshop

Support Activities

Aims to address prevalent social issues in the communities such as poverty, literacy, health and nutrition, overpopulation, and gender equality that have implications on sea turtle conservation and coastal resource management.

1. Development of Sustainable Livelihood Projects
2. Informal Education Project
3. Trainings and Seminars to Increase Awareness on Sanitation, Reproductive Health and Nutrition
4. Increase Women Participation in the Management Planning and Implementation



Public Awareness and Education

Aims to inform, educate and communicate with the local communities about the importance of the conservation of sea turtles and the sustainable management of the coastal environment. The community's participation in the program will lead to social and community mobilization that is vital to the success of the conservation efforts.

1. Film Showings
2. Focus Group Discussions
3. Lectures, Seminars and Workshops

Community Organizing

Serve as the tool to achieve the program's goals. Community participation in every stage of the program implementation is crucial to the success of the program. Activities under this component will focus on:

1. Community/People Development
2. Institutional Building

Linkages

Aims to encourage active participation of outside agencies and interest groups in the program's activities and to build responsible roles of concerned NGOs, POs, academe, international and local conservation and research groups and government agencies including the local government units (LGUs).

ACTIVITIES (ONGOING/CONDUCTED)

1. Knowledge, Attitude and Behavior Survey (KAB)
2. Participatory Coastal Resource Assessment (PCRA)
3. Habitat Assessment of the Coastal Ecosystem
4. Film Showings
5. Coastal Clean-up
6. Community Billboard Installation
7. Training on Sea Turtle and Nesting Beach Monitoring
8. Coastal Resource Management Training and Planning Workshop
9. Information, Education and Communication Campaign at Schools
10. Preliminary Nesting Beaches Monitoring and Tagging

Acknowledgements:

This project is partially supported by the Project AWARE Foundation and the Rainforest Alliance Catalyst Grant. We are grateful to the local government unit of Dolores, Eastern Samar, Philippines, Pawikan Conservation Project and Eastern Samar State College for their support. We would like also to express our thanks to all the volunteers whose dedication and commitment are unmeasurable. Sagip Pawikan Philippines also acknowledges the travel support provided by The David and Lucile Packard Foundation.

STOMACH CONTENT ANALYSIS OF A GREEN TURTLE (*CHELONIA MYDAS*) FOUNDED IN PORSHOURE, ZULIA STATE, VENEZUELA

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La Universidad del Zulia, LUZ, Facultad Experimental de Ciencias, Departamento de Biología. Laboratorio de Investigaciones Piscícolas

ABSTRACT

The Venezuelan's Gulf is considered one of the most important food areas of the green turtle (*Chelonia mydas*) whose feeding characteristics in the gulf aren´t yet known. The purpose of this work is to make a preliminary study of the diet of this species of sea turtle in the Venezuelan´s Gulf. During field activities that took place in the Guajira Camp 2000, which was organized by the Tortugueros of the Venezuelan´s Gulf (TGV), since August 15th to August 25th of 2000 in the Porshoure place in the Venezuelan high Guajira (11º41'55" N; 71º33'44" W), one female subadult specimen of *Chelonia mydas*, was caught and killed by some local fishermen, and a study of the digestive system of the reptile was done by us, so we could analyze its content. This content was collected in plastic bags and then kept frozen until its later study. Turtle's morphometric characteristics were: Maximum Carapace Length (LMC) 800 mm and Maximum Carapace Width (AMC) 730 mm. Plastrom measurements were 660 mm and 610 mm of length and width

respectively. Then, using a dissection equipment we proceed to take samples of food from different parts of the digestive system, and we found as dominant component the vascular plant *Thalassia testudinum*, followed by the marine algae *Fosliella* sp., *Halimeda opuntia* and in less proportion *Sargassum* sp. We suggest to give continuity to the diet studies of the green turtle, because is the most abundant of the Venezuelan´s Gulf turtles and they exclusively migrate to feed in it.

INTRODUCTION

The green turtle (*Chelonia mydas*) is a circumglobal species which represents a primary herbivore in marine ecosystems. Its overexploitation as a food source for humans has turned either in a drastic slope or extinction of some green´s turtles populations in the Great Caribe (Jordal, B. et al., 2000).

Garnett et al., in 1985, determined that the main genera of plants consumed by the green turtle (*Chelonia mydas*) in Torres Strait island (Australia), are *Hypnea*, *Laurencia*, *Videlia*, *Sargassum* and *Thalassia*, concluding that this turtle´s geographic heterogeneity seems to be determined by the herbs and algae´s availability and the structure of the herbivore´s local community. In the Venezuelan's Gulf, diet's composition, feed habits and analysis of the digestive tract system of the turtle have been issues of few interest. The purpose of the present work, is to make a preliminary study of the stomach content and diet composition of (*Chelonia mydas*), and justify its presence in the Venezuelan's Gulf waters as the main zone for feeding of this turtle's species.

MATERIALS AND METHODS

In Porshoure's locality, which is an indigenous community in the high venezuelan Guajira (11º41'55" N; 71º33'44" W) were collected and sacrified by some local fishermen two specimens of green turtle (*Chelonia mydas*). Dead turtles were then weighed and their carapaces measured in total length and width. Later, their digestive tract was extracted and frozen to make its further analysis.

The digestive tract was dissected from the esophagus until the large intestine and cut into pieces in order to reach a better observation of the esophagus, stomach, small intestine and large intestine contents. Every sample obtained from each segment of the digestive tract, was then weighed and fixed using formaline and of course, preserved in alcohol at 70%.

The identification of the examined material was done using taxonomic clues of the vegetal marine life and also by comparison with samples from catalogues of the western part of the country.

RESULTS AND DISCUSSION

The identification of the examined material was done using taxonomic clues of the vegetal marine life and also by comparison with samples from catalogues of the western part of the country .

ISLA AVES WILDLIFE REFUGE MANAGEMENT PLAN (VENEZUELA)

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INTRODUCTION

It is very important to clarify that the management plan proposed here for Aves Island Wildlife Refuge in Venezuela is a preliminary version and in the future will be necessary to introduce some adjustments.

Aves island was declared as a wildlife refuge in September 20th, 1972. This protected area is located to the North East of the Caribbean Sea. It is located to 650 kilometers from the main port of Venezuela (La Guaira) and 200 kilometers from Dominica and Guadaloupe. The studied area has 158,000 hectares and the emerged zone has only 4. There is a naval base close to the island. The access to the protected area must be by maritime way and occasionally by airway.

METHODS

First of all it was performed a bibliographic searching related to the wildlife refuge and also considered the opinions of researchers who knew the protected area. This information was analyzed and the island visited with the purpose to formulate the preliminary management plan . The wildlife refuge was visited during December 2000 and all the environmental conditions were observed and evaluated. Finally, it was prepared the preliminary version of the management plan.

RESULTS

The management plan proposed include the following chapters:

Introduction: The legal fundaments of the creation of this protected area are explained in detail.

Primary Objectives:
a. To conserve the nesting population of green turtle (*Chelonia mydas*) and preserve its habitats.
b. To protect in order to conserve the different resident or migratory birds populations, including the protection of their habitats.
c. To protect and contribute to conserve the fauna and its habitats.

Secondary Objectives
a. To promote the scientific investigation in geomorphology, ecology of endangered species, hydrology, climate and related subjects necessary to understand the dynamic of the protected area.
b. To conserve the ecosystems, the biodiversity and the genetic flew.
c. To conserve the original terrestrial and marine vegetation.
d. To contribute to the management of virgin zones.
e. To incorporate the military personnel in an environmental educational process.

Importance of the wildlife refuge

It is remarkable the geo-strategic meaning of this protected area because it is located close to international navigation routes. This protected area is important not only for Venezuela but also for the international community because Aves island is the most important nesting site in Venezuela and results to be the second in the Caribbean region.

There are some sections related to natural and cultural elements of the wildlife refuge.

It has been identified the most relevant problems in the area, such as:

- Hurricanes occur with some frequency. Obviously, the nests and eggs are lost in this case and the surface available for nesting is reduced.
- Artificial lights installed in the naval base, to illuminate at night disturb the sea turtle females behavior especially with respect the nesting and hatchling. This problem troubles the orientation sense of the adult sea turtles and the new born turtles.
- From the observations performed during the stay in the zone it has been concluded that the surface of the protected area is greater than what has been declare.
- It was also observed that it is necessary to protect the sea turtle nesting area and its feeding grounds, as well as the refuge sectors and mating area.
- The protection of this additional area requires an agreement with the naval base, because this zone is under its administration.
- Naturally the presence of the military base with its contingent generates waste material which should be discarded adequately.
-The restricted access to the protected area, because as it has been mention, the only way to arrive there is by military transport. In this way the control and environmental studies are limited. So, the last systematic observations about sea turtles and birds were performed in 1997.

The zoning proposed in this plan indicates that the integral protection zone (area with more restrictions) is one of the biggest. It guarantees to protect the green sea turtle nesting area, its feeding grounds, refuge sectors and mating areas.

Surrounding the cited zone is the managed natural environment zone. The special use zone corresponds to the site where is located the naval base. It has been proposed two navigation channels. The chapter of using regulations include a whole of forbidden, restricted and allowed activities and uses in the wildlife refuge. These regulations are oriented to maintain its natural condition and let mainly the access of personnel involved in vigilance and conservation.

The administration and management programs include: basic and applied investigation and those related with process analysis of accumulation of sediments, environmental education, protection and vigilance.

CONCLUSIONS AND RECOMMENDATIONS

According the different considerations presented here the conclusions and suggestion for the first step of the management plan shall be:

- To establish an agreement between the Minister of the Environment and Natural Resources and the Venezuelan Navy. Among the purposes of this agreement should be to avoid the duplication of functions and get the reciprocal collaboration in order to facilitate the access to the protected area.
- To get the performing guaranty of the proposed programs, to diffuse them in order to promote the participation of environment NGO´s, universities and other institutions related with conservation.
- The goal is to establish an investigation center and generate additional financial support from national and international sources.
- To define and precise the plan with solid fundaments in order to diffuse it with success at the national and international level.
- A well elaborated plan is necessary to get the financial support by different sources.

ACKNOWLEDGEMENTS

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LOGGERHEAD (*CARETTA CARETTA*) NEST PLACEMENT ON PRITCHARDS ISLAND: MEASURING GROUND-WATER INUNDATION AND SAND TEMPERATURE FOR MANAGEMENT SUCCESS

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INTRODUCTION

Pritchards Island, SC, USA is a highly erosional, undeveloped, 4 km long barrier island. Due to increasing erosion experienced on the island, suitable nesting habitat is restricted to a 1.25-km section of beach fronted by a low dune system. Nest management practices on the island include nests left in situ, nests relocated higher on the beach, and those relocated to a hatchery (58 %, 17 %, and 25 % respectively during the 2000 season). Two studies were conducted to evaluate ground-water inundation of nests and sand temperature of a hatchery in order to assess these nest management practices.

STUDY 1: GROUND-WATER INUNDATION OF NESTS

Nests that are laid at and below the spring high tide line typically experience tidal inundation as well as ground-water inundation (Hamilton & Cowgill, 2000). Nests that receive prolonged periods and excessive amounts of inundation may result in poor hatch success. This study assessed the ground-water inundation of nests laid at or below the spring high tide line.

METHODS

Four, 36” long, calibrated pipes were fitted with styrofoam floats attached to marked wooden dowels. The dowels were marked off in 1-inch segments. The pipes were buried 24 inches below the surface of the sand at the mean, and spring high tide lines, in the middle of the wash zone between the mean and spring high tide lines, and at the level of the hatchery along a transect perpendicular to the beach. As the tide advanced, the floats allowed the dowel to move up through the calibrated pipe with the rise in ground water. During new moon spring tidal events, measurements were recorded every 15-minutes for a period of 2 hours before and 2 hours after the predicted high tide (based on tide-table readings for the area). Measurements were collected by reading the number of inches the dowel rose above the top of the calibrated pipe. Data was collected for a 3-day period during the 3 new moon spring tidal events in June and July. The readings at each hour were then averaged from all three trials to show the mean water level at each hour.

RESULTS

The mean water level, in inches, for each hour measured at the mean high tide line, in the middle of the wash zone between the mean and spring high tide lines, and spring high tide line was determined. The hatch success difference for nests laid above the spring high tide line, at or below the spring high tide line, and hatchery nests was calculated. There was no registered rise in ground-water at the level of the hatchery. Note: All figures and tables available upon request.

DISCUSSIONS & CONCLUSIONS

The results found on Pritchards Island are similar to those found on Kiawah Island by Hamilton & Cowgill (2000). Nests laid at or below the spring high tide line were inundated during some spring tide cycles. Approximately 30 – 45 minutes before the predicted time of peak high tide, the ground-water begins to rise at the spring high tide line. Nests laid at the mean high tide line start to receive some degree of ground-water inundation two or more hours before the predicted time of peak high tide. Both the predicted tidal height and the offshore winds, which push the tide further up the beach slope, influence the level of rising water. This inundation could explain the difference in hatch success between the nests laid in the wash zone (i.e., spring high tide line or below) and those located on higher areas along the beach. Therefore, it is recommended that nests laid at or below the spring high tide line should be relocated to higher areas on the Pritchards Island nesting beach.

Limitations and recommendations of the study include:
- Measurements were restricted to new moon spring tides. A wider range of tidal occurrences across the entire nesting season can provide a broader picture of the extent of ground-water inundation.
- Need to duplicate the transects at several different locations along the nesting beach to establish a ground-water profile for the entire nesting area.
- Sand accumulation at the bottom of the measuring devices (calibrated pipes) needs to be remedied. Adding a fine mesh sieve at the bottom of the pipe, that allows only water to pass through, may resolve this problem.
- Need to evaluate beach characteristics, such as slope, grain size and composition, that affect the rise and flow of ground-water.
- Collecting and applying meteorological information to explain variation in the rise of water level during trials.

STUDY 2: SAND TEMPERATURE OF A HATCHERY

According to Mrosovsky and Yntema (1980), the temperature at which a nest is incubated determines the sex of the hatchlings produced in a nest. Therefore, it is important to ensure that sand temperatures inside a hatchery are similar to those outside a hatchery. The objective of this study was to record and compare sand temperature profiles both inside and outside a hatchery throughout the nesting season.

METHODS

Calibrated electronic HOBO temperature dataloggers were used to monitor sand temperature at 15, 30, and 60 cm. Four locations were selected to record sand temperature: two locations inside the hatchery between two rows of seven nests each, and two locations outside the hatchery at a distance of two feet away from the hatchery walls. Dataloggers were not placed inside nests, but rather in the sand. The dataloggers were programmed to record temperature at 30-minute intervals from 21 May – 29 September 2000. Data was analyzed with a MS Excel ’97 statistical package using ANOVA. All sets, both inside and outside the hatchery, were compared between each other. (Note: The hatchery was constructed entirely of plastic materials).

RESULTS

The bi-monthly means for sand temperature for all datalogger sets, both inside and outside the hatchery, at 15, 30, and 60 cm respectively were calculated. The mean for each datalogger set at each location (± SD), inside and outside the hatchery, over the entire nesting season, as well as means that were significantly different from other means in the data set (ANOVA, $P < 0.05$) were determined. Note: All tables and figures available upon request.

DISCUSSIONS & CONCLUSIONS

Analysis of the sand temperature data indicate that there are statistically significant differences, (ANOVA, $P < 0.05$), between the means of the sand temperature inside and outside the hatchery. While the differences in the mean values are small, a difference of one degree can make a difference in the sex ratio of sea turtles, making a more detailed research effort necessary. As expected, there were greater fluctuations in temperature at the surface depth (15 cm) than at the lowest depth (60 cm).

Limitations and recommendations of the study include:
- Possible ghost crab activity around the dataloggers. Ghost crab activity inside and outside the hatchery needs to be controlled in the future.
- Possible impact caused by relocating new nests into the hatchery in the vicinity of the dataloggers.
- Creating a more extensive data set using replicates and several more sampling sites inside and outside the hatchery.
- Future use of more compact dataloggers with a higher precision of measurement.

The current study has identified a potential difference in sand temperatures between the hatchery and the adjacent dunes, indicating a need for further investigation. Therefore, this research will be continued in order to more thoroughly evaluate the use of hatcheries on Pritchards Island, given the current need to use hatcheries due to extensive loss of nesting habitat. Alternatives to the use of hatcheries will continue to be explored and evaluated as well.

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HILABAAN AND TIKLING GROUP OF ISLANDS: IDENTIFIED SEA TURTLE NESTING AND FEEDING GROUNDS IN EASTERN SAMAR, PHILIPPINES

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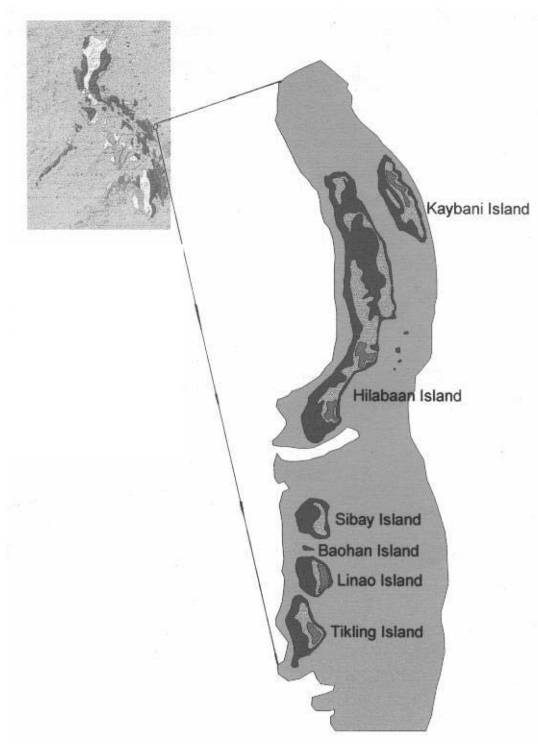
INTRODUCTION

Hilabaan and Tikling group of islands are known foraging and breeding grounds of hawksbill turtle (*Eretmochelys imbricata*) and green sea turtles (*Chelonia mydas*). They are often seen foraging along the reefs of the islands. Likewise, they are seen nesting from April – August. However, sea turtle populations in the area are threatened with extinction because the local inhabitants hunt them for their meat and collect their eggs.

Based on a survey conducted in 1993, the Department of Environment and Natural Resources – Regional Office 8 (DENR – RO 8) recommended the declaration of Hilabaan and Tikling group of islands as a Marine Turtle Sanctuary or Marine Park. However, the proposal was disapproved by the Protected Areas and Wildlife Bureau (PAWB) of DENR - Central Office because the islands are inhabited and inaccessible for conservation-oriented recreation and education. Again in 1994, based on a Protected Area Suitability Assessment (PASA) and a Resource Basic Inventory (RBI) conducted, DENR - RO 8 submitted another proposal. This time, as a Marine Protected Area under the National Integrated Protected Area System (NIPAS) Law. The primary objective of declaring the area as such was for scientific, academic and tourism purposes. Until now, the proposal is still pending while the sea turtles are being exploited and their habitats continuously destroyed.

PROJECT SITE

Hilabaan and Tikling Group of Islands are situated at the eastern part of the Philippines facing the Western Pacific Ocean (Fig. 1). The coordinates are 12O02’23.1” N and 125O33’49.8” E. They group of islands belong to the municipality of Dolores, Eastern Samar. They have a combined land area of 161.20 hectares. Hilabaan is composed of the island of Hilabaan, Kaybani and Kankahinbong while Tikling is composed of Sibay, Baohan, Linao and Tikling. They are known for its extensive reef flat and sea grass beds, white sandy beaches and the presence of sea turtles. A survey conducted by the Department of Environment and Natural Resources confirmed the presence of nesting and feeding hawksbill and green sea turtles in the area. About 50 or more are known to nest in the islands per season. A third species, the Leatherback, is usually encountered by the fisherfolk while fishing.



Hilabaan group of islands comprises 1 barangay with 3 villages. These are Centro Hilabaan, Sitio Botnga and Sitio Kaybani. On one hand, Tikling group of islands comrpises another barangay with 2 villages. These are Sitio Linao and Tikling itself. Based on secondary data and a survey conducted, the 2 barangay islands have a combined population of 2,787 with an average family size of 8 individuals. The main source of income is fishery, both deep sea and artisinal. Average daily income is 151.00 – 200.00 Philippine peso (US$3.78-5.00). Highest educational attainment in the islands is high school level.

Preliminary data gathered have identified nine beaches as nesting sites. However, the nesting population is very critical with only two nests of hawksbill recorded and none for the green sea turtle last April – June 2000, a far cry from the numbers reported by DENR. In contrary, the local fisherfolk are regularly able to catch juvenile and adult hawksbill and green sea turtles suggesting a good number of feeding populations. This reflects the urgency for the conservation of the sea turtles and their habitats in the islands.

PRELIMINARY RESULTS

Based on interviews and preliminary monitoring of the area from April – May 2000, the following data were gathered:

Species Found : Hawksbill Turtle (*Eretmochelys imbricata*)Green Sea Turtle (*Chelonia mydas*)
Nesting Season: April – August
Identified Nesting Beaches: 9 (Dadhikan, Darnasan, Maktang, Liogan, Sapao, Sibay, Baohan, Linao and Tikling)
Feeding Season: Year-round
Feeding Grounds: The green sea turtles prefer the western side of the islands where sea grass beds are extensive.The hawksbill turtles prefer the eastern side where corals abound at the reef edge.
Number of Nests Found: 1 Hawksbill turtle nest(150 eggs)
Number of Turtles Tagged: 1 Green sea turtle(CCW = 76 cm & CCL = 85 cm)
Number of Turtles Captured: 8 Hawksbill turtles (ave. CCW = 33.31 cm & CCL = 35.18 cm)9 Green sea turtles(ave. CCW = 46.05 cm & CCL = 49.33 cm)

CONCLUSION AND RECOMMENDATION

As shown by the preliminary data gathered, the islands are indeed potential nesting and feeding grounds. However, there is a need for an intensive data gathering on nesting and feeding populations and genetic study in order to characterize the sea turtle population in the islands. Results of these studies should be the basis for declaring or rejecting the islands as protected areas for sea turtles.

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COMPARISON OF METAL CONCENTRATIONS IN THE BLOOD AND CARAPACE OF WILD KEMP'S RIDLEY SEA TURTLES (*LEPIDOCHELYS KEMPII*) ALONG THE TEXAS/LOUISIANA COAST

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Heavy metal (Ag, Cd, Dr, Cu, Hg, Pb and Zn) concentrations for blood and carapace tissues were determined of Kemp’s ridley (*Lepidochelys kempii*) taken in entanglement sets along the upper Texas and Louisiana coast during May-August 2000.

All metal concentrations were highest in carapace tissues. Cu and Hg concentration in blood and carapace tissues was positively related to size of turtles. Blood-borne Cd varied directly with turtle size while that in carapace tissues exhibited no definitive relationship. Pb concentration-size relationships for blood and carapace tissues were the converse of those for Cd. No concentration-size relationships were detected for Cr and Zn.

Blood and carapace tissue represent effective non-invasive indicators of heavy metal uptake in sea turtles. However, safe invasive sample collection techniques must be developed for characterizing metal concentrations in internal organs and muscle tissue. The latter analyses are essential to a complete understanding of contamination uptake across the ridley’s life span.

DISTRIBUTION AND IMPACT OF ANTS ON A SEA TURTLE NESTING BEACH IN PALM BEACH COUNTY, FLORIDA

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The best known and most destructive exotic ant species in the US is the red imported fire ant, *Solenopsis invicta*, which arrived in Alabama by ship from South America less than 80 years ago. This predatory ant, well-known for its powerful sting, has spread across the southeast US from Texas to North Carolina, particularly disturbed areas, where it displaces the native fire ant *Solenopsis geminata*, kills off native invertebrates and vertebrates, and causes tremendous economic damage (Tschinkel 1988; Porter & Savignano 1990; Wojcik 1994). *Solenopsis invicta* is a well-known killer of hatchling birds and reptiles (see Dickerson 1995; Lockley 1995; Love 1997; and many others). For example, Drees (1994) found that attacks by *S. invicta* and other ants resulted in a 92% reduction of hatchling survival in several species of colonial waterbirds. Allen et al. (1997) found that hatchling alligators stung by *S. invicta* showed decreased weight gain and increased mortality. The depredations of *S. invicta* in the US are far from unique; other ant species are causing similar problems all over the world.

Most sea turtle nesting areas in Florida are now infested to varying degrees with fire ants, particularly *S. invicta* (J. Wyneken, pers. comm.). Hatching sea turtles are vulnerable to attack by ants because hatchlings typically take from several hours to several days after pipping before they emerge from their nests. During this time, ants invade the nests and attack trapped hatchlings, particularly their sensitive eyes. The great threat of S. invicta to hatching sea turtles is only recently gaining recognition. In Key West Wildlife Refuge, Florida, Wilmers et al. (1996) found a great increase between 1990 and 1994 in the proportion of sea turtle nests infested with *S. invicta*, e.g., infestation rate at Main Beach in Marquesas Keys increased from 0% in 1990-1992, to 9% in 1993, and soared to 50% in 1994. LeBuff (1990 in Moulis 1997) concluded that on Sanibel Island, Florida, "fire ants were the most dangerous predators upon hatchlings." Whereas numerous papers report fire ants attacking sea turtle hatchlings, the only quantitative work on impact was done by Moulis (1997) in Wassaw National Wildlife Refuge, Georgia, who found a significant decrease in emergence success in loggerhead (*Caretta caretta*) nests infested with fire ants compared with uninfested nests (40.6% vs. 54.0%).

In our research, we documented the distribution of ants in a South Florida sea turtle nesting area to evaluate the impact of ants on sea turtle hatchlings.

METHODS

We studied ants at sea turtle nests along a 9 kilometer stretch of beach in northern Palm Beach County, on the southeast coast of Florida, "piggy-backing" with on-going research at the Marinelife Center of Juno Beach on sea turtle emergence success (Rusenko and Wood 1995; Wood et al. 1999). Every morning during nesting season, March to October 2000, we identified all new turtle nests along the entire stretch of beach, recording information on their locations using DGPS, as well their distance from high tide mark and dune vegetation. We then marked a fraction of the nests for further study: ~10% of loggerhead, ~50% of green turtle (*Chelonia mydas*), and 100% of leatherback (*Dermochelys coriacea*) nests. Each marked nest was then monitored every day for disturbances such as mammal predation or nest inundation. Three days after hatchling emergence (or 70 days after laying, if no eveidence of hatching was observed), we excavated each marked nest and recorded the number of unhatched eggs, shells of hatched eggs, and live and dead hatchlings (pipped or fully hatched) within each nest.

We surveyed ants on marked nests by placing a folded index card with 1 g of tuna within 0.5 m of the marking stake between 10 PM and 11:30 PM. We returned 2 hrs (+ 15 min) later and collected the cards, putting each in a separate zip-lock bag. After killing the collected ants in a freezer, we counted the ants in each bag and preserved the ants for later identification. In addition, because *S. invicta* typically dominates only disturbed habitats (Tschinkel 1988), we recorded adjacent land use and level of human recreational activity along this stretch of beach.

RESULTS

We surveyed ants on 912 marked sea turtle nests: 587 loggerhead, 292 green, and 33 leatherback turtle nests. A total of 570 (62.5%) of these nests had ants present (for baits with ants: range = 1 - 1030 ants; median = 41 ants). The percentage of nests with ants present declined from 93.1% for nests within 2m of the dune vegetation, to 14.8% for nests further than 18 m from the dune vegetation (Figure 1). We found a total of 19 ant species (Table 1), the most common of which was *Solenopsis invicta*, occurring at 328 nests (36.0%). Eleven of the ants species were not native to Florida (Table 1).

Combining data on nest location, ant distribution, sea water inundation, adjacent land use, and other factors with turtle hatchling mortality data will allow us to examine how different factors related to hatchling mortality within the nest. So far, we have only performed very basic analyses of our data. Of the 912 surveyed nests, 745 succeeded in producing live hatchlings (the remainder were primarily washed away or dug up and destroyed by vertebrate predators, such as raccoons). Nests without ants (n = 262), with 1-9 ants (n = 128), 10-99 ants (n = 180), and 100+ ants (n = 174) at the bait had, respectively, an average of 3.7, 4.0, 4.5, and 5.8 dead hatchlings (pipped or hatched) per nest. Thus, nests with more than 100 ants at the bait had 57% more dead hatchlings within the nest than did nests without ants.

DISCUSSION

Our research indicates that sea turtle nests with more ants present have increased within-nest hatchling mortality. Nests further from the dune vegetation are less likely to be attacked by ants, but these nests are also closer to the water where they are likely to be inundated by the tide or washed away during storms. Nesting placement for sea turtles thus involves a trade-off of threats, especially on narrow beaches. We still need to perform detailed MANOVA analyses to evaluate how all measured factors interact to influence within-nest mortality of hatchling sea turtles.

In addition to *S. invicta*, we found at least one other exotic ant species that may seriously threaten sea turtle hatchlings: the little fire ant,*Wasmannia auropunctata*. Locals in the Solomon Islands reported that W. auropunctata, commonly attacks the eyes of dogs who eventually become blind (Wetterer 1997). Similarly problems with *W. auropunctata* have been reported from West Africa (Wetterer et al. 1999). The tropical fire ant (*Solenopsis geminata*), though native to Florida, may also have a negative impact on hatchlings. For example, Kroll et al. (1973) reported *S. geminata* preying on nestling Barn Swallows, Hirundo rustica. *Solenopsis geminata* is also an important invasive pest on Pacific islands (Wetterer 1997).

In 2001, we plan to continue our research on the distribution of ants on turtle nesting beaches and the impact of ants on within-nest hatchling mortality. In addition, we plan to begin new research on the impact of ants on post-emergence hatchling mortality. Hatchlings stung by fire ants while emerging may suffer great increases in subsequent mortality. Live sea turtle hatchlings that we find outside nests covered with *S. invicta*, as well as other stung hatchlings brought into the Marinelife Center for rehabilitation, usually die within a few hours to a few days. We believe that hatchlings may be seriously impaired by even a single fire ant sting and show increased misorientation and susceptibility to predation. In the future, we also plan to examine methods to help minimize the impact of exotic ants on hatching sea turtles.

We hope our research will increase public awareness of the threat of invasive ants to endangered sea turtles and other wildlife, and of the impact of exotic species in general. We are also interested expanding our research on the distribution and impact of ants at other sea turtle nesting sites around the world and invite anyone interested in collaboration to contact us.

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Figure 1. Occurrence of Ants on Turtle Nests

cross hatch = *S. invicta* present

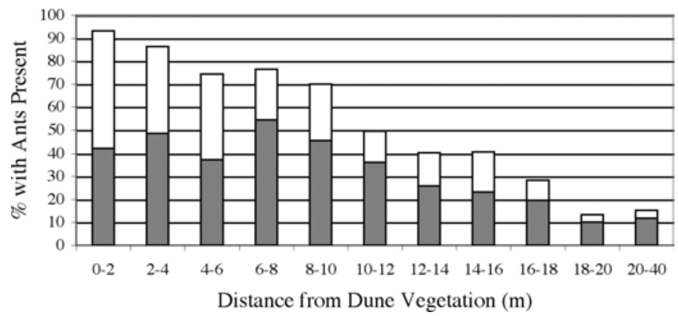

Figure 1. Ant species at bait on 912 sea turtle nests

Known threat to hatchlings	Nests	Exotic
Solenopsis invicta : red imported fire ant	328	X
Pheidole megacephala : big-headed ant	20	X
Wasmannia auropunctata : little fire ant	12	X
Solenopsis geminata : tropical fire ant	2	
Threat to hatchlings not known		
Paratrechina bourbonica : crazy ant	80	X
Dorymyrmex bureni : pyramid ant	60	
Paratrechina longicornis : crazy ant	56	X
Tapinoma melanocephalum : ghost ant	32	X
Camponotus floridanus : carpenter ant	11	
Tetramorium bicarinatum : Guinea ant	10	X
Pheidole floridana : Florida big-headed ant	3	
Technomyrmex albipes : white-footed ant	3	X
Brachymyrmex depilis : rover ant	1	
Cardiocondyla emeryi : sneaking ant	1	X
Cardiocondyla venustula : sneaking ant	1	X
Forelius pruinosus : odorous ant	1	
Pheidole dentata : big-headed ant	1	
Solenopsis globularia : fire ant	1	
Tetramorium simillimum : groove-head ant	1	X

CAPTURE OF JUVENILE SEA TURTLES IN THE BAY SYSTEMS OF ALABAMA

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ABSTRACT

During the spring, summer, and fall of 2000, we surveyed various areas in the bay systems of Alabama in an attempt to identify potential foraging grounds for juvenile sea turtles. We used a tangle net methodology combined with observational surveys. Our results to-date suggest that juvenile Kemp's ridleys and loggerheads do occur in the bay systems but they are at relatively low abundance. We tagged and released two juvenile Kemp's ridleys which were captured near the Mobile Bay channel. Additionally, we have observed and captured juvenile loggerheads in an inlet connected to Perdido Bay. In the case of the juvenile loggerheads, at least one of the turtles was positively identified several weeks later in the same location. We also had several observations of juvenile loggerheads in that same inlet over a period of several months. These data indicate that juvenile turtles occur in Alabama bays, and in the case of at least one location, there is some evidence that turtles may temporarily reside in specific areas. Survey data of this sort are a prerequisite for establishing effective management strategies for endangered sea turtles.

INTRODUCTION

Estuarine ecosystems have been suggested to be a vital habitat for sea turtles in the northern Gulf of Mexico (Hildebrand, 1982; Ogren, 1989). These estuaries may be critical to the survival of Kemp's ridley and loggerhead sea turtles, since they could serve as developmental habitat for juveniles (Musik and Limpus, 1990). Estuaries may be prime foraging grounds for juvenile turtles, since location of turtles has been correlated with certain crabs which are abundant in estuaries (Ogren, 1989).

The coast of Alabama represents one of the largest estuarine systems in the northern Gulf of Mexico. Anecdotal observations in the past indicate that numerous juvenile turtles have been captured in trawls in this area (Carr, 1980; Ogren, 1989). Further, stranding data indicate that both Kemp's ridleys and loggerheads inhabit the near shore waters and bay systems of Alabama. However, these data do not identify specific foraging areas within these waters.

During the spring, summer, and fall of 2000, we surveyed a variety of areas in the bay systems of Alabama for juvenile sea turtles. Information of this sort is a prerequisite for designing an optimal management strategy for juvenile sea turtles.

METHODS AND MATERIALS

We used a tangle net methodology combined with observational surveys in order to examine a variety of areas in the Alabama bay systems. The tangle net methodolgy was similar to that currently being used on a routine basis by sea turtle projects in Florida and Texas (Ehrhart, 1983; Goodman et al., 1996; Schmid, 1998). The tangle net is a relatively long (223 m), shallow depth (3 m), wide mesh (25 cm) net. It is anchored on both ends and supported by floats along the top line of the net. The net is set in potential foraging areas and is continually tended and checked at regular intervals.

We also used observational methods which utilized a "strike net" strategy which has proven effective for catching Kemp's ridley at Ten Thousand Islands, FL (Schmid and Witzell, pers. comm.). This technique involved systematic observational surveys of nearshore waters from a boat. Typically, we would anchor the boat for approximately 30 minutes and post observers to watch for turtle heads in the entire 360 degree area surrounding the boat. We would systematically move the boat in order to cover a given survey area. If a turtle was spotted, the net was then deployed in an attempt to capture the turtle.

RESULTS AND DISCUSSION

During the spring, summer, and fall of 2000 we conducted 22 sampling and/or observational surveys in areas ranging from the far western portion of the Alabama near Grand Bay and Bayou La Batre to the far eastern portion of Alabama in Perdido Bay. We were unsuccessful in capturing or spotting any turtles in bay waters of the western portion of Alabama. We tagged and released two Kemp's ridleys which were captured near the Mobile Bay Channel. One of these turtles was captured by a local fisherman and other was captured during a research trawl by a Dauphin Island Sea Lab vessel. We applied sonic and radio tags to one of those ridleys and tracked it immediately after its release into bay waters off Dauphin Island. The following day we were unable to locate it, thus suggesting that it had moved a considerable distance from the release site. This hypothesis was strengthened by the report several days later of a sighting of small sea turtle with flipper tags and attached objects matching the description of our transmitters. This sighting occurred on the Gulf side of Dauphin Island. Thus the turtle would have had to travel a relatively large distance from the release site through Mobile Channel or Petit Bois Pass and then down along the coast of Dauphin Island.

During the middle of the summer we began surveying Perdido Bay. On two consecutive surveys, we were able to capture two juvenile loggerheads in a channel directly adjacent to Perdido Pass (i.e. Cotton Bayou). We positively identified one of those turtles in the same channel several weeks later. Additionally, we sighted two other juvenile loggerheads on subsequent surveys spanning a two month period in Perdido Bay, but we were unable to deploy the net due to boat traffic. Further, we had two confirmed sightings of "small brown sea turtles" during that time period by workers at local businesses on Cotton Bayou adjacent to Perdido Pass.

These data indicate that juvenile turtles occur in Alabama bays, but we have not found them in high abundance. However, in at least one location (i.e. Perdido Bay) there is some evidence that turtles may temporarily reside in specific areas. We will be continuing our sampling of the bay systems of Alabama during 2001. This study represents a unique opportunity to effectively evaluate the abundance and distribution of sea turtles within the estuarine areas of Alabama.

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NESTING SEA TURTLES RESPOND TO THE EFFECTS OF OCEAN INLETS

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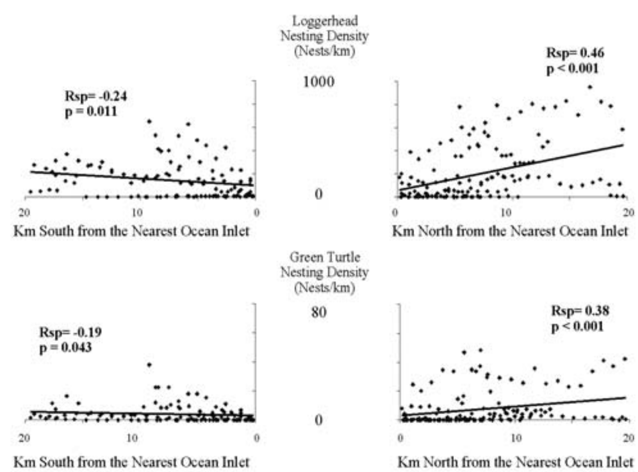
Ocean inlets are tidal channels that lead from the ocean into inshore waterways. Many are anthropogenic and are maintained for navigation. This maintenance involves placement of shore-perpendicular jetties at the ocean mouth of the inlet, periodic dredging of the channel, and occasional artificial placement of sand on the adjacent beaches. Inlets interrupt longshore sand movement on adjacent beaches and frequently mark a boundary between net sand accretion and net sand erosion. In Florida, USA, many inlets cut through barrier islands that serve as sea turtle nesting habitat. We hypothesized that an influence of ocean inlets through barrier islands might affect the nest-site choices of sea turtles. To test this hypothesis, we used a detailed, l2-year record of nesting activity by loggerheads and green turtles at index beaches on the Atlantic coast of Florida to examine relationships between proximity to an inlet and either nesting density (nests/linear-coastline) or nesting success (nests/attempts).

METHODS

Sea turtle nesting data came from a set of Florida index beaches monitored consistently during the 12 years of 1989-2000. Index beaches are monitored daily by track-count surveys during a 109-day season each year. In this study we used nesting data from 249 zones averaging 0.8 km in length, all on the Atlantic coast of Florida and within 20 km of an inlet. Seventeen ocean inlets occur within the coastline covered by these zones and of these inlets, four are centered within index beaches so that at least 6 km of monitored beaches lie both north and south of the inlet. We examined relationships between nesting activity and inlet proximity in two data sets: 1) a composite data set including all nesting zones within 20 km of any of the 17 Atlantic inlets, and 2) four individual case studies of inlets where all nesting was surveyed within 6 km of the inlet.

Figure 1. Relationship between mean annual (1989-2000) loggerhead or green turtle nesting density and the distance north or south from the nearest ocean inlet. Data are from index beach sites on the Atlantic coast of Florida, USA. Rsp is the Spearman Correlation Coefficient for the relationship. Bold statistics are significant at alpha=0.05.



Composite Data

Nesting data came from 249 zones covering approximately one half of the available nesting beach on Florida's Atlantic coast. We plotted the relationship between inlet proximity and two measures of nesting activity by loggerheads and green turtles -- mean annual nest density (nests/km) and mean annual nesting success (nests/attempts). Because variances were unequal despite transformation, a Spearman rank correlation was used to examine relationships between variables.

Figure 2. Relationship between mean annual (1989-2000) loggerhead or green turtle nesting success and the distance north or south from the nearest ocean inlet. Data are from index beach sites on the Atlantic coast of Florida, USA. Rsp is the Spearman Correlation Coefficient for the relationship. Bold statistics are significant at alpha=0.05.

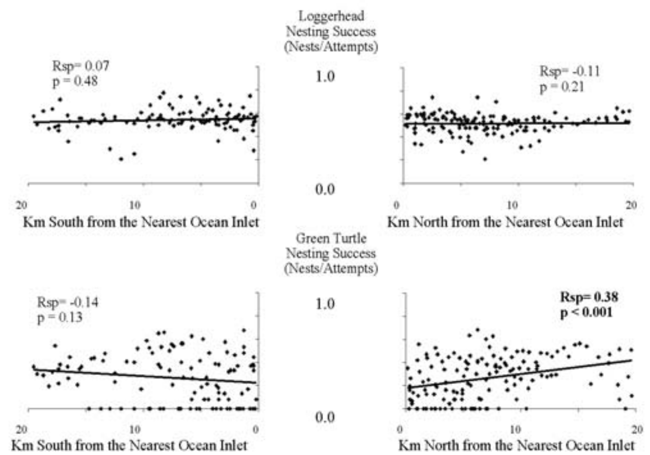
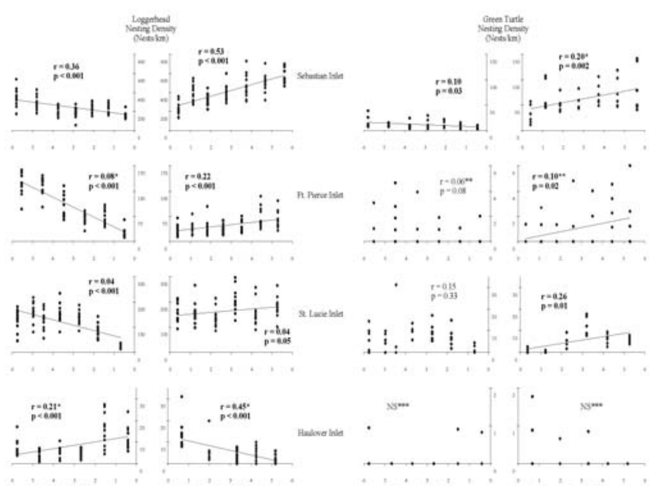


Figure 3. Loggerhead and green turtle nesting density and distance from inlet (south or north) at four ocean inlets on the Atlantic coast of Florida. Nesting densities are means for the period 1989-2000 (see text). Trend lines are present where significant at alpha = 0.05. Some unequal variation in the dependent variable required that the data be transformed. Correlation coefficients marked * are for square-root transformed data, those marked ** are for natural-log transformed data, and *** indicates where there were too few data for hypothesis testing.



Individual Case Studies

We chose four inlets where all nesting was surveyed on adjacent beaches within 6 km of the inlet. For each of these case studies we plotted the relationship between the distance north or south from the inlet and the annual nest density during the period of 1989-2000. High biennial variation in green turtle nesting required that consecutive high- and low-nesting years be combined, however, each of the 12 years of loggerhead nesting density was plotted.

RESULTS

Mean annual nest density (1989-2000) for both loggerheads and green turtles was positively correlated with distance from the closest ocean inlet (Fig. 1). This reduction of nesting density near inlets occurred both north and south of the closest inlet. There was no relationship between distance from inlet and mean annual nesting success in loggerheads, and a significant relationship between the two variables for green turtles was only observed north of the closest inlet (Fig. 2). Loggerhead nesting density was positively correlated with distance from inlet within 6 km either north or south of Sebastian Inlet, Ft. Pierce Inlet, and St. Lucie Inlet (Fig. 3). However, loggerhead nesting density at Haulover Inlet, Miami Beach, was negatively correlated with distance. Green turtle nesting density was positively correlated with distance from inlet within 6 km either north or south of Sebastian Inlet, within 6 km north of Ft. Pierce Inlet, and within 6 km north of St Lucie Inlet (Fig. 3). Green turtle nesting at Haulover Inlet was too sparse to test for relationships between variables.

DISCUSSION

The composite data set shows a general trend of reduced loggerhead and green turtle nesting density near ocean inlets on the Atlantic coast of Florida. For loggerheads, we could not explain this inlet effect by a tendency for loggerheads to abandon nesting attempts on the beach. Rather, loggerheads may attempt to nest at a lower frequency near inlets. Green turtles showed a tendency to abandon more nesting attempts closer to inlets only on the north side of the closest inlet. Of the four inlets used in case studies, Sebastian Inlet, Ft. Pierce Inlet, and St. Lucie Inlet, all showed decreases in loggerhead nesting density with proximity to the inlet. A similar pattern was seen for green turtles, but was statistically significant in only four of six tests (two tests, north and south, per inlet), perhaps because of low overall nesting in the vicinity of two of the inlets. The fourth inlet, Haulover Inlet, is unique from the other three both in its low level of nesting (especially green turtle nesting) and in its high level of human development. It is possible that extensive artificial lighting associated with the city of Miami Beach greatly influenced the pattern of nesting we observed and overwhelmed any effects from Haulover Inlet.

There are many ways that beaches with inlets through them are different from beaches without inlets. One of the largest differences may be in the sand dynamics of the adjacent beaches. Because ocean inlets interrupt longshore movement of sand, beaches near inlets tend to show extensive net accretion on their updrift side and extensive net erosion on their downdrift side. At the Atlantic-coast inlets in this study, beaches immediately north of inlets were typically updrift (accreting) and beaches immediately south were downdrift (eroding). Both accretion and erosion can be the source of high mortality in sea turtle nests. Erosion downdrift from inlets makes it necessary to artificially place sand onto adjacent beaches in order to protect beachfront property. Each of these processes causes inlet beaches to be unstable. We speculate that beach instability near inlets may explain the decreased sea turtle nesting we observed near these features. We suggest that inlets may provide for useful "natural experiments" to study how nesting sea turtles respond to erosion and accretion. Other influences from ocean inlets include the presence of rock jetties, tidal currents, and human activity (likely to be low during nightly nesting). Although it is impossible to examine these effects separately in our study, we reason that each is likely to have a smaller influence on nests and nesting activity than the more profound effects of erosion and accretion.

PRELIMINARY STUDY OF LOGGERHEAD TURTLE NESTING AT A NEW SITE ON KEFALONIA, GREECE

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SURVEY OF WESTERN GREECE

A 1,612 km survey of the entire western coastline of Greece was conducted from 10-18th July 2000, by members of the Ionian Sea Research Institute. The two main objectives were to assess the current *Caretta caretta* nesting patterns in the Ionian Sea, and to record the human impacts in the coastal zone. The survey, which included Kefalonia and Lefkas, extended from the Albanian border southwards and ended at Githio, to the south of the Peloponnese Peninsula. 'Archelon' (STPS) patrols most of the southern beaches, but nests were found in the area of Kiparissia bay that STPS do not monitor constantly. Some nests had been eroded by heavy wave action.

A number of beaches between Igoumenitsa and Preveza were potentially suitable for nesting but had campsites and lighting adjacent to the beach, or were mechanically cleaned at frequent intervals. Two sites have supported nesting but this survey found no evidence of current use. At Ligia beach in the community of Vrachos, it appears that the fisherman still kill the turtles. The west side of Lefkas, south of Agia Nikita, is used as an internesting habitat and may still support nesting.

Garbage

People used every beach that had vehicle access and garbage was present at all sites. Most was plastic (>90%), and much of it ended up in the sea.

Kefalonia - Xi nesting beach

Evidence of nesting was found at Xi and Mega Lakos, two adjoining beaches on the southern shore of the western peninsula of Kefalonia. The site was surveyed weekly by KMTP (1996-1998) but never studied. A research permit was obtained in mid-July 2000 to study *Caretta caretta* throughout the Ionian Sea. As this was too late in the season to properly investigate the female nesting population, it was decided to focus on hatchling emergence and identify nest numbers retrospectively. The nesting season in the Ionian Sea typically extends from the end of May to the first half of August, about 64-68 days (White 1998).

The coastline at Xi divides naturally into three areas, separated by small headlands, extending almost 3 km between 38.09.58N / 020.24.63E and 38.09.70N / 020.26.13E with Mega Lakos being the easternmost beach. The three areas of beach were identified as A, B, and C. The substrate consists of well-drained fine sand on a clay base, and is backed by clay cliffs (2-25m high), with a single small area of sand dune on beach B. A number of bars and pavilions are built on and behind the beaches during the summer months, which are very popular with tourists. A curious feature of the site is that the beach is very narrow (1-3m) in places and can change width during the summer. It can be completely overwashed during the autumn, and was submerged in late-1998. Hatchling crawl length (direct to sea) varied from 3-20 m. The beach width on 16th February 2001 varied between 12-18 m, and is part of an on-going study.

Nest clusters

Fourteen nests were identified from four small areas of the beach. Beach 'A' had 50% of the nests in two small areas backed by low cliffs. Beach 'B', with 36%, had more sporadic nesting, including one in the dune system. Beach 'C' (14%) two nests were laid very close together, in a beach bar, by different turtles, as the first emergents were within three days of each other; hatchlings had to crawl through the sunbeds to reach the sea.

The shortcomings of this study were that only successful nests could be found, as nests were located from emergent hatchling tracks. In addition, nests were not located if tracks were obliterated. Six nests were not found, because either it was not prudent to excavate them, in a beach bar, or wave action completely shifted the surface of the beach in early October.

Nest excavations

Nests were excavated and their contents inventoried wherever possible, after all hatchling emergence activity ceased. The success rate, in-nest mortality and egg number was determined for each clutch at excavation. Dead neonates were preserved for future DNA analysis. Success rate is high 86.28%, SE 2.41SD 6.37, Confidence (95%) 5.89, Range 77-93% (n=7 inventoried nests) and there are no predators. Mean clutch size was 111.4 eggs, S.E. 5.61, S.D. 14.84, Confidence (95%) 13.73, Range 91-139 eggs, (n=7). 780 eggs were inventoried, with 673 live hatchlings produced from 7 nests.

Intermittent hatchling emergence

Asynchronous hatchling emergence, identified by KMTP at Mounda beach 1996-1998 (Houghton and Hays, 2000; White 1998), also was observed for most nests at Xi. The longest period of emergence between first and final emergents from the same nest was 12 days. Mean 5.2 days, S.E. 1.02, S.D. 3.07, Confidence (95%) 2.36, Range 2-12days, (n=9 nests).

Sheep

Late in autumn, 150-200 sheep and goats (Ovidae), traversed the beach early each morning, walking parallel to the water for about one kilometre. All hatchling tracks were obliterated by the sheep but as no hatchling carcasses were found in the sand, I presume that sheep and turtles fortunately missed each other. The most curious observation was that the hoof marks exactly followed the water's edge - producing a scalloped effect in the sand. The flocks used the entire width of the beach, which ranged from 1-15 metres at this time of the year.

Threats

The beach reduced in width during the study period but has yet to be quantified over the whole year. A period of stormy weather in September - October resulted in beach overwash and an extended incubation period for developing nests. The main threats at this site were light-induced hatchling disorientation, sunbed entrapment, garbage, and vehicles occasionally being driven on the beach. Most parasols were permanently fixed, so posed little threat to nests, the sunbeds were placed adjacent to them; no predators were observed in the area. Artisanal fisheries operate just offshore but their impact on sea turtles currently is unknown.

Disorientation

Coastal zone lighting is the main anthropogenic problem but the beach bars and watersports facilities are all in the same area (Beach 'C'). One pavilion has a grey-painted wall at the back of the beach, which is lit from above. Hatchlings emerging from a nest nearby suffered severe disorientation, which in the worst instance, resulted in an >85 m crawl parallel to the sea. The hatchlings hit the wall at the back of the beach on three occasions.

Male foraging area at Argostoli

The nearby lagoon in Argostoli was identified in the early 1990's as a foraging ground for a number of male loggerheads *Caretta caretta*. A stone bridge (height 2 m) links the eastern and western shores and has archways that the turtles swim through. The foraging behaviour was studied in 1998 (Houghton et al. 2000) and turtles were observed on most days.

Construction of a new marina began in 2000, adjacent to the bridge, and very few turtles were observed throughout the year. Turtles may have been present but not visible because the sea surface was always choppy; or they could have gone to other sites because of the increased sediment load in the seawater. The marina is almost complete now (March 2001), so the male turtles may return; regular surveys are being conducted.

Mating areas

Mating may occur in the Ionian Sea because of the males foraging grounds. Marine habitat use is currently being investigated and it is not known if females from different rookeries mate in a common site.

Seawater temperature

The seawater temperature was measured twice per day, using a microcomputer thermometer (Hanna instruments Model HI 9060). The probe was inserted about 5cm below the surface. The study began on 27th August 2000 and is still in progress. The weekly Mean seawater temperature during the 25 weeks ranged between 15.57°C – 25.87°C. Mean temperature 20.15°C, S. E. 0.645, S. D. 3.223, (95%) Confidence 1.33 (n=25 weeks)

Strandings Network

An effective strandings network is in place on the island of Kefalonia. The Port Authority and flotilla sailing holiday companies are amongst the boat users that feed back information to the Ionian Sea Research Institute. Visitors to the museum at Fiskardo can also report sightings of animals at sea.

Rome turtle

23rd December 2000, the Port Authority reported a stranded turtle near to Sami, Kefalonia. This was a large female loggerhead (CCL 83 cm, CCW 77 cm), which had been dead for some time and had a large hole in her skull – cause unknown. The animal was tagged [C67] by the Department of Zoology, University of Roma, in 1991 - following its capture by a trawler from Pescara in the central Adriatic Sea. Measurements at tagging (1991) CCL 69 cm, CCW 64 cm. Growth increments = 14 cm CCL, 13 cm CCW over an 8-year period. No records of nesting have been reported.

Assos turtle

6th September 2000, tourists reported a dead loggerhead at Assos harbour, Kefalonia. This female juvenile (CCL 55 cm, CCW 56 cm) had been dead for some time but the cause of death was a 15 cm long piece of plastic bubble-wrap blocking the mouth and throat.

CONCLUSIONS

The site at Xi and Mega Lakos probably supports a small loggerhead population but the live success rate for nests is fairly high. When loggerhead nesting is considered for the Ionian region, as a whole, there appears to be little crossover between the different sites, and each island may have its own distinct nesting population of loggerheads. Kefalonia may be approaching the northern limits of nesting in the Mediterranean, although nesting may occur in Albania. Nesting has been recorded on Kerkyra (Corfu). Lighting is the main problem at Xi but some of the hoteliers are becoming interested in the turtles, so this issue may be resolved easily. The prestigious Blue Flag award for good beaches includes biological criteria, so can be used to provide additional leverage for protection of sea turtle nesting beaches.

The beach width halved between 24th July and 31st July. First hatchlings were observed on 30th July 2000 and the final nest was laid on 13th August 2000. Wave overwash in the autumn resulted in the failure to excavate the last three nests laid during this study. Hatchlings emerging late in the autumn will probably face stormy weather and lower ambient temperatures, reducing their chances of survival.

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REPRODUCTIVE HISTORIES OF INDIVIDUAL LOGGERHEAD SEA TURTLES ON WASSAW ISLAND, GA

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INTRODUCTION

Several studies have quantified and reported the average reproductive effort or output of individual sea turtles over the course of a nesting season based on clutch size and clutch frequency data (Ehrhart 1980, Frazer and Richardson 1985). Although clutch size and clutch frequency are important quantifiable traits that may provide insight into the evolution of life history tactic in sea turtles, they are certainly not the only determinants of reproductive effort (Frazer and Richardson 1985). In this study we determined: 1) yearly and seasonal trends in clutch size and 2) reproductive effort, which is the total volume of eggs produced by a female per nesting year, for 5 loggerheads on Wassaw Island, Georgia.

MATERIALS AND METHODS

Using nest information collected from the long-term monitoring of loggerhead sea turtles on Wassaw Island, Georgia (Figure 1) from 1973-2000, we compiled the reproductive histories (number of nesting seasons observed) and contributions (number of nests deposited, number of eggs in each nest and reproductive effort of each turtle) for 5 individual turtles. See Williams and Frick (2001) and for detailed methodologies concerning beach patrols and data collections. Data were analyzed using regression analysis and ANOVA. Reproductive effort per nesting year was calculated for each female using the following equation, modified from Van Buskirk and Crowder (1994):

Reproductive Effort (L / nesting year) = [(egg volume) x (total # eggs)] / t

where egg volume was estimated using the volume of a sphere: 4(pi)r3/3 and t = total # of Observed Nesting Years.

RESULTS

There were no statistically significant trends in clutch size for four out of the five individual turtles observed throughout a single nesting season or over consecutive nesting seasons. Only one turtle (Turtle #2) showed a significant increase in average clutch size throughout her 7 year nesting history. Although her average clutch size was consistently low (n= 30 nests, range = 45-73 eggs per nest) and only one of her nests contained more than 100 eggs (106 eggs total), her average clutch size did increase from 51 eggs in 1978 to 84 in 1994 (r^2 = .38, p=.03). The other turtles examined for this study (#'s 1,3,4,5) had average clutch sizes of 120-126 eggs/nest.

Using morphometrics and mass recorded from 298 eggs, the average egg volume was calculated to be 36.88 cc per egg for Wassaw Island nesters. Table 1 presents a summary of each turtle's average observed reproductive effort per nesting season and the known total reproductive effort for each turtle. Since our data are based only on observed nesting events, the reported reproductive effort (L) is the minimum amount of liters of eggs per nesting year.

The range for the minimum reproductive effort per individual turtle per nesting year was 9.69 L – 18.62 L/ nesting year. For each nest deposited, turtles incorporated 2.2 – 4.7 L of eggs per nest (average = 4.1 L of eggs/nest). The total amount of liters of eggs produced by individual turtles within their observed reproductive lifetime ranged between 55.9 – 89.3 L of eggs.

With the exception of Turtle #2, the loggerheads examined in this study contributed similar amounts of L of eggs per nest (Turtle #'s 1, 3, 4 and 5; Table 1; average L of eggs per nest = 4.6). Although Turtle #2 incorporated the lowest amount of L of eggs per nest (2.2 L/nest, Table 1) and consequently the lowest amount of L of eggs per nesting season (9.7 L of eggs/nesting year), she had the third highest contribution of the total number of L of eggs produced during her observed reproductive lifetime (67.8 L of eggs). However, despite Turtle #2's frequent observed nesting episodes (31 nests in 7 years, Table 1), another turtle (Turtle #4) has also been observed for 7 nesting years but contributed 21.5 more L of eggs during her observed reproductive lifetime in fewer nesting episodes (depositing 20 nests, Table 1).

DISCUSSION

Our results support those of Frazer and Richardson (1985) and Ehrhart (1980) for Little Cumberland Island, Georgia and central coast Florida loggerheads, respectively. That is, the loggerheads examined for this study did not show any marked variability between the number of eggs per clutch within a nesting season or over the course of several nesting seasons. However, Turtle #2 (Table 2) did show a slight increase in the number of eggs per clutch from 1978 to 1994 (averaged 51 eggs per nest in 1978 but increased to 84 eggs per nest in 1994). Considering the number of variables potentially associated with egg production (i.e. nutrition, age, genetics, etc.), we are unable to speculate why the average number of eggs per clutch deposited by Turtle #2 has increased.

Van Buskirk and Crowder (1994) reported an annual reproductive effort for loggerheads worldwide as 5.43 L of eggs per year per female. Since the equation they used to determine annual reproductive effort was adapted to incorporate averaged data from numerous loggerhead populations worldwide and to compare their results with other sea turtle species, we adjusted their equation to suit Wassaw's nesting data from a single locality with a smaller sample size. For example, we present our data based on the known number of nesting seasons rather than an average remigration interval determined from several different populations. As a result, the reproductive effort per nesting season for loggerheads reported in our study (average = 13.3 L eggs / nesting year) is higher than the annual reproductive effort reported by Van Buskirk and Crowder (1994).

The reproductive effort (L eggs/nest) displayed by Wassaw Island nesters was fairly consistent between individual turtles, again with the exception of Turtle #2 (Table 6). As a result, Turtle #2's seasonal amount of L of eggs produced was also lower than the other turtles examined (Table 6), despite the fact that she laid the most nests. Thus, clutch frequency is not a good indicator of reproductive effort. It is possible that the difference observed between the seasonal reproductive effort of Turtle #2 and the other turtles examined for this study (Turtle #'s 1,3,4 and 5) is a result of the turtle's nutrition condition (or foraging ground location/condition), phylogenic origin, or age.

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Table 1. Summary of reproductive effort for five individual turtles nesting on Wassaw National Wildlife Refuge, GA 1973-2000. RE = reproductive effort, NYr = nesting year.

Turtle #	Observed Nesting Years	Total # of Observed Nests	Total # Eggs	Total Observed RE (L)	Yearly Observed RE (L/NYr.)	Average RE / Nest (L / Nest)
1	6	18	2135	78.7	13.1	4.6
2	7	31	1839	67.8	9.7	2.2
3	3	12	1515	55.9	18.6	4.7
4	7	20	2421	89.3	12.8	4.5
5	4	11	1318	48.6	12.2	4.4

SEA TURTLE CONSERVATION: NOT JUST PROTECTING AN ENDANGERED SPECIES

Ben Wolf

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INTRODUCTION

In Nigeria, the current state of the Niger Delta can be truthfully described as a collection of angry communities confronting each other, the government and the oil industry. This was not always so, but it was a prediction which sadly came true.

In 1990, the fast growing oil industry was warned by traditional rulers in the region that they were losing control of their youth and that unless the problem was addressed soon, anarchy would descend on the Niger Delta. "Community development" has been for most years limited to military suppression and the throwing around of money to keep the locals quiet. Neither of these measures had helped the communities. By the late 1990s, the Niger Delta was experiencing widespread unrest, mainly involving youths who were, in the absence of military rule, venting their anger over the inequality of the sharing of oil wealth by direct, and sometimes violent, action.

As trouble flared for the oil industry with the local communities fighting for their share, the international press began to demand positive action by environmental and human rights organisations. In the middle of all this sits Akassa, an Ijaw clan of around 30,000 people spread over 3 main islands, sandwiched between other clans, and the oil industry installations in the Gulf of Guinea and throughout the mangrove swamps. Like most Ijaws, the Akassans are primarily fishermen living from hand to mouth, happy to take what they can, when they can and always on the lookout for bettering their lives, which includes looking for oil money handouts. The main difference is that in Akassa, this was done largely peacefully. As one Reuter’s correspondent put it, Akassa is "a haven of sanity in a sea of madness". The question is - why is Akassa different?

The Akassans have tried a new approach to community development - interactive participation by all sectors of the society, using a facilitated bottom-up approach. Instead of having so called ‘development’ being thrust upon them by outside funders who have no idea what is really needed, the Akassa process is one of self-analysis and decision-making by the local people. This process of community development is managed by The Akassa Community Development Programme (ACDP) or Angala (local word for mangrove) as it is often referred to by the Akassans. The ACDP is owned by the Akassa people, facilitated by the NGO Pro Natura International and funded by various interested parties, notably Statoil (Nigeria) Limited.

With a staff of less than 40 and a budget of only around 20,000 US Dollars a year, the ACDP tries to undertake practically all aspects of improving the lives of the Akassans. Poverty alleviation was perceived by the community as being the root cause of their problems and thus is a major constituent of the ACDP’s work. Secondly the villagers agreed that primary health care had to be improved and that training and education are of great importance. The people also showed great concern for their natural resources, especially the forests they rely on for building material and fuel as well as the dwindling fish stocks that are their main source of food and income. Surprisingly, the importance placed on infrastructural development by most outside donors came low on the Akassan list of priorities, although it is not forgotten altogether.

So where do sea turtles come into all this?

Since the 1970s, the Akassans have noticed that their normally bountiful ocean, estuaries and creeks were producing lower catches every year. This was a very disquieting prospect for the people and one they did not know how to deal with. When the ACDP came along, one of the requests for assistance was to find out why fish stocks were collapsing and what could be done about it. Workshops were held with fishermen and women, fisheries researchers, facilitators and members of the ACDP Natural Resource Unit. It quickly became clear that many of the reasons for this decline in aquatic productivity were already known by the Akassans. These included over-fishing due to factors such as lengthened fishing seasons, more boats and people, better equipment, engines, also the emergence and continued presence of commercial trawlers in the near off-shore regions, pollution from oil industry activities and the failure of the younger generation to follow the traditional closed seasons due to the ever increasing cost of living. It was decided by the people to implement a local Fisheries Law to reduce fishing effort and bring in closed seasons again. But how to fight pollution and commercial trawling? With the help of ACDP facilitators it was agreed that one possible angle was to use the sea turtles that come to nest on the Akassan beaches as a tool in the fight against commercial trawlers and (oil) pollution. The use of what was always seen as a bonus supply of meat, a gift from the ocean gods, in the fight against negative outside influences ; was a bit strange at first. However, for most people it soon became clear that this unlikely ally could be used for better purposes than just to fill a cooking pot. The possibility of attracting national and international attention to the plight of the sea turtles, and therefore to the plight of the local fishermen and the environment, was accepted by most Akassans.

A meeting was announced for those interested in this new idea of sea turtle conservation and the facilitators were surprised at the number of participants, especially youths. It was decided to form a conservation initiative with sea turtles as the main focus. Workshops were held to teach the basics of conservation, data collection and conservation education. It was decided that the sea turtle should become the designated emblem of Akassa and the Turtle Club grew quickly into the biggest volunteer club in the Clan.

Currently the official membership list for the club, now called the Akassa Coast Conservation Initiative, numbers just under 100 members. A small amount of funding was made available and in addition to the help of the turtle club volunteers, the ACDP employed 4 full-time Turtle Wardens to cover the stretches of beach on the three main islands of Akassa.

Information on Akassa:

Geophysical info: Akassa is situated along the southernmost Atlantic edge of Nigeria in the Gulf of Guinea, spread over 3 main islands. Oginibiri is part of a larger island to the west, Sangana-Okumbiri in the middle island and Fishtown part of an island to the east. There is approximately 35 kilometres of coastline in Akassa, much of which is sadly unsuitable as nesting sites for sea turtles. The Atlantic shore is subject to a great amount of natural flux, with large masses of sand being carried away in some places and deposited in others. It is not uncommon for beaches to change radically in geophysical make-up over a matter of weeks. This state of flux means that while some areas are developing into ideal nesting sites, others are eroding so badly that trees are toppling onto the beach, making access for man and turtle difficult. Nonetheless, every year there are areas suitable for turtle nesting and the turtles make use of them.

Political and Social info:

The Akassa Clan is divided into approximately 18 villages which are further divided into family compounds headed by a Chief or elder. There may be more than one Chief per village, but there is always an acting head Chief in residence. There are Kings for each major village or group of related villages, but they tend to live outside Akassa in the bigger towns and visit their home communities occasionally. There is a paramount ruler of Akassa, the King or Amanyanabo of Akassa, to whom all other Kings and Chiefs defer to if necessary. Males have a higher status than females, although the average Akassa woman is vocally emancipated within the traditional norms.

Since the advent of oil money, the youths have become more autonomous and respect for their elders, although still there, is not what it used to be.

Although not immediately evident, it must be remembered that ultimate power is in the hands of the local deities via the traditional priests. Juju is real and an everyday factor of life. As there is no police enforcement in Akassa, it is the local traditions that are the law. There is relatively little theft or physical violence as the punishments are harsh.

Sadly, after many years of peace, there have been two short wars between Akassa and neighbouring communities, one having started in November 1999 and another in May 2000. For these reasons Turtle Club activities have been largely restricted to the Sangana-Okumbiri beach since the wars.

Turtle species: From sightings and local knowledge, it was possible to confirm that 3 species were present and nesting in Akassa and a possible 2 further species at least used to be seen in the area.

Turtle conservation as a tool -

Turtles vs. Oil companies:

Although the Niger Delta may give the impression of a largely untouched expanse of jungle (it is one of the largest areas of mangrove swamp left on earth), this impression is false. Every corner, every last islet has been harvested for what it is worth by man, and the Delta supports a huge oil industry, the swamps are dotted with oil installations including numerous gas flares and the ocean is home to an army of oil rigs. Subsequently, pollution is a problem, not only oil based, but also general refuse – from human waste to plastics, much of which ends up on shore. The average Akassan will never drink a Becks, but they all know what a can of it looks like – their children collect them from the beach to make toys.

The actual environmental impact of oil industry activities is poorly understood by the conservationists. It is only the oil companies or those with political power and money who have the facilities to undertake detailed surveys, and they will never part with any information that may shine a bad light on the activities that make them rich. It is common practise for tankers to flush residues into the ocean and for dispersants and emulsifiers to be used to sink oil spillages before the international press is alerted.

A sea turtle conservation programme is something that generates more interest internationally than yet another plea for help for a marginalized community. People are more willing to join the cause to petition oil companies to 'clean up their act' when they hear the pollution is destroying the nesting habitat of an endangered species, as opposed to merely dirtying the nets of some fishermen. Akassans are beginning to appreciate this, and it is the main reason why the sea turtle conservation project has a good chance of becoming sustainable.

Turtles vs. Trawlers:

Legal and illegal trawling abounds off Akassa. Every month there are reports of trawlers plying their trade as close as 300 meters offshore. Like most countries, Nigeria has a 5-mile exclusion zone for commercial trawlers. This means that up to 5 miles from the coast of Akassa, the ocean is reserved for indigenous fishing only. This restricted zone is known as an Exclusive Economic Zone (EEZ). Theoretically no non-indigenous trawlers are allowed in this zone. Unhappily it is common knowledge that the State and Federal Fisheries Ministries as well as the Nigerian Navy claim not to have the funds to undertake ocean-going patrols. So it is free reign to any commercial trawler wishing to fish Akassan waters. It is only the local population that makes any attempt to police their waters.

It matters little where these trawlers come from, but come they do, on a regular basis. Since 1998, the ACDP has been collecting information on trawler activity in Akassa. There are at least 3 sightings of trawlers within Akassa's EEZ every month. On average, there is an incident of trawlers damaging nets, fishermen and/or boats once every 3 months. They often trawl at night for fear of having their registration numbers recorded by locals, and persistently steal the fish that belong to Akassa. In nearly every case brought to the attention of the authorities nothing has been done. There have even been documented cases of armed violence by trawler crews against locals. Incidents of trawler crews using automatic rifles against local fishermen are not fictitious. Official investigations get buried in the corridors of officialdom.

Additionally, although Nigeria agreed to enforce the use of TEDs on commercial trawlers, it is common practise for the trawlers that do have them to sew them shut for fear of losing part of the catch. It is not known how many sea turtles drown in trawlers nets at sea, but in Akassa the number of turtles that are found washed up on shore in trawler nets has begun to be recorded.

Turtle Media:

Without government assistance, it is unlikely that a sustainable turtle conservation programme will succeed. In our campaign to increase pressure on the government of Nigeria, trawling companies and the oil industry, the ACCI and the NR Unit of the ACDP have begun a media campaign. Local information/education campaigns are undertaken, but the message needs to be broadcast outside of Akassa as well. In an attempt to generate national and international interest in sea turtle conservation, radio broadcasts on the issues involved have been undertaken in Bayelsa State radio and are planned for nationally. Newspaper articles and letters to the editor in State and National Nigeria press have also been achieved, with much media interest being generated after the Texaco Funiwa 5 flow station blowout in November 2000. However, the Nigerian press is not immune to exaggeration and there is little one can do about it. In the near future the ACCI hopes to be filmed by a fisheries programme broadcast via satellite throughout Europe, and thus we hope to bring footage of our conservation efforts outside of Nigeria.

Turtles and the Government:

The NR Unit petitions the Government over the issues involved. Letters to the relevant State and Federal Ministries (Fisheries, Environment, Forestry etc) are sent out on a monthly basis. Additionally the NR Coordinator attends meetings of the Nigerian CMS Committee as a representative of PNI Nigeria and is forging other links where possible.

Sea turtles are (theoretically) protected internationally. Even after 4 years, there is not yet full agreement between those Akassans that hunt turtles for food and the conservationists. Nonetheless some funding has come in for conservation efforts, not only in Akassa, and Nigeria has been brought back into the International Convention of Migratory Species (CMS) after having been excluded. Nigeria now sits on Scientific Committee of the CMS and is therefore obliged to enforce the regulations of the trawlers that illegally catch and often kill sea turtles while plundering Nigeria's offshore territories.

It would be foolish to pretend all is rosy in Akassa, the Niger Delta is not an easy place to work and the ACDP has had its share of problems and obstacles. One overriding factor is that money does make the world go round and there simply is not enough of it in the budget to implement all the projects that people want. This leads to conflict and jealousy. There are also a significant number of influential bodies that belittle the efforts made by the ACDP, both inside Akassa and without. Local prejudice includes the belief by some that the ACDP has a hidden agenda and is actually prospecting for oil for it's own benefit. There are still a number of benefit captors who are determined to undermine the work of the ACDP so that the old tradition of collecting money from oil companies to be shared among those with power continues. Nigerian corruption and human greed are also found in the Delta.

However, the ACDP is in its 4th year now and continues to strive for sustainable development and self-empowerment for all Akassans. Some projects have succeeded, others have failed and many more are still struggling to become truly sustainable. The tide of negativity is strong in a people who have seen their homeland abused and destroyed by oil companies and corrupt leaders, and thus it is to be expected that mistrust is common. It would be fair to say that although steps are being taken in the right direction, changing the common attitudes of apathy, greed and selfishness is a battle we have not won yet. It is also a battle we have not given up on yet.

Table 1.0 – Species found in Akassa

Species	Local Name	Common name	Present & nesting	Potentially present but not confirmed
Dermochelys coriacea	Obonghoro	Leatherback	✓	
Lepidochelys olivacea	Henn	Olive Ridley	✓	
Chelonia mydas	Obor	Green	✓	
Caretta caretta	Large Henn	Loggerhead		✓
Eretmochelya imbricata	Mindi-okoko	Hawksbill		✓

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The status of the sea turtle in Nigeria is just beginning to be understood. The major contributors to this report are listed below.

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A LONG-TERM DIETARY ANALYSIS OF LOGGERHEAD SEA TURTLES (*CARETTA CARETTA*)FROM CUMBERLAND ISLAND, GEORGIA

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Foraging is one of the most fundamental ways in which an organism interacts with its environment. Information is lacking as to regional specialization and foraging behaviors of loggerhead sea turtles (*Caretta caretta*), indicating a lack of basic biological knowledge regarding these animals 1,2,3,4. The need for species-specific and spatially-specific information in regard to loggerhead foraging has been suggested for effective management of sea turtles 6.

We conducted an analysis of loggerhead gut contents collected by C. Ruckdeshel of the Cumberland Island Museum from dead stranded turtles on Cumberland Island, Georgia from the years of 1979-1999. Only samples representing complete digestive tracts were used in this study (n=369). This large sample size allowed us to: establish baselines for what is normal in diets; document changes in diet over time; conduct analyses and make detailed comparisons across time and turtle body sizes as well as between sex and health categories; and document how bias may result from shorter-term studies.

Necropsies were performed and gut contents collected from dead stranded turtles on Cumberland Island, Georgia from 1979-present. Each turtle stranded was assigned a unique number corresponding to stranding date, referencing information on the turtles including standard measurements, sex, and body condition and notes on health of the turtle. Entire gut contents were placed on a fine screen, washed, and allowed to dry. Identifiable soft body tissue was preserved when found. ID numbers were kept with all samples, allowing cross-referencing of all information gathered on the stranding.

Food and non-food items were separated and dry weights were recorded for each item found in the sample. Numbers of each prey item were also recorded to allow non-weight-based comparisons of relative abundance of these items whether preserved wet or dry. Unique identifiers representing individuals were counted in order to obtain information on numbers of prey species (e.g. otoliths for fish, chelipeds for crabs, rostral spines for shrimp, etc.). Percent occurrence of food and non-food items was calculated by dividing the number of samples containing each item by the total number of samples (n=369), and multiplying by 100. Proportions for each category of items (e.g. crabs, mollusks, bottom debris, etc) in individual samples were calculated by using the Proportion Number of items. Proportion number represents the number of each prey type divided by the total number of prey species in the sample. These proportions were used to make comparisons and control for biases associated with weight-based comparisons (bias due to heavy prey) as well as biases due to the size of the turtle.

Multiple least squares regression analysis was used to make comparisons of food and non-food items between sex and health categories as well as among seasonal categories. Length (CCL) of turtle was centered and treated as a continuous variable to allow for comparisons across all sizes for each category. Seasonal, sex, and health categories were weighted to account for unequal n in all regressions and Post hoc probing was performed to examine significant effects for any category or interaction 9. The sex category contained 122 males, 217 females and 30 unknown turtles. The seasonal category was comprised of 105 turtles in the spring, 214 in summer 48 in the fall. Only two samples were collected in winter months, so these were dropped from comparisons. 266 turtles were apparently healthy, while 64 were apparently unhealthy and 39 were of unknown health due to lacking field notes. The average CCL for the turtles used in this study was 68.9 cm.

The most common prey type in the diets of these loggerheads were crabs (~78% occurrence) followed by mollusks (~75%) and then fish (~50%). Common taxa found in all of the samples were "micromollusks" (1-3 mm). Due to the extremely small size of these organisms, they are thought to be incidentally ingested and not a target species. Further, most of the micromollusks had drilled shells indicating that they were dead when ingested by the turtle.

Anthropogenic debris (mainly fish hooks, plastics, metals, etc) was found in relatively few of the samples (~12% occurrence) while natural non-food items, such as plant material, occurred in approximately 75% of the samples. Bottom debris, or blackened shell material, was found in roughly 60% of the samples analyzed.

Predominant prey items switched over time. Turtle diets were dominated by crabs in the years of 1979, 1981-87, and 1991-95. In the years of 1988-90 and 1996-99, the diets were dominated by mollusks. In 1980 the diets were slightly dominated by fish. This switching has ramifications for sampling bias in shorter-term studies.

Crabs were the most common prey item in the diets of loggerheads from Cumberland Island. Based on occurrence, hermit crabs were the most common (~68% occurrence) followed by box crabs (*Hepatus* and *Calappa* ~63%), spider crab (*Libinia* ~ 60%), perse crab (*Persephona* ~ 59%), portunid crabs (*Callinectes*, *Ovalipes*, *Araneus*, etc ~ 55%), miscellaneous commensal and unidentified species (~35%), stone crab (*Menippe* ~15%), and lastly horseshoe crab (*Limulus* ~ 3%). While hermit crabs and horse shoe crabs are not true crabs, they are grouped with crabs for convenience.

Amount of crab was found to vary significantly with size of the turtle, showing that the proportion of crabs in the diet increased with increasing turtle size. There were no main effects for health, sex, or season categories in regard to the proportion of crabs eaten. There was a significant health by size interaction (DF = 3.301, $p < 0.05$), however this was solely due to the significance of the 'unknown health' category of turtles ($t = 2.554$, $p = 0.01$). Turtles of unknown health were shown to eat significantly more crabs than healthy or unhealthy turtles while the later categories did not differ from each other statistically.

Mollusks were the second most common prey items. Moon shell (*Polinices* spp.) and whelks (*Busycon* spp.) were the most common of the target species of mollusks. A significant seasonal effect was found (DF = 4.543, $p < 0.01$), showing that there were significantly fewer mollusks in diets in the spring than summer ($t = -3.503$, $p < 0.01$) and that significantly more mollusks are eaten in fall than any other season ($t = 2.818$, $p < 0.01$).

Health of turtle also had a significant effect on the amount of mollusks in the diets (DF= 3.387, $p < 0.05$) showing that unhealthy turtles differed significantly from healthy turtles in the proportions of mollusks in the diet ($t = 2.043$, $p<0.05$). Males and females did not differ in the proportions of mollusks eaten. However, turtles in the unknown sex category ate significantly fewer mollusks than either males or females ($t = -3.138$, $p<0.01$).

Fish were the third most common of the prey types. Loggerheads are not thought to be able to swim fast enough or maneuver well enough to catch most fish. Further, the fish species found are the same as the predominant species in trawl bycatch 10, so we assume these turtles were feeding on bycatch from shrimp trawlers in these waters. Smaller turtles were eating proportionately more fish than larger turtles ($t = -2.075$, $p<0.05$). Males and females did not differ in proportions of fish eaten, however turtles of the 'unknown sex' category ate significantly more fish than either males or females ($t = 2.244$, $p < 0.05$).

No significance was found for size, season, sex, or health categories in the amount of natural non-food items, such as plant material. The amount of anthropogenic materials ingested (mainly fish hooks, plastics, metals, etc.) varied with turtle size ($t= -2.701$, $p<0.01$), decreasing in proportion as the turtles get larger. Healthy and unhealthy turtles did not differ in the amount of this material eaten.

Diets in loggerheads from Cumberland Island were shown to shift significantly over years and among seasons as well as across size classes. These findings point to possible biases in making statements about diets of populations of turtles based on short-term studies that lack a robust representation of size classes.

The larger proportion of bycatch (fish) in smaller turtles may indicate that younger turtles are preferentially foraging on this material. This behavior may place them at greater risks of interactions with trawlers at a life stage that has been noted as being critical to the success of sea turtle conservation 11.

Males and females are not partitioning food resources. The only significant differences found in the sex-based comparisons were due to the 'unknown sex' turtles as compared to males and females. However, this result is not related to sex, but reflects a temporal shift in prey during the earlier years of this study (1980-1981). During these years turtles frequently were not sexed during necropsy.

Healthy and unhealthy turtles differed only in proportions of mollusks in the diets. Significant differences were found for the 'unknown health' category of turtles. However, as this category represents turtles lacking recorded information in field notes, it is likely these were actually 'apparently healthy' turtles. If this is so, differences between healthy and unhealthy turtles may not be fully represented here.

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NESTING STATUS OF THE HAWKSBILL TURTLE, *ERETMOCHELYS IMBRICATA*, IN JAVA SEA AND ADJACENT WATERS, INDONESIA

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Indonesian archipelago consists of 17,508 big and small islands. The islands are surrounded by sea, in which large variety of marine lifes are found include sea turtle. Six species of sea turtle are found in Indonesian waters, i.e.: the hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*), olive rydley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*) and flatback (*Natator depressus*) sea turtle. Among these species loggerhead and flatback have not been found nesting in Indonesian beaches. In the last 20 years, the hawksbill populations have shown a significant decrease compared to other species that has been known nesting in Indonesian beaches.

Base on Indonesian Marine Conservation Data Atlas (1984), there are at least 30 rookeries of hawksbill in Java Sea and its adjacent waters from South China Sea - Karimata strait - Java Sea through Macassar Strait. We have visited most of rookeries to assessed clutch numbers then compare with data summarized by Groombridge and Luxmoore (1989).

The existence of some 30 rookeries in the region of Java Sea and adjacent waters has been documented, but their current status, as well as the population dynamics of hawksbill turtle in Indonesia have been poorly studied. From 1995 through 2000, we conducted beach surveys at 26 rookeries and our findings are presented in this paper.

METHODS

We assessed the status nesting using the following methods:

i) Beach Survey. We used body pit counts to estimate the number of clutches in all of rookeries we visited.
ii) Interview with local people. Information on nesting seasonally at some locations is based on our own observations. At other sites, however, we depended on information obtained during interviews with local people or eggs collectors.
iii) Records kept of payments made to the government where the bid system was implemented. To estimate the numbers of egg clutches were based not on beach survey, but rather on the bid price paid to the local government. The winners of bid system are allowed to collect all of the eggs in the concession area.

RESULTS AND DISCUSSION

Based on our observations at some locations that we protected since 1997, we were able to distinguish between body pits produced during the current and previous nesting seasons. For the site, which we were unable, to use body pits as an index of nesting activity (bid system implemented area), the estimation using bid price as an alternate source data. The result of our surveys, the estimated nesting and comparison to previous clutch estimates provided by Groombridge and Luxmoore (1989) are presented in table 1.

Surveys of 26 of the 30 known hawksbill rookeries in the Java Sea and adjacent waters (Fig. 1) showed that more turtles nested in the western part than in the eastern. The largest number of nests was found on uninhabited islands, and there were only a few very important islands at each rookery.

The table 1 compares the results of our survey of Indonesia rookeries conducted in 1995-2000 with data summarized by Groombridge and Luxmoore (1989). During past decade there has been a drastic decline in nesting hawksbill over a wide geographic area. Overall, when making direct comparisons for only those rookeries surveyed during both our study and the review by Groombridge and Luxmoore (1989) there has been an estimated regional hawksbill nesting decline of about 78% (2540 versus 11620 annual clutches). Actually, sea turtle capture and egg poaching are clearly prohibited by law and government regulations. But because of poorness in law enforcement and the lack of public awareness, the illegal capture of turtles is still continued. In some locations, local government organizes exploitation of sea turtle eggs through bid system.

The decrease in populations of hawksbill is mainly caused by two factors:

1. Capture of adult and sub adult turtles to be stuffed or killed for their carapace. Numbers of hawksbill turtle were exported to provide raw shell (bekko) and stuffed turtle to Japan.
2. Poaching eggs by local people, lighthouse guards, fishermen or the people who make a living by collecting eggs. The eggs to be sold in the market or to be illegal export. Intensive egg collection

prevents reproduction. Although some nest had clearly been predated by the common Asiatic monitor (*Varanus salvator*). Such large-scale egg collection, however, is a relatively recent phenomenon in the region. There are a variety of systems establishing the right of egg collection in the region, including; i) the bid system; ii) egg collection by the staff of lighthouses; iii) egg collection by land owners; iv) the right of egg collection for short periods (about one week) granted to a person first landing on an uninhabited island; v) egg collection by seamen of regular cargo boats; vi) sale of eggs by collectors to a local broker; and vii) the right of the first finder of a nest to collect it. Many local people make a living by collection eggs on the numerous small islands scattered throughout the Java Sea.

This, combined with the poor communications between the mainland and these small islands makes law enforcement very difficult. The worst case is that in which the local government illegally promotes egg collection in a manner contrary to national law. It may already be too late to prepare an effective conservation strategy that will adequately protect the sea turtle of Indonesia. The immediate priorities for action are to identify and effectively protect the most important remaining rookeries. In a program of the Indonesia Sea Turtle Research Center that has so far proven successful, since December 1997, we have hired former egg poachers to protect natural nests in the Segama Islands, Momperang Island and Pesemut Island. Our best hope may be to delay the local extinction of the various hawksbill rookeries in the region.

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Table 1. Estimated annual clutch of hawksbill turtle in Java Sea and adjacent waters and comparison between present assessment and summarized by Groombridge and Luxmoore (1989)

Map Reference (Fig. 1)	Region	Counted Number of Body Pit	Estimated Number of Nests	Groombridge et al. (1989)	Nesting Decline (%)
1	Natuna Selatan Islands	323	500	620	19
2	Paloh River (1997-99)	452,427,415	450	200	-125
3	Momperang Islands	384	400	3250	88
4	Badas Islands	205	300	-	
5	Lima Islands	272	300	300	0
6	Around Bintan	102	250	-	
7	Gresik Island Area	216	250	-	
8	Segama Islands (1997-2000)	180,169,264,234	250	-	
9	Tambelan Islands (1995)	42	200[a]	1000	80
10	Laut Kecil Islands	145	200	1000[b]	80
11	Tiga Island Area	119	150	350	57
12	Seribu Islands (1997-99)	100,101,93	120	500	76
13	Karimunjawa Islands	56	100	300	67
14	Balabalakan Islands	85	100	-	
15	Tujuh Islands	67	100	-	
16	Ayermasin Islands	44	50	-	
17	Lerelerekan Islands	42	50	-	
18	Takabonerate Islands	36	50	3000-4000[c]	
19	Spermonde Islands	43	50	(40)[d]	
20	Langkuas Island Area	18	20	100	80
21	Selayar Island Area	8	20		
22	Marabatua Islands	4	10	-	
23	Masalima Islands	0	0		
24	Rotan Island Area	-	0	-	
25	Around Kabaena	0	0	-	
26	Sembilan Islands	0	0	1000	100
	Totals		3920	11660	
	Comparative Totals		2540	11620	78

Notes:
[a] Estimated number of nests calculated from bid price
[b] Include Marabatua Islands (22)
[c] Include Spermonde Islands (19), Selayar Island Area (21) and Masalima Islands (23)
[d] Only Panambungan Island (Schulz, 1984)

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CENSUS OF SEA TURTLE NESTING ON THE NORTH-EAST COAST OF ARUBA

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ABSTRACT

During the 2000 nesting season, a pilot research was conducted to investigate the breeding success of sea turtles on the north-east coast of Aruba (120 30' N, 700W). The north east coast is the windward side(persistency 98 %; average speed 22.3 mph) of the island and has rocky- sandy beaches and bays. Before the nesting season, beach and bay characteristics were studied: dominant vegetation, width and depth of the bays, grain size; dune profile; distance from dunes till tide-mark; shoreline- and beach accessibility. In total 37 sandy bays (total length 2985m) and shorelines (total length 2040m) were monitored once to twice a week from March till November 2000. The bays located in the national park, Parke Nacional Arikok (PNA) were monitored daily by their rangers. Ground surveys of the bays were conducted on foot. In case of tracks and nests, the track width and nest size were measured. Moreover, nest location was described. The tracks distance from the tide-mark to the nest location was not measured; an estimate of this was based on nest placements descriptions. Tracks- and nest identification was based on Pritchard and Mortimer (1999). After observing hatchlings crawls, the encountered nests were excavated to determine hatchlings success.

At the end of this breeding season, a total of 48 crawls and false crawls were observed. The most tracks were observed in PNA at three adjecent bays; Boca Prins, Dos Playa- Grandi and Chiquito (fig.1) Hatchling success and clutch size could not be determined. However, hatchlings of the Green turtle (*Chelonia mydas*), Leatherback (*Dermochelys coriacea*) and Hawksbill (*Eretmochelys imbricata*) were observed at Boca Prins. No hatchlings of the Loggerhead (*Caretta caretta*)were observed on the north east coast, this nesting season. Remarkable were the locations of the emerging crawls and nests; 70% of the observed crawls and nests were leeward of the cliff wall, except those of the leatherback (fig.1). All these crawls and nests were located on the open sand. Dunes close to the cliff wall are higher than on the open beach. Gravid females choosed nest locations above the high tide level and therefore preferred these higher cliff dunes (Horrocks & Scott, 1991; Camhi, 1993 in Wood & Bjorndal 2000). However, in some cases the approach to these cliff dunes seemed to be obstructed . Nest site selection can affect the fitness of the parents trough the survival of

their offspring (Wood & Bjorndal, 2000). Could it be possible that a cliff wall environment increases the survival of the emerging hatchlings?

Bays at PNA seem to be more suitable nesting locations compared to the rest of the bays; 50% of the observed tracks were located at PNA (fig. 2). However, the monitoring frequency on the PNA bays was much higher (daily) than at the other bays (maximum twice a week). The northeast side of the island is the windward part and sand sifting storms could cover crawls of gravid females, especially the hawksbill crawls, and those of the emerging hatchlings. With a lower beach monitoring frequency, less crawls can be observed under windy conditions. A higher beach monitoring frequency is advisable to increase crawl detection. Besides, to study beach preference of sea turtles factors affecting beach- and nest size location such as slope and nests temperature need to be studied.

This study shows that the bays and beaches at the northeast side of Aruba are important nesting locations for sea turtles. Beach morphology appears to be a key in nest site selection. A low monitoring frequency (1-2/week for only one year) seems to be insufficient to determine sea turtle breeding success. To have an indication as to the status of the nesting sea turtles in Aruba, at least two more years monitoring with a higher observation frequency is advisable.

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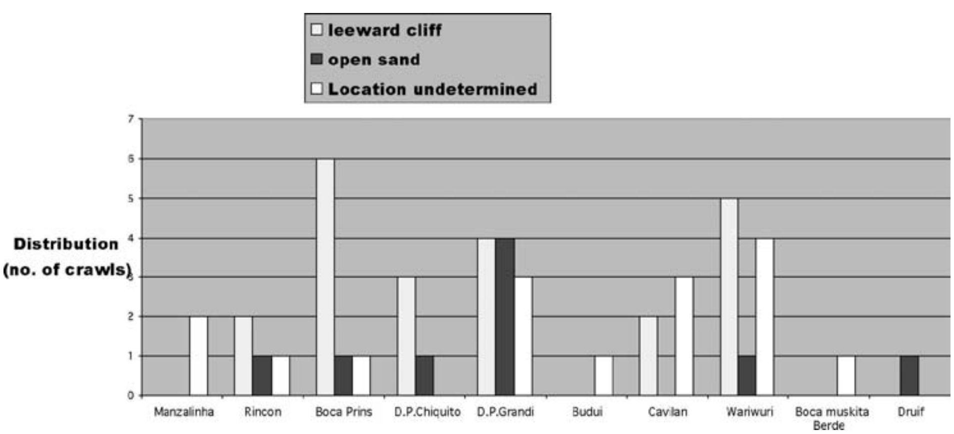
Figure 1. Distribution in number of emerging crawls on specific locations (leeward, open and undetermined) at the different bays on the north east coast of Aruba. The nesting bays Manzalinha, Rincon are located further east; Boca Prins, D.P. Chiquito and D.P. Grandi are adjacent bays located in the national park, Parke Nacional Arikok; Cavilan; Wariruri Boca Druif and Boca Muskita Green are bays located further north of the island



THE CONSERVATION OF IMMATURE MARINE TURTLES IN PERU

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Four species of marine turtles occur off the coast of Peru. East Pacific green turtle (*Chelonia mydas agassizzii*), leatherback turtle (*Dermochelys coriacea*), hawksbill turtle (*Eretmochelys imbricata*), and olive turtle (*Lepidochelys olivacea*) have been reported in Peruvian waters during the last few decades.

Approximately twenty years have elapsed since the last scientific investigation was made to determine the status of marine turtles inhabiting offshore of San Andres Inlet, Peru (an area with historically high marine turtle exploitation). That is the reason why a group of researchers from La Molina National Agrarian University, decided to develop a pilot investigation to implement later, upon results, a long term research project concerning the conservation of these species.

Weekly surveys were made during the months of April to July 2000 at the San Andres Inlet, located south of Lima. The purpose was to make contact with the fishermen of the area who supplement their activities with the illegal capture and commerce of marine turtles. The researchers were given temporary access to a deposit of marine turtle carapaces. The results from the analysis of thirty-four sea turtle carapaces showed that most of them were immature green turtles.

The preliminary results on the capture of marine turtles off the coast of Peru has state the hypothesis that this zone apparently functions as development habitat and also as feeding habitat for some species of sea turtles, before they migrate to nesting beaches in countries north of Peru. A future action considers, investigations to prove the hypothesis mentioned above and also the development and implementation of an environmental education plan as an important and strategic alternative to prevent the unlawful harvest of marine turtles by poor fishermen and in this way contribute to the conservation of immature marine turtles in the Peruvian coast.

PART III. VIDEO PRESENTATIONS

LESSONS FROM PACUARE; A HIGH PLAINS FILMS DOCUMENTARY

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In May, 2000, 49 students and 12 teachers came to the Pacuare Nature Reserve on the Caribbean coast of Costa Rica (located 30 km north of Puerto Limon), to participate in a scientist-student partnership program at a leatherback sea turtle nesting grounds. Costa Rican public and private high school students took part in a unique experiential field ecology program where they attended science classes at the reserve during the day, and assisted biologists collecting field data at night. This conservation education partnership benefited both the students and scientists in terms of conservation, education, and culture. Students collected quality ecological data that met the the biologist's monitoring needs, learned and applied the scientific method by developing their own biological research project, and prepared and delivered a presentation of their results. This project marked the beginning of a conservation dialog between the Pacuare Nature Reserve and the adjacent community of Matina. This film incorporates unique night photography of the nesting leatherbacks and other footage showcasing the beauty and biodiversity of the area, as well as documenting the student work at the reserve and the collaborative spirit that made the program a success.