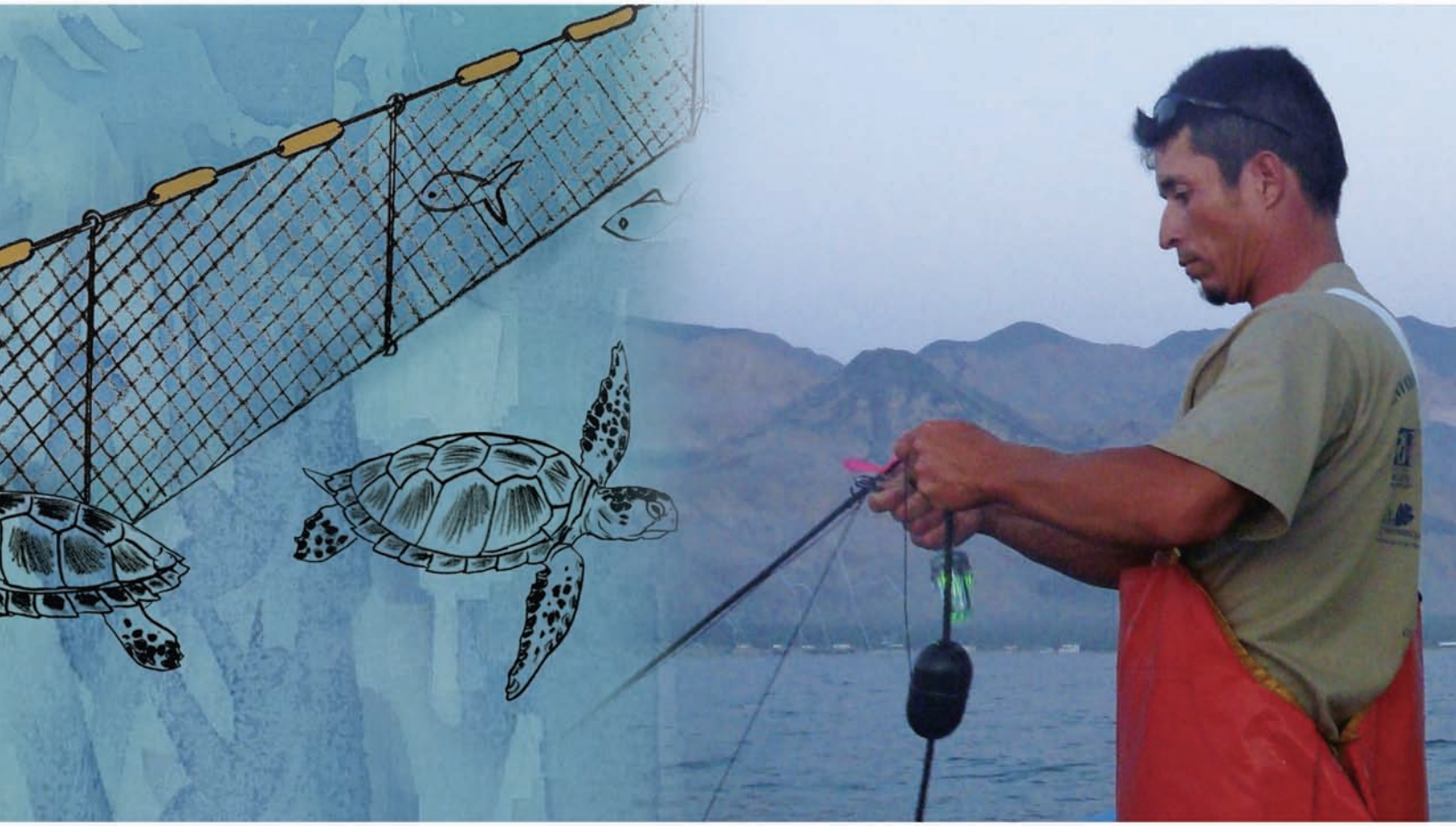
# PROCEEDINGS OF THE TECHNICAL WORKSHOP ON MITIGATING SEA TURTLE BYCATCH IN COASTAL NET FISHERIES



HONOLULU, HAWAII USA, 20-22 JANUARY 2009

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# PROCEEDINGS OF THE TECHNICAL WORKSHOP ON MITIGATING SEA TURTLE BYCATCH IN COASTAL NET FISHERIES

**Honolulu, Hawaii, U.S.A., 20-22 January 2009**

**Edited by**
**Eric Gilman**

# 1. EXECUTIVE SUMMARY

Sea turtles are adversely affected by a range of factors, some natural and others caused by human activities, such as fishing operations. As a result, all sea turtle species whose conservation status has been assessed are listed as threatened or endangered in the International Union for the Conservation of Nature's Red List. While the understanding of the relative risks of the full suite of mortality sources for individual turtle populations is generally poor, there is growing evidence that small-scale artisanal fisheries may be the largest single threat to some sea turtle populations.

Coastal passive net fisheries use gillnets, trammel nets, pound nets, fyke nets and other static gear that catch, and in some cases, drown turtles. Small-scale fisheries have the potential to substantially contribute to sustainable economic development. However, to secure their long-term economic viability and to ensure conformance with international guidelines for the conduct of responsible fisheries, they need to mitigate problematic bycatch of sea turtles and other sensitive species groups. Such mitigation approaches are part of an overall effective fishery management framework that includes measures to prevent the overexploitation of all retained and discarded catch, as well as unobserved fishing mortalities.

Forty-nine participants from 17 countries, representing fishery bodies and other intergovernmental organizations, national fishery management authorities, environmental non-governmental organizations, academic institutions, fishing industries and donor organizations attended the *Technical Workshop on Mitigating Sea Turtle Bycatch in Coastal Net Fisheries* from 20-22 January 2009 in Honolulu, U.S.A. The five workshop co-hosts were the International Union for the Conservation of Nature, Western Pacific Fishery Management Council, Southeast Asian Fisheries Development Center, Indian Ocean – South-East Asian Marine Turtle MoU and the U.S. National Marine Fisheries Service Southeast Fisheries Science Center.

**Accomplishments**

This workshop represented the first opportunity for experts from multiple disciplines relevant to this issue to meet to share information from 20 coastal net fisheries worldwide to disseminate and transfer best practices for sea turtle bycatch assessment and mitigation. Accomplishments during the three-day workshop included:

- Identifying the status of assessment and mitigation activities of fisheries represented at the workshop;
- Describing the state of knowledge for the effective and commercially viable (economically viable, practical, safe) mitigation of sea turtle capture and mortality in coastal passive net fisheries;
- Identifying characteristics of coastal passive net fishing gear and methods likely to have a significant effect on sea turtle and target species catch and mortality rates;
- Identifying research priorities to advance promising new turtle-friendly fishing gear and methods, based on the understanding and gaps in knowledge of why and how sea turtles interact with passive net gear, and the understanding of gear characteristics that significantly affect turtle capture and mortality rates;
- Exploring the full suite of tools available to assess, mitigate and manage sea turtle bycatch in artisanal fisheries;
- Identifying a list of optimal information to understand the degree of risk a fishery poses to sea turtles and identify mitigation opportunities;
- Sharing lessons learned of effective and ineffective practices and approaches for working with artisanal fishing communities to assess and manage bycatch; and
- Fostering partnerships and catalyzing assessments, commercial demonstrations and mitigation activities identified as priorities during the workshop, in part, by transferring

the lessons learned in the few net fisheries where progress has been made to priority fisheries in other regions.

**Range of Potential Fishery-Specific Solutions**

Several practices were identified as having the potential to effectively avoid, minimize and offset sea turtle capture, and improve the survival prospects following gear interactions in coastal passive net fisheries. Bycatch mitigation practices discussed during the workshop included: modifications to fishing gear and methods; gear restrictions; marine protected areas (temporal and spatial restrictions on fishing); changing to a gear type with lower turtle interactions; and handling and release best practices. However, participants recognized that the efficacy at reducing sea turtle capture rates, economic viability, practicality and safety are fishery-specific and therefore fishery-specific assessment is required before recommending a mitigation approach.

**Priority Gaps in Understanding**

Participants identified priority gaps in knowledge warranting further investment in order to advance mitigating sea turtle bycatch in coastal net fisheries. There is a need for:

- A generic decision tree or logic framework process tool, which could be used as a starting point to guide artisanal fishery-specific assessment and mitigation activities;
- Improved understanding of why turtles interact with coastal net fishing gear (e.g., are they attracted to the catch and/or floats); how turtles interact with the gear (e.g., what mechanism is responsible for capture [gilling, entangling, entrapping], and in which part of the gear are turtles captured); how the gear behaves under actual fishing conditions; what characteristics of the gear design, materials and fishing methods are significant factors affecting sea turtle capture and mortality rates; and, ultimately, what the opportunities are for mitigating turtle capture, injury and mortality;
- Standardized terminology and a classification scheme for coastal passive net fishing gear, focusing on factors that significantly affect sea turtle capture and mortality rates;
- Standardized units to report sea turtle catch-per-unit-of-effort (e.g., catch per trip, set, unit length of net, unit area of net, unit area per soak time, net weight).
- Accurate data on the relative impact of coastal net fisheries and other anthropogenic hazards on the long-term viability of sea turtle populations, so that limited resources can be allocated to address priority threats, accounting for the likelihood that interventions will successfully mitigate targeted anthropogenic mortality source;
- Characterizations of the degree of risk individual fisheries pose to affected sea turtle populations, based on accurate assessments; and
- Improved understanding of the indirect effects that coastal net fisheries have on sea turtles (e.g., obstacle to critical habitat and migration routes, ghost fishing, repeat captures, altered diet from depredating catch from gear, reduced predators or prey populations), information that is needed to produce precise risk characterizations.

**Gear Technology State of Knowledge**

Empirical evidence of the fishery-specific efficacy and commercial viability of gear technology approaches (changes in fishing gear designs and materials and fishing methods) at mitigating sea turtle capture in coastal net fisheries is available from only a small number of fisheries and studies. The following are gear technology approaches that have been shown to significantly reduce sea turtle catch rates in individual gillnet fisheries:

- Reducing net profile (vertical height);
- Increasing tiedown length, or eliminating tiedowns;
- Placing shark-shaped silhouettes adjacent to the net; and
- Illuminating portions of the net using lightsticks.

Of these techniques, only net illumination was found to not cause a significant decrease in target species catch rates.

In coastal poundnets, several turtle bycatch mitigation approaches have been explored:

- Replacing mesh with ropes in the upper portion of leaders has been observed to cause a significant reduction in the turtle capture rate with an increase in catch rate of one target species and no significant difference in catch rates of four other target species;
- Incorporating a prototype turtle releasing device into the roof of a cone-shaped pound in the small-scale southern Japan pound net fishery resulted in high escapement of green sea turtles with nominal target species escapement
- Modifying the roof of the pound in the Japanese large-scale pound net fishery to a rectangular-pyramid-shaped pound with the top angled at 20 degrees toward the apex effectively directed turtles towards the roof apex of the pound, where an escapement device could be situated.
- Observations document that pound nets with open versus closed capture chambers (also referred to as pounds or traps) have higher survival rates of captured turtles.

Broad assessments in individual fisheries must precede advocacy for uptake of specific turtle bycatch reduction methods. This is because there are several locally variable factors that significantly affect sea turtle and target species catch rates, and industry acceptability of any reductions in catch rates of commercially important species will depend on the local socioeconomic and regulatory context.

**Gear Technology Research Priorities**

It is unclear at this incipient stage in investigating this conservation issue whether or not gear technology approaches will be an effective and commercially viable solution to sea turtle interactions in most coastal passive net fisheries. Several promising new approaches warrant additional or new investigation:

- Fishing at sufficiently shallow depths, and increasing net liftability by adjusting the weighting design and/or anchoring system to allow captured turtles to reach the surface and breathe during the gear soak, increasing the proportion of caught turtles that survive the gear interaction;
- Minimizing gear soak time/time between patrolling gear in order to reduce the time incidentally caught turtles remain in the gear;
- Using alternative net materials and illumination to reduce the risk of turtle capture. For instance, making the upper portion of nets more visible, while leaving the lower portion relatively undetectable might be an effective and economically viable method. Using a clear, UV-absorbent plastic material for netting could reduce turtle bycatch without compromising fish catch rates. Using coarse multifilament line in place of monofilament in the upper portion, embedding luminescent materials into netting material and incorporating lightsticks are additional strategies to increase net visibility for turtles but not for target fish species. Continuing research on the effects on turtle and target species catch rates from alternative spectral frequencies and light brightness for net illumination is needed;
- Using buoyless floatlines might reduce turtle attraction to the gear and entanglement in the floatlines. Modifying float characteristics and reducing the number of floats and vertical float lines might reduce turtle attraction and incidence of entanglement in floatlines and the net;
- Conducting research, development and trials of devices to avoid and minimize turtle entrance into pound net and fyke net traps, such as use of a deflector grid;
- Modifying baiting techniques, in cases where baiting is used;

- Setting gear perpendicular to the shore to reduce capture rates with nesting females, and exploring effects of other gear orientations to and distance from the coastline;
- Continuing research on reduced net profile and increased length or elimination of tiedowns. Expanding this to research if increasing the net hanging ratio (ratio of net height to net width) reduces turtle entanglement risk;
- Continuing research on using shark-shaped silhouettes. For example, constructing the silhouette from clear UV-absorbent plastics instead of PVC and plywood could retain the turtle deterrent efficacy but avoid the reduced target species catch rate observed in trials. There is also a need to develop an improved attachment mechanism;
- Developing other sea turtle deterrents, such as chemical olfactory repellents or acoustic repellents;
- Using alternative net materials (appropriate twine diameter and material) to produce a breaking strength that allows turtles to break free of the gear and escape;
- Continuing research, development and testing of prototype turtle escapement devices for use in different types of pound net and fyke net gear;
- Continuing research on shapes of catchment chambers of pound nets with the aim of consistently directing turtles towards a location where an escapement device could be incorporated; and
- Investing in research, development and testing of equipment to disentangle turtles caught in nets (e.g., purpose-made line cutters, selecting a headlamp light color to reduce turtle stress during handling).

**Consideration for Successful Artisanal Fishery Assessments**

Participants identified optimal information to collect through fishery assessments in order to understand the degree of risk a fishery poses to sea turtles and to identify mitigation opportunities. Participants identified four broad categories of information to be collected during fishery assessments:

- Magnitude of the problem both in terms of effect on sea turtle populations (conservation status of affected turtle populations, age classes affected, status and trends in levels of turtle mortality from fishery interactions, and ultimately are population-level effects occurring) and effect on the fishery (gear damage and loss from interactions, time to remove turtles from the gear and repair or replace gear, lost catch, effects of any relevant regulatory measures);
- Fishery characterization, including gear types used, characteristics of each gear type, fishing operations, and catch characteristics;
- Management framework (self-management, co-management, or no management), including monitoring, control and surveillance; and
- The socioeconomic context.

Considering potential socioeconomic effects of alternative sea turtle bycatch mitigation practices was seen as a fundamental requirement to achieve successful sea turtle bycatch management. This includes considering all potential effects on a fisheries' commercial viability, including economic viability, practicality, and crew safety. Long-term data series may be needed to account for high inter-annual variability in gear used, gear designs, fishing grounds, turtle interaction rates and other fishery characteristics.

Pros and cons were discussed for alternative assessment practices, including: social surveys; onboard and dockside observers; logbooks; satellite imagery (to observe number of participating vessels); and electronic vessel monitoring systems in combination with data on spatial distribution of turtle abundance (to provide an indirect index of turtle interactions). At-sea data were seen as optimal for understanding catch characteristics and rates, noting that limited observer coverage can provide an index of the fleet as a cost-effective preliminary assessment.

Fisher surveys were seen as useful in providing a first order qualitative understanding of whether or not problematic sea turtle capture levels are occurring and an initial understanding of the magnitude of the problem. Techniques to optimize the quality of results from social surveys were discussed.

**Practices and Approaches to Work with Artisanal Fishing Communities**

Participants discussed reasons why direct participation of artisanal fishers is critical for successful fishery assessment and bycatch mitigation activities. Fishers have a large repository of knowledge, which can be tapped to contribute to finding effective and commercially viable solutions to problematic bycatch that will ultimately be acceptable to the artisanal fishing community. To optimize the likelihood of fishers adopting measures identified as effective at reducing unwanted turtle bycatch, fishers must first be convinced that catching turtles is a problem and then must buy into the use of the mitigation practices.

Considerations and lessons learned for maximizing the direct participation of artisanal fishers and effectively working with artisanal fishing communities were identified and discussed. For instance, identifying progressive individuals in a fishery who are open to consider changes and lead by example, the need for a sufficiently long-term investment to develop the credibility needed to gain the trust and access of stakeholders, and expertise needed on teams working with artisanal fisheries to mitigate bycatch were highlighted.

**Next Steps**

Participants committed to pursue development of a decision tree process tool to guide future interventions with artisanal fishing communities, to further explore sea turtle sensory physiology and behavior with an aim to identify differences with target species, to expand collaborative research on gear technology approaches to mitigate sea turtle bycatch in coastal passive net fisheries, and to contribute to finalizing an in-progress IUCN technical report *Mitigating Sea Turtle Bycatch in Coastal Passive Net Fisheries*. On-the-ground assessment, commercial demonstration and mitigation activities will hopefully folllow as a result of the workshop, leading to direct sea turtle conservation benefits, and improved environmental sustainability and long-term economic and social viability of passive coastal net fisheries.

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**Tuesday 20 January 2009**

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| 8:30 – 9:00 | Registration – Garden Lanai meeting room |
| 9:00 – 9:15 | Mitigating Sea Turtle Bycatch in Coastal Net Fisheries: What We Hope to Achieve. Opening Statement. **Eric Gilman**, IUCN |
| 9:15 – 9:35 | Historical Perspective from the Western Pacific Fishery Management Council. **Paul Dalzell**, WPRFMC |

## SESSION 1: ASSESSMENTS

Presentations to describe the coastal net fisheries, status and trends of sea turtle interactions in coastal net fisheries, degree of risk each fishery poses to sea turtles (taking into account, for instance, the conservation status of affected turtle populations, age classes affected, level of turtle mortality from fishery interactions), and initiatives, if any, to mitigate sea turtle bycatch in these fisheries.

9:35 – 9:50 Introduction and common terminology for coastal net fisheries, and aspects that pose threats to sea turtles, **Martin Hall**, Inter-American Tropical Tuna Commission

9:50 – 10:45 **Session 1, Part 1: East and South-East Asia**
Thailand and the greater Southeast Asian region, **Bundit Chokesanguan** and **Somboon Siriraksophon**, Southeast Asian Fisheries Development Center (SEAFDEC)
China, **Yamin Wang**, College of Ocean,Shandong University at Weihai and **Jian Zhang**, Shanghai Ocean University
Japan, **Takashi Ishihara**, Sea Turtle Association of Japan
Malaysia, **Rosidi Ali**, SEAFDEC and **Nick Pilcher**, Marine Research Foundation
Questions, discussion (15 minutes)

10:45 – 11:05 Coffee Break

11:05 – 11:55 **Session 1, Part 2: Eastern Pacific**
Peru and Chile, **Joanna Alfaro-Shigueto** and **Jeff Mangel**, ProDelphinus & University of Exeter; **Miguel Donoso**, O.N.G. Pacifico Laud; and **Jose Carlos Marquez**, IMARPE
Costa Rica, **Antonio Porras**, Instituto Costarricense de Pesca y Acuicultura
Mexico, **Ana Rebeca Barragán**, Comisión Nacional de Areas Naturales Protegidas, Semarnat, Mexico

11:55 – 13:30 Lunch

13:30 – 14:20 **Session 1, Part 3: Greater Caribbean**
French Guiana, **Laurent Kelle**, WWF French Guiana and **Michel Anthony (Tony) Nalovic**, CRPM G French Guiana Regional Fisheries Comity
Trinidad, **Scott Eckert**, WIDECAST and **Anderson Inniss**, Nature Seekers
Jamaica, **Rebecca Lewison**, San Diego State University and **Larry Crowder**, Duke University

14:20 – 15:40 **Session 1, Part 4: Uruguay, Brazil, Comoros, US, Africa**
Uruguay, **Cecilia Lezama**, Karumbe NGO
Brazil, **Neca Marcovaldi**, Fundação Pró-TAMAR
Comoros, **Melissa Hauzer**, Community Centred Conservation (C3)

Sierra Leone, Tanzania, Cameroon and Nigeria, **Larry Crowder**, Duke University**,** and **Rebecca Lewison**, San Diego State University
North Carolina, USA, **Blake Price**, North Carolina Division of Marine Fisheries, and **Jeff Gearhart**, U.S. National Marine Fisheries Service
Chesapeake Bay, Virginia, USA, **Kate Mansfield**, University of Miami

15:40 – 16:00 Coffee Break

16:00 – 16:10 Range of Tools for Fisheries Bycatch Mitigation – Group Discussion (Refer to Table 1. Methods to reduce sea turtle bycatch in coastal net fisheries, in background paper) **Eric Gilman**, IUCN; **Frank Chopin**, FAO; **Scott Eckert**, WIDECAST

16:10 – 17:20 Discussion on Session 1

17:20 – 17:30 Announcements

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**Wednesday 21 January 2009**

9:00 – 9:15 Announcements, recap previous day and review agenda, **Paul Dalzell**, WPRFMC

**SESSION 2: GEAR TECHNOLOGY SOLUTIONS FOR SEA TURTLE BYCATCH REDUCTION IN COASTAL NET FISHERIES**

9:15 – 9:45 Reducing sea turtle bycatch - A fishing technology perspective, **Frank Chopin**, Food and Agriculture Organization of the United Nations

9:45 – 10:15 First attempts to categorize and stratify nets for bycatch estimation, and for bycatch mitigation experiments; **Martin Hall**, Inter-American Tropical Tuna Commission

10:15 – 11:45 **Session 2, Part 1: Pound Net Fisheries**

Development of Sea Turtle Bycatch Mitigation Measures for Pound Net Fisheries: A Design Concept to Release Turtles Spontaneously, **Osamu Abe**, SEAFDEC, and **Daisuke Shiode**, Tokyo University of Marine Science and Technology

Alternative Leader Designs to Reduce Bycatch of Sea Turtles in Chesapeake Bay, Virginia Pound Nets, **Henry Milliken**, U.S. National Marine Fisheries Service

11:45 – 12:00 Coffee break

12:00 – 13:30 **Session 2, Part 2: Gillnet Fisheries**

Modified gillnet gear lessons learned from North Carolina, USA demersal gillnet flounder fishery, **Charlie Van Salisbury**, North Carolina gillnet fisherman, **Jeff Gearhart**, U.S. National Marine Fisheries Service, **Blake Price**, North Carolina Division of Marine Fisheries

Reducing leatherback (*Dermochelys coriacea*) sea turtle bycatch in the surface gillnet fisheries of Trinidad, West Indies, **Jeff Gearhart**, U.S. National Marine Fisheries Service, **Scott Eckert**, WIDECAST and Duke University, **Anderson Inniss**, Nature Seekers, Trinidad and Tobago

13:30 – 14:30 Lunch

14:30 – 16:00 **Session 2, Part 2: Gillnet Fisheries, cont'd**

Developing visual deterrents to reduce sea turtle bycatch: Testing shark shapes and net illumination, **John Wang**, Joint Institute of Marine and Atmospheric Research, University of Hawaii

Loggerhead Bycatch and Reduction off the Pacific Coast of Baja California Sur, Mexico. **S. Hoyt Peckham**, University of California at Santa Cruz and Grupo Tortuguero

16:00 – 16:15 Coffee break

16:15 – 16:50 Using Bayesian belief networks to evaluate the relative risk of coastal net fisheries on sea turtle stocks, **Milani Chaloupka**, Ecological Modeling Services

16:50 – 17:00 NFWF's new solicitation for proposals to address sea turtle bycatch and general tips on fundraising, **Michelle Pico**, National Fish and Wildlife Foundation

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**Thursday 22 January 2009**

9:00 – 9:15 Announcements, recap previous two days, review remaining agenda, **Paul Dalzell**, WPRFMC

9:15 – 9:30 Discussion of alternative focus areas for Session 3, **Eric Gilman**, IUCN

**SESSION 3: Breakout Groups**

9:30 – 12:30 Three breakout groups:

(a) **Process Tools for Assessment and Mitigation**: Decision tree, logic framework and risk-based decision analysis framework for assessment of sea turtle interactions in coastal net fisheries. (**Eric Gilman**, IUCN, record discussion and report back to group).

(b) **Promising Approaches**: Promising new strategies and research priorities for gear technology and handling and release practices to mitigate sea turtle bycatch and reduce injury and mortality in coastal net fisheries, based, in part, on the understanding of why and how turtles interact with passive net gear. (**Michelle Pico**, NFWF, record discussion; **Martin Hall**, IATTC, report back to group).

(c) **Practical Experience Working in Artisanal Fishing Communities**: Approaches to obtain artisanal fishers' direct participation in fisheries bycatch assessment and mitigation. (**Doug Hykle**, IOSEA, record discussion and report back to group).

12:30 – 14:00 Lunch

14:00 – 16:15 Three breakouts report back to full group, discussion

15:00 – 15:15 Coffee break

16:15 – 16:30 Discuss logistics and schedule for production of the workshop proceedings and IUCN Technical Report, **Eric Gilman**, IUCN

18:00 – 21:30 Reception at Nico's Restaurant, Pier 38

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## 4. REFERENCES FOR BACKGROUND MATERIALS

The following two documents were distributed to workshop participants as background information:

Gilman, E., Gearhart, J., Price, B., Eckert, S., Milliken, H., Wang, J., Swimmer, Y., Shiode, D., Abe, O., Chaloupka, M., Hall, M., Mangel, J., Alfaro-Shigueto, J., Dalzell, P., Ishizaki, A. In Progress (2009). *Mitigating Sea Turtle Bycatch in Coastal Passive Net Fisheries*. International Union for the Conservation of Nature, Gland, Switzerland. ISBN: 978-2-8317-1128-7.

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# 5. PRESENTATION ABSTRACTS AND PAPERS

## 5.1. Mitigating Sea Turtle Bycatch in Coastal Net Fisheries: What We Hope to Achieve

### Opening Statement

Eric Gilman, Marine Science Advisor, International Union for the Conservation of Nature

On behalf of the five co-hosts, the International Union for the Conservation of Nature, Western Pacific Fishery Management Council, Southeast Asian Fisheries Development Center, Indian Ocean – South-East Asian Marine Turtle MoU, and the U.S. National Marine Fisheries Service Southeast Fisheries Science Center, I'm pleased to welcome you to the *Technical Workshop on Mitigating Sea Turtle Bycatch in Coastal Net Fisheries*. I would like to acknowledge and express my gratitude for the financial support provided by the National Fish and Wildlife Foundation – represented by Michelle Pico at our meeting, the Save Our Seas Foundation and the Western Pacific Fishery Management Council. We are 49 participants from 17 countries, representing intergovernmental organizations including fishery bodies, national fishery management authorities, environmental non-governmental organizations, academic institutions, fishing industries, and donor organizations.

Sea turtles are adversely affected by a range of different factors, some natural and others caused by human activities, such as fishing operations. As a result, all sea turtle species whose conservation status has been assessed are threatened or endangered. There is growing evidence that small-scale artisanal fisheries may be the largest single threat to some sea turtle populations. These fisheries use gillnets, pound nets, large fixed fish traps and other static gear that catch and drown the turtles. Small-scale fisheries have the potential to substantially contribute to sustainable development, but need to mitigate problematic bycatch of sea turtles and other sensitive species groups to secure their long-term economic viability and to ensure conformance with international guidelines for the conduct of responsible fisheries. This workshop represents the first opportunity for experts from the multiple disciplines relevant to this issue to meet to share information from 20 coastal net fisheries worldwide to advance the dissemination and transfer of best practices for sea turtle bycatch assessment and mitigation.

We have an opportunity during the three-day workshop to:

- Review the status of assessment and mitigation activities of the fisheries and characterize the relative degree of risk that individual fisheries and regions pose to sea turtles;
- Identify the state of knowledge for the effective and commercially viable mitigation of sea turtle capture and injury in coastal net fisheries;
- Describe research priorities to advance promising new turtle-friendly fishing gear and methods, based on the understanding and gaps in understanding of why and how sea turtles interact with passive coastal net fisheries;
- Explore the range of tools available to assess, mitigate and manage sea turtle bycatch in artisanal fisheries;
- Share lessons learned of effective and ineffective approaches for working with fishing communities to manage bycatch in artisanal fisheries; and
- Foster partnerships and catalyze assessments, commercial demonstrations and mitigation activities identified as priorities during the workshop, in part, by transferring the lessons learned in the few net fisheries, where progress has been made, to priority fisheries in other regions.

I look forward to a productive meeting. Thank you.

## 5.2. Historical Perspective from the Western Pacific Fishery Management Council on Mitigating Threats to Pacific Sea Turtles

Paul Dalzell, Senior Scientist, Western Pacific Fishery Management Council

About a decade ago, the issue of sea turtle interactions with pelagic longline vessels, which had been simmering for a while, came to the forefront of this Council and the National Marine Fisheries Service (NMFS, the U.S. fishery management authority). Litigation brought by environmental non-governmental organizations (NGOs) resulted in the Hawaii-based longline fishery having to terminate shallow-set longline fishing for swordfish between 2001 and 2003. I won't dwell at length on the social and economic impacts this had to the fishing industry here, as these have been well documented, but rather look at the positive aspect of this development.

From this unpromising beginning, the Western Pacific Council grasped the bull by the horns (or more correctly, turtles by the flippers) and recognized that it must become fully engaged in Pacific sea turtle conservation, i.e. not just confining itself to fishery mitigation. The Council established a protected species coordinator's position, amongst whose responsibilities were to manage conservation projects for loggerhead and leatherback turtles at nesting sites and foraging grounds around the Pacific, guided by the expertise of our Turtle Advisory Committee.

At the same time gear technologists in the Gulf of Mexico and Atlantic were developing the large circle hook and fish bait technology that, to many people's surprise, including my own, was shown to reduce sea turtle interactions by up to 90%. This Council had in the 1990s worked on seabird mitigation technologies, along with partners from the NMFS Honolulu Lab, and it soon became clear that some relatively simple technical fixes could create one-to-two order of magnitude declines in seabird bycatch. It was thought that a similar 'silver bullet' for turtles was unlikely and that maybe some measures that incrementally would reduce sea turtle interactions was more likely.

Fortunately, we were wrong as John Watson and his colleagues from the NMFS Pascagoula Lab showed. We implemented the circle hook/fish bait technology in the U.S. Pacific in 2004, along with a full package of measures, including hard caps for leatherback and loggerhead turtles, 100% observer coverage, 50% effort reduction and a suite of turtle handling and release measures designed to minimize sea turtle post-release mortalities. We are now in 2009, the sixth year of this management regime, although year one, 2004 doesn't really count as so few boats fished and so we have four years of operational experience.

We've seen two years where the fishery operated throughout the years and approached, but never hit a hard cap. We've had a year where the fishery reached its loggerhead cap after about two months and the fishery closed. And we had last year, with zero loggerhead takes, while the Japan nesting season recorded in excess of 10,000 nests, about twice the recent annual average.

Over this same time period, more and more information has gradually accreted on turtle populations and on threats to these animals. If the focus of the last ten years was longline fisheries, I think it is fair to say that over the next decade will be on coastal fishery impacts. Our colleagues here at this meeting from Japan have documented the impacts of gill nets, pound nets and bottom set longlines in Japan and Mexico on loggerhead turtles. The numbers of interactions and mortalities may well exceed the fleetwide interactions and mortalities from longline fishing. However, we have a solution for longlining, one that has been widely tested globally, some of which with Council support. And, although not perfect, the recent Western and Central Pacific Fishery Commission meeting adopted a Conservation and Management Measure for turtles that included circle hooks. Over time, it is my belief that this will lead to

widespread adoption of circle hooks, at least for shallow set fisheries, if not all pelagic longlining.

I have also been extremely encouraged by work that was presented at the Fourth International Fishers Forum on gillnets and turtle interactions, which showed that diligent research can lead to workable solutions for gillnets. I am sure the same is true for other fixed gear fisheries, such as pound nets. And so, I'm looking forward to seeing the presentations at this meeting and hope we have some productive discussions. I remain cautiously optimistic that turtle populations that have been depleted can be rebuilt, if not to previous numbers, at least to levels where long term continuity is assured. Successively identifying, quantifying and minimizing the various threats to turtles are part of this process.

It only remains for me to welcome you once again and to hope you enjoy your stay in Hawaii and have a productive meeting.

## 5.3. Thailand and the Greater Southeast Asian Region
## Mitigating Interactions and Reducing the Mortality of Sea Turtles Due to Fishing: SEAFDEC Initiatives

Bundit Chokesanguan and Somboon Siriraksophon, Southeast Asian Fisheries Development Center

The expansion of fishing activities in coastal areas and in the high seas over the past few decades has contributed to important changes in the marine ecosystems. This is not only in terms of the target fisheries resources but also the other ecosystem components that are directly or indirectly affected by fishing activities. In response to such developments and concerns over the deteriorated status of the marine ecosystems, a number of global and regional initiatives have been initiated. These include the 1992 UN Conference on Environment and Development (UNCED), the 1995 FAO Code of Conduct for Responsible Fisheries, the 1995 UN Fish Stock Agreement, the 2001 Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem, and the 2001 ASEAN-SEAFDEC Resolution on Sustainable Fisheries for Food Security for the ASEAN Region. All of these initiatives are pointing to a common concept, which is "sustainable use of aquatic ecosystems."

Sea turtles are highly migratory and share the waters of the Southeast Asian region. However, sea turtles are affected by man-made interventions, either fishing or non-fishing activities. In view of the importance to maintain the sea turtle biodiversity and overall aquatic ecosystem balance, the SEAFDEC Member Countries have over the years been taking initiatives in the conservation and management of sea turtles in the region.

### Conservation and Management of Sea Turtles in Southeast Asia

In 1997, the Agriculture and Forestry Ministers of the ASEAN Member Countries endorsed the Memorandum of Understanding (MoU) on ASEAN Sea Turtle Conservation and Protection, aimed at promoting the protection, conservation, replenishing and recovery of sea turtles and their habitats based on the best available scientific evidence, taking into account the environment, socio-economic and cultural characteristics of the respective ASEAN countries. The MoU has been initially supported by the ASEAN and SEAFDEC collaborative program on Conservation and Management of Sea Turtles in Southeast Asia from 1998 to 2004 (*Managing Sea Turtles in Southeast Asia: Hatcheries and Tagging Activities, Fish for the People*, Vol. 1 No. 3: 2003). The major achievements of the program, which was funded by the Japanese Trust Fund, are shown in **Box 1**.

| **Box 1. Achievements of the ASEAN-SEAFDEC Program on Conservation and Management of Sea Turtles** |
|---|
| 1. Establishment of the ASEAN-SEAFDEC Sea Turtle Research Network comprising national coordinators from the ASEAN countries and used as a regional forum for exchange of information on national programs and priorities on sea turtle research;<br>2. Organization of a number of regional conferences and workshops to exchange information and expertise as well as to develop a harmonized format for collecting data and information on sea turtles in the region;<br>3. Compilation and dissemination of information and research results on sea turtle conservation and management in the region in various forms of publications such as books/proceedings/technical and information papers, among which two have been noted internationally, such as the "Sea Turtle Management and Conservation in the ASEAN" and the "Field Guide for Hatchery Management Practices on Sea Turtles for ASEAN-SEAFDEC |

Member Countries";
4. Distribution of 11,300 inconel tags and applicators to all Member Countries, except Lao PDR and Singapore, used for the migratory study of sea turtles in the region; and
5. Development of turtle excluder device (TED) applicable for the regional situation and conduct of research and demonstration on TED in various ASEAN Member Countries in response to pressure of the US embargo on shrimp export starting in 1997.

A follow-up program on Research for Stock Enhancement of Sea Turtles in the ASEAN Region was initiated from 2005 until 2008 (**Box 2**), also funded through the Japanese Trust Fund.

| **Box 2. Research on Stock Enhancement of Sea Turtles in the ASEAN Region (2005-2008)** |
|---|
| 1. DNA study for the stock/population identification of sea turtles from the ASEAN region and detection of multiple paternities for estimation of stock size of male sea turtles;<br>2. Tagging and satellite telemetry study using inconel tags at established rookeries in the ASEAN countries, focusing on populations where no or very little information is available, such as in Indonesia, Malaysia, Myanmar and Vietnam;<br>3. Feasibility study on head-starting (Sea Turtle Nursery) by reviewing the head-starting technique as a management tool for sea turtles and where global and regional attempts on the head-starting experiments are reviewed to find out whether they were successful or not; and<br>4. Interaction between sea turtles and fisheries<br>4.1 information collection on sea turtle interaction with fishing operations in Southeast Asia<br>4.2 comparative study on the efficiency of the Circle hook and the J-hook in pelagic and bottom longlines<br>4.3 assessment/evaluation of lessons learned from the introduction and promotion of TEDs in shrimp trawls, taking into account the 2004 FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations. |

While noting that conservation and management of sea turtles are not easy tasks, the SEAFDEC Member Countries are determined to take steps towards this endeavor, a strong commitment that was reaffirmed at the 13th Meeting of ASEAN Sectoral Working Group on Fisheries in May 2005. During that Meeting, the progress and achievements in conservation and management of sea turtles in the region since 1998 were discussed, and the strong support to the initiatives and implementation of the activities on the Research for Stock Enhancement of Sea Turtles in the ASEAN Region, as promoted by SEAFDEC, was reaffirmed.

Such commitment was further reaffirmed at the 38th Meeting of SEAFDEC Council in April 2006 in Brunei Darussalam, where the Member Countries also officially launched the "Year of Turtle" in the ASEAN region. This initiated the regional campaign in building awareness and exchange of information and experiences among the SEAFDEC Member Countries at regional and national levels on the issue, and was also regarded as a joint effort of SEAFDEC to the 2006 Year of Turtle promoted by the Indian Ocean-Southeast Asian (IOSEA) Marine Turtle Secretariat.

**Reducing the Interactions and Mortality of Sea Turtles due to Fishing**

One factor that contributes to the success in sea turtle conservation and management in Southeast Asia lies on the importance of better understanding the interactions between sea turtles and fishing activities. Such understanding could not only improve sea turtle mortality from fishing in general but also help focus all efforts in improving other measures and initiatives for

the conservation and management of sea turtles. Along this line, a number of activities and initiatives to reduce interactions and mortality of sea turtles from fishing has been undertaken by SEAFDEC over the past years. The summary results of such activities and initiatives are given in **Box 3**.

| **Box 3. SEAFDEC Program on Reducing Interactions and Mortality of Sea Turtles from Fishing** |
|---|
| 1. **Development and Application of Turtle Excluder Devices (TEDs) in Shrimp Trawls**<br>In response to the US shrimp embargo in 1996, SEAFDEC in collaboration with Thailand, Malaysia, the Philippines, Brunei Darussalam and Indonesia conducted a regional collaborative program on the development and application of TEDs in shrimp trawls, with funding support from the Japanese Trust Fund. The major activities included the design, development and implementation of the "Thai Turtle Free Device" (TTFD, Fig. 1) in shrimp trawl fisheries; experiments on various designs of TEDs, namely Anthony Weedless, Supershooter, Bent Pipe, Georgia Jumper and Mexican models. The experiences on the application of the various designs were further used to develop another Thai TED called the "Thai-KU" that is tailored to the fisheries situation in the region. Since then, a series of on-site demonstrations and training for government officials on the installation and use of TEDs were conducted in the region.<br>2. **Mitigation of Fishery-Sea Turtles Interactions: Efficiency of the Circle Hook in Comparison with J-hook in Longline Fishery**<br>As recommended in the FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations concluded during the FAO Technical Consultation on Sea Turtles Conservation and Fisheries in Bangkok, Thailand in December 2004, comparative studies between Circle hook and J-hook in longline fishing was initiated by SEAFDEC in 2005. Preliminary results of the experiments indicated that the Circle hook has higher catch rate of target species and lower bycatch, compared to the J-hook, with the Circle hook also showing higher performance than the J-hook.<br>3. **Regional Expert and Technical Consultations on Progress of Initiatives in Reducing Sea Turtles Mortality from Fishing**<br>Based on the research results on the designs and experiments on TEDs in the region, a series of regional expert and technical workshops and consultations on the application of TEDs and initiatives to reduce sea turtle mortality from fishing have been organized since 1996. Experts and government officials who work on the interactions between sea turtles and fishing have been meeting at least once a year under the SEAFDEC regional collaborative project on Responsible Fishing Technology and Practices to exchange information and experiences in addressing the issue. The outcomes from such workshops and consultations have been published and disseminated in the region and worldwide.<br>4. **Information Packages and Awareness Building Campaigns on Conservation and Management of Sea Turtles**<br>From the results of the research and experiments on TEDs as well as the regional workshops and consultations, a series of regional TED training courses were conducted at national and regional levels. In addition, a wide range of promotional media for public awareness purposes (e.g. videos, posters, brochures, etc.) on the use and benefits of TEDs have been developed and disseminated targeting the fishers, the governments of the Member Countries, coastal communities and researchers. The materials focused on the need to conserve sea turtles and the use of TEDs with an attempt to further improve fishers' acceptance of the use of TEDs and compliance to related management measures. |

**Future Directions**

In taking progressive steps towards improved conservation and management of sea turtles in the region, the existing initiatives and collaboration would be continued and to some extent intensified. Assessing the relationship between sea turtle mortality and fishing could reinforce the conservation and management interventions of the sea turtles. In this regard, SEAFDEC in collaboration with the Member Countries plans to undertake a number of priority projects beyond 2008 (**Box 4**).

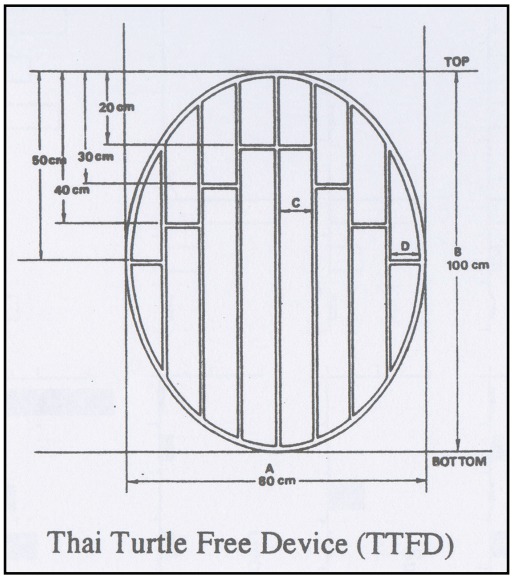


Fig.1. Illustration of the Thai Turtle Free Device (TTFD) used in shrimp trawl fisheries.

| **Box 4. Future Actions on Reducing Interactions and Mortality of Sea Turtles due to Fishing** |
|---|
| 1. Comprehensive assessment of application of Turtle Excluder Devices (TEDs) in the region by clarifying the factors contributing to successes and failure in the application of such devices;<br>2. Expansion of the experiments and demonstrations on the comparative study on Circle and J-hooks (Fig. 2), involving wider fishers in the conduct of such experiments to provide direct opportunity and first-hand experience for the fishers, which in return, could enhance their cooperation and compliance;<br>3. Increased efforts on awareness building through wider dissemination of information packages on the conservation and management of sea turtles, particularly addressing the importance of reducing sea turtle mortality from fishing; and<br>4. Fostering the expansion of networking, collaboration and partnership with organizations at national, regional and international levels in conservation and management of sea turtles in the region in general as well as reduction of sea turtle mortality from fishing in particular. |

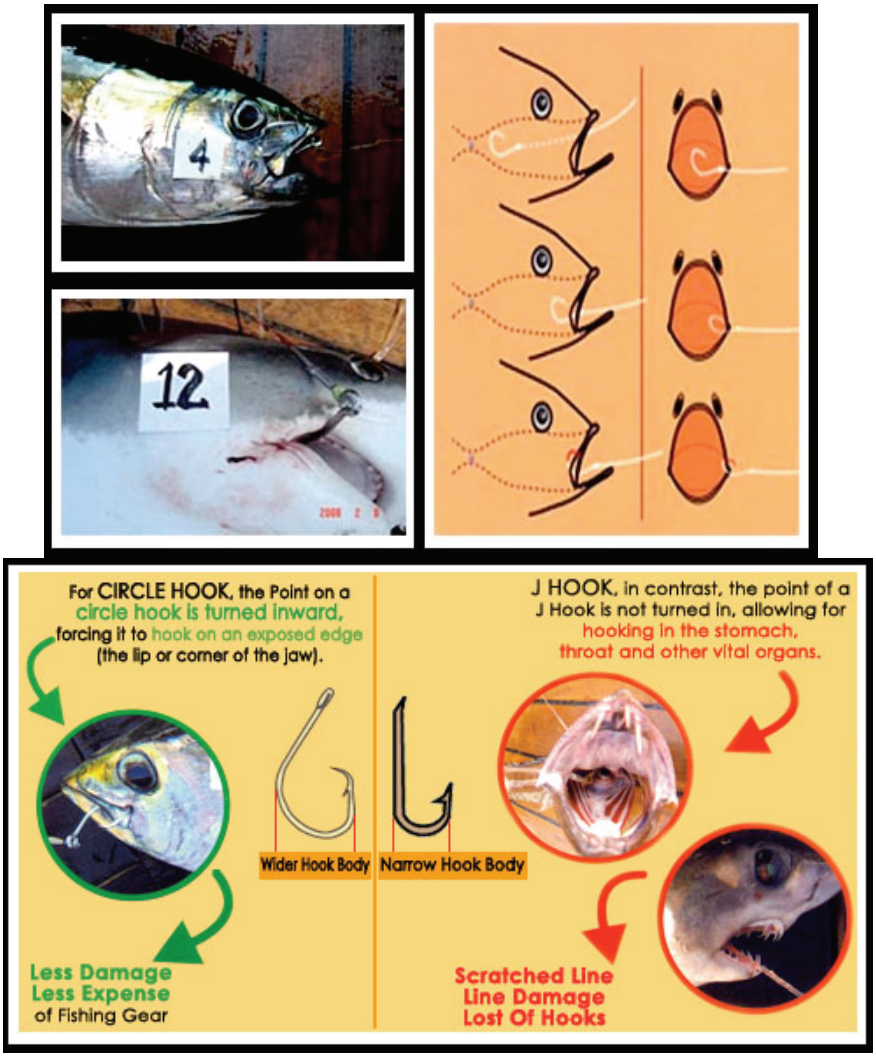


Fig. 2. Circle-shaped hooks (top, bottom left) typically catch fish (and turtles) in the jaw, while J-shaped hooks (bottom right) are swallowed.

## 5.4. Marine Fisheries, Sea Turtle Management and Conservation in China

Yamin Wang, College of Ocean, Shandong University at Weihai

China's' fisheries are important in the world, with about 577,035 engine-driven fishing vessels operating in 2007. Total marine fisheries catch is about 12,435,480 tons, with about 75% as fish catch. Some of China's fishing vessels use longline gear for shark and tuna fish catch in different parts of the world. All of these fisheries have encountered sea turtle bycatch problems. Five species of sea turtles are found in China: the Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Olive or Pacific Ridley (*Lepidochelys olivacea*), and the Leatherback (*Dermochelys coriacea*). Most are documented in the South China Sea, with the greatest abundance reported from the Xisha (Paracel), Nansha and Hainan islands.

An estimated 14,000 to 40,000 sea turtles annually migrate to the Xisha Islands (a group of low coral islands and reefs in the South China Sea, approximately 280 km southeast of Hainan Island) and to the Nansha Islands. About 2,300 to 5,000 migrate to Hainan Island (including Guangdong Province). These migrations involve mixed species groups, estimated at 87% Green, 10% Hawksbill, and 3% other species (Wang, 1993).

Sea turtle populations have been sharply reduced in China over the past 50 years. Half a century ago, there were several identifiable sea turtle nesting sites at Hainan Island (Qionghai, Wanning, Ya, Dongfang) and in Guangdong Province (Nana, Huilai, Haifeng, Huidong, Wanshan, Taishan, Yangjiang, Dianbai). Today, only Huidong is known to have sea turtle nesting in China. Currently, the only hope for additional populations would be the discovery of nesting sites on some far and desolate island.

The major factors threatening China's sea turtle populations are: fisheries bycatch; the killing of nesting females, the collection of eggs for sale and consumption; and a general lack of public awareness of the declining trends in sea turtle populations nationwide. A major challenge is the difficulties on estimating sea turtle bycatch by China fishing vessels.

In China, the management authority for sea turtles is the Bureau of Fisheries (BOF) within the Ministry of Agriculture (MOA). To protect sea turtles, China promulgated the "Law of Wildlife Protection, China [1989]," the "Ordinance of Aquatic Wildlife Protection, China," and the "Ordinance of Nature Reserve, China [1993]." In 1988, China also declared the sea turtle a protected species (Grade II under the Law of Wildlife Protection) and Guangdong Province promulgated the "Rule of Guangdong Sea Turtle Resources Protection [1988]."

To secure the future of sea turtles in China, the following measures are recommended: surveys to identify critical habitat and better document population trends; the development of a National Action Plan to guide conservation and management efforts; enhanced international, regional and national co-operation; improved public awareness and participation; stronger measures to protect habitat; a science-based plan to restore populations to effectively mitigate major threats; and the reduction, in particular, of fisheries bycatch.

## 5.5. Status of Japanese Coastal Sea Turtle Bycatch

Takashi Ishihara, Sea Turtle Association of Japan

The Sea Turtle Association of Japan (STAJ) studies and monitors Japanese sea turtle nesting, stranding, bycatch, and other related activities. From October 2006 to September 2007, STAJ gathered 121 bycatch information reported by fishermen. Sea turtles were caught by pound net (72%), gill net (11%), trawl net (8%), encircling net (3%), and other fisheries (6%). All pound nets and gill nets were set at coastal waters and almost all others operated at coastal waters.

STAJ has established pound net bycatch research bases. In 2007, a STAJ pound net bycatch research base in Miyama captured 138 sea turtles with 97.1% mortality. Another STAJ research base in Nomaike, on the other hand, reported 0% mortality.

The difference in mortality rates appear to be due to the types of pound nets used. Pound nets are classified into Open type with a cover and Roofed type with roofed cover. Roofed nets prevent turtles from reaching the ocean surface to breathe. The Nomaike net is open type, and Miyama net is roofed type. The roofed type pound nets are assumed to be high mortality for sea turtles. Changing the pound net from roofed to open type has considerable beneficial effects on the conservation of sea turtles, but it costs a great deal to change it.

## 5.6. A Review of the Status of Malaysia's Coastal Fisheries and Progress in Mitigating Sea Turtle Interactions

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This paper describes briefly the coastal fisheries in Malaysia, including the fishing zones, fishing gears used and their contribution to the national marine fish landings. The paper also reviews studies on the interaction of fishing gears operating in the coastal waters with the sea turtle, elaborates on the efforts to minimize the incidental catch of the sea turtle and presents the current observations on the mortality of the sea turtles in the country.

The coastal fisheries in Malaysia refer to fishing activities by vessel less than 70 GRT in waters within 30 n.m. from the shores. The area comprises of three fishing zones, namely Zone A, Zone B and Zone C. The Zone A covers waters of less than 5 n.m. from the shore that is solely reserved for owner-operated fishing vessels. These utilize traditional fishing gears and vessel-operated anchovy purse seine nets in vessels less than 40 GRT. The Zone B, which is within 5 n.m. to 12 n.m. from shore, is for owner-operated vessels using commercial fishing gear, such as trawl nets and purse seine nets, and operating vessels less than 40 GRT. Zone C encompasses waters of 12 to 30 n.m. from shore is for commercial fishing vessel of 40 to less than 70 GRT.

A total of about 37,000 fishing vessels are licensed for operation in the coastal waters. The major estimated fishing gears are gill nets (59%), trawl nets (15%), hook and lines (13%) and fish purse seine nets (1.6%). The coastal fisheries contribute about 82% of national marine fish landings and amounted to 1.13 million tonnes. Major estimated distribution comes from trawl nets (53%), fish purse seine nets (15%), gill nets (12.3%) and hooks and lines (4%).

Rich with fisheries resources, the coastal areas in Malaysia, including sandy beaches, coral reefs and sea-grass areas, are also good habitats for sea turtles. Four species of sea turtles, the Leatherback (*Dermochelys coriacea*), the Green (*Chelonia mydas*), the Hawksbill (*Eretmochelys imbricate*) and the Olive Ridley (*Lepidochelys olivaceae*), are inhabit these areas.

The overlapping of areas can cause interactions between sea turtles and fishing gears operated in these areas. A survey reported that the fishermen operating fish traps, beach nets, purse seine nets, gill nets (include ray nets), lift-nets and trawl nets have experienced incidental captures of sea turtles. However, none of the fishermen operating hooks and lines (include longlines) had such interactions. Studies also indicated that the green turtle was the most frequently caught by the fishing nets, especially the gill net. Several studies to mitigate the incidental catch of sea turtles have been implemented and others are in progress. These include the feasibility of circle hook on longlines, TED on shrimp trawl net and acoustic herding device on gill net. Comprehensive assessment on the interaction of sea turtle with coastal fishing gears has yet to be conducted.

Despite the lack of available comprehensive evidence, various precautionary approaches and measures have been implemented to reduce coastal fishing gear interaction

with sea turtles. Catching of sea turtles by any type of fishing gears and methods is prohibited under the Fisheries Act of 1985. The adoption of maximum mesh size of 25.4 cm for gill nets in 1989 aims to minimize sea turtle entanglement with gillnets. In 1989, the waters off Rantau Abang Turtle Sanctuary have been designated as Fishing Prohibited areas to mainly protect the leatherback, especially during its inter-nesting period. The installation of large concreted artificial reef in Zone A has limited the encroachment of trawlers in the near shore waters, thus minimizing interaction with sea turtles. The establishment of marine parks has also minimized coastal fishing activity interaction with sea turtles. Public awareness programs have been promoted to provide information on the importance and urgency of protecting and conserving sea turtles.

The current monitoring shows a reduction in the mortality of sea turtles. The findings possibly indicate the effectiveness of efforts to mitigate sea turtle interaction with coastal fishing gears. Further investigations are to be conducted to verify this assumption.

## 5.7. Summary of Gillnet Fisheries and Sea Turtle Interactions in Peru and Chile

Joanna Alfaro-Shigueto[1], Jeff Mangel[1], Miguel Donoso[2], Jose Carlos Marquez[3]

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[2] O.N.G. Pacifico Laud
[3] Instituto del Mar del Peru

**PERU**

Along the Peru coast, there are 122 ports and landing sites used by the artisanal fishery. A survey of the artisanal fleet conducted in 2004-2005 found that there were 9,667 artisanal vessels operating in Peru of which 3,190 were gillnet vessels, the most frequently used gear type (Estrella, 2007). During 1999, 63,083 gillnet trips were conducted (Estrella *et al.*, 1999, 2000) and the fleet has grown by 54% since 1997.

Gillnets are popular in artisanal fisheries due to their low operational costs. Net fisheries operating in Peru include surface driftnets, bottom set nets and trammel nets. These fisheries are distributed along the entire Peru coast with a higher concentration in the center and north of the country and related to the width of the undersea continental shelf. Five sea turtle species occur in Peru waters – leatherbacks, loggerheads, greens (black), olive ridleys and hawksbills.

Pro Delphinus has onboard observer data on net vessels and sea turtle bycatch from 165 fishing trips from three ports: Salaverry port (driftnets), San Jose (driftnets, bottomset gillnets and trammel nets), and Constante (bottomset gillnets). During these trips, a total of 195 turtles were captured: 85.6% greens, 9.2% olive ridleys, 3% leatherbacks, 1% loggerheads and 1% unidentified. Some 87% of turtles were entangled alive and 58% were released without injury. The size classes caught included large juveniles for both greens and olive ridleys, while, while for leatherbacks, both juveniles and adults are caught.

**Driftnets**: This fishery targets multiple species, mainly blue and short fin makos sharks, but also hammerhead sharks and thresher sharks, rays, angelsharks, smoothhounds, bonito and mahi mahi. Bycatch included green, olive ridley and leatherback sea turtles, sunfish, swordfish, yellowfin tuna, black-browed albatrosses, guanay cormorants, Humboldt penguins, sooty shearwaters, white-chinned petrels, pink-footed shearwaters, bottlenose dolphins, dusky dolphins, Burmeister's porpoises and common dolphins.

The driftnet vessels were monitored out of the port of Salaverry. The gear was typically set in the afternoon and retrieved the following morning. Gillnets observed were made of multifilament nylon cord, with a recent shift from hand-made multi-filament nets to cheaper, imported prefabricated nets. Stretched mesh sizes ranged from 4.5 to 10 inches (11.2 x 25.4cm). Preliminary analysis based on observed trips shows that of the 108 turtles caught with this gear, 82% were greens, 88% were entangled alive and 75% of turtles were released with no injury. The observed bycatch rate was 1.6±2.7 turtles/trip.

**Bottomset nets**: Target species of this fishery are guitarfish *Rhinobatos planiceps,* flounder *Paralichthys adspersus*, lobster *Panulirus gracilis*, smooth hounds *Mustelus* spp. and *Triakis* sp., and rays *Myliobatis* spp. Bycatch included green turtles, olive ridleys, hawksbill turtles, Burmeister's porpoises, Humboldt penguins, catfishes, seahorses, and sea shells. The fishing area used by bottom-set gillnet vessels from the village of Constante was Sechura Bay. All sets were in shallow waters (9 – 27m).

From the trips monitored, 97% of entangled turtles were greens, 85% of turtles were entangled alive, and 63% were sold for human consumption. The observed bycatch rate was 1.8±2.7 turtles/trip.

**Trammel nets**: We have recently begun monitoring the trammel net fishery in the port of San Jose, northern Peru. There is an observed bycatch of two olive ridley turtles from six total trips (28 sets). Both were released without injury.

**Existing legislation**: The minimum mesh size established for capture of sharks and rays is 200-330mm, and for flounder is 120-145mm (RM 209-2001).

**Bycatch mitigation initiatives:** None at present. Considering characterizing fishing gears regionally and trials with light sticks, shark silhouettes (adapted from Wang *et al*., in prep.) and possibly gear patrolling.

## CHILE

Fisheries regulations and categories are typically established according to Chile's geopolitical regions (I-XIII; FAO, 2008). Regions X and VIII have the highest numbers of fishers, vessels and landings. In the past few years, aquaculture activity has increased within coastal areas. Fisheries are regulated by decree 18.892. Control mechanisms used include bans, temporal or permanent closures, establishment of annual quotas for target species, declarations of protected areas, establishment of percentages of bycatch landings , establishment of minimum sizes or weights per species in a specific area, and establishment of dimensions and characteristics of fishing gears.

Progress has been observed since the passage of Decree 19.713, LMCA (Maximum limit of captures by boat owners [*armadores*]), which outlines the distribution of the industrial portion of the global capture quota of a specific fishery unit among all the *armadores* registered to operate in each region. The following are fisheries that fall under LMCA regime: purse seines, demersal trawls, horizontal longline, gillnets, trap lines (*linea de trampas*), and midwater trawls.

**Swordfish fishery**: Fifty-six percent of swordfish captures were by the gillnet fleet and 44% by the longline fleet. A sample of 298 fishing trips representing 75% of the fishery (2,626 sets) was collected in 2006 (Donoso and Barria, 2006). The ports sampled were Iquique, Tocopilla, Caldera, Coquimbo, Valparaíso, San Antonio, Isla de Juan Fernández, Coliumo, Tomé, Talcahuano, Tumbes, and San Vicente. The most active ports were Caldera (21), San Antonio (37), San Vicente (38) and Lebu (134). Fishing areas in 2006 were between 26°33' - 36°30'S and 71°00' – 78°00'W.

Ninety-four vessels operate in this fleet with typical vessel lengths of between 10.6 - 18 m. In the port of Lebu, 72% of vessels ranged from 16.1 – 18 m. Average vessel length was 16.7 m. The GRT was between 7 and 50 t (mean=37,5 t). Average engine power was 319 Hp (range: 80 to 480 Hp), with 75% of vessels higher than 250 Hp.

Net panes were 900 to 1700 fathoms in length and 27-30 fathoms in height. They are set in mid-water with buoys in the main line separated by 20f. Multifilament was used for the nets, with 80% using black-colored filament. Vessels also used light sticks lures.

A previous study of the swordfish gillnet fishery (Frazier and Brito Montero 1990) noted bycatch of leatherback turtles and, to a lesser extent, green turtles. There is a need for updated information on sea turtle bycatch in nets, because the majority of swordfish captures now comes from the gillnet fleet.

**Bycatch mitigation initiatives**: None at present.

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## 5.8. Costa Rica's Coastal Fisheries

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Costa Rica is located in Central America. It has 51,000 square kilometers of land territory and an Economic Exclusive Zone of 589.000 square kilometers. The length of its Pacific coastal line is 1160 km, and 200 km along the Caribbean.

The most important fishing activity occurs in the Pacific, because of the large number of fishermen and fishing vessels. Fishing is conducted by the artisanal fishermen, with a fleet consisting of 1,625 boats. The fishing fleet semi-industrial is composed of 72 ships, 69 of which is comprised of trawling shrimp boats, two sardine seine vessels, and a small seine tuna ship measuring less than 24 meters.

The artisanal fishing fleet uses gillnets for shrimp and fish, and hand-fishing rope and bottom longline for other coast species. Other fish species, such as *Dorado* (mahi mahi) and other pelagic, are caught with 5km long line. The semi industrial trawling shrimp boats harvested 3.886.261 kilograms in 2005. The total fish landing in the Pacific in 2005 was 15.111.986 kilograms.

Costa Rica's Caribbean fishing activity consists of artisanal fisheries, composed by 237 boats, and one ship. The main fishing gear of the Caribbean fishermen are gillnets and hand-lines. The total fish landing during 2005 was 540.533 kilograms.

### Sea Turtle Bycatch in Coastal Net Fisheries

Turtles found in Costa Rica's waters include the Leatherback turtle (*Dermochelys coriacea*;) the green, white or black turtle (*Chelonia mydas*); the hawksbill turtle (*Eretmochelys imbricata*); the Loggerhead turtle (*Caretta caretta*) and the Pacific Olive Ridley or dark-brown turtle (*Lepidochelys olivacea*).

The recently completed research project, Reduction of Environment Impact from Tropical Shrimp Trawling, through the Introduction of By-Catch Reduction Technologies and Change of Management (EP/GLO/201/GEF) addresses the issue of turtle bycatch in coastal waters. This project was sponsored by the Global Environmental Facility (GEF) of UNEP, with technical support provided by FAO. The research focused on the composition and amount of bycatch from shrimp fishing in the Pacific Coast of Costa Rica from May 2007 to June 2008.

Fourteen research trips, with approximately 54 sets per trip, were conducted in the main fishing grounds of shrimp trawl vessels from Punta Guiones to Punta Violines, along Costa Rica's Pacific coast. The bycatch of eight marine turtles, two of them retrieved dead, were reported by the project.

Research results in this area suggest that interaction between trawling shrimp boats and incidental marine turtle bycatch is low. However, despite the use of the Turtles Excluder Device, turtle deaths still occurred. A likely reason is the incidence of garbage in the nets that made turtle escape from the nets difficult.

### Initiatives to Mitigate Sea Turtle Bycatch in Costa Rica's Coastal Net Fisheries

In 2003, an international cooperative project was initiated in Ecuador to reduce marine turtle bycatch in longline fisheries in the Eastern Pacific Ocean, with participation from IATTC, NOAA, Ocean Conservancy, the Western Pacific Regional Fishery Management Council (WPRFMC), the Overseas Fisheries Cooperation Foundation of Japan (OFCFJapan), and WWF. After five

years, the program has grown to a region-wide bycatch network and the largest regional artisanal fisheries conservation program in Latin America.

In Costa Rica, the program, begun in 2004, has been working along 3 ports, with 58 fishing vessels cooperating with the program. In four years, 181 experimental fishing trips were completed and 1,718 longline sets, for a total of 911,068 hooks, were observed. In addition, 16,000 circle hooks have been changed to J hooks and tuna hooks in the country.

Turtle Excluder Devices have been used by trawling shrimp boats since 1996, the first year the decree mandating coastal shrimp vessels to use TEDs was enforced.

## 5.9. Incidental Capture of Sea Turtles in the Mexican Pacific: The Case of the Leatherback Turtle

Ana R. Barragán, Programa Nacional de Tortugas Marinas, Comisión Nacional de Areas Naturales Protegidas, Semarnat, Mexico

In Mexico, gillnets are used legally in the small-scale fishing of shark, fish in general and in some cases, they are used for the capture of yellow snapper, red snapper, Pacific sierra, mullet, etc. For the large pelagic fisheries, gillnets have been divided according to the target species and the boat size in which they are operated: 1) Gillnets for sharks in small vessels; 2) Drifting gillnets for swordfish and sharks in medium-sized boats; and 3) Set gillnets for coastal sharks in the Pacific, with medium-sized boats. As of May of 2007, the application of the Mexican Official Standard *NOM-029-PESC-2006* started, as a regulation for the responsible fishing of sharks and rays. This Standard lists the characteristics of authorized gillnets per fleet and geographical region, prohibits the use of drifting gillnets for shark fisheries and bans the use of gillnets in front of important sea turtle nesting beaches.

The incidental capture of leatherback turtle adults and juveniles in gillnets and longlines has been listed as one of the causes of the decline in the nesting population of the species in the Mexican Pacific. Mexico is structuring a National Action Program for the conservation of this species, which will include actions intended to evaluate and mitigate the effects of the interactions between leatherback turtles and fishing gear. Among the actions implemented in this Program are:

- Characterization of coastal and oceanic fisheries occurring near leatherback priority beaches, defining types of gear, time of operation, size of fleets and geographical location
- Implementation of temporal closures of fisheries in critical areas close to priority beaches, with:
    - social, economic and cultural studies of factors related to incidental capture of leatherbacks along their distribution range, evaluating the possible social impact of the fishing closures;
    - establishment of an economic compensation or incentive system for affected fishermen; and
    - enforcement of surveillance activities at sea
- Research on marine habitat use and inter-nesting movements of females, using telemetry to identify critical areas
- Strengthening of the current programs of onboard observers and establishment of such programs in fisheries that still don't have them, including standardization of data log protocols for observers, including specific information of sea turtle species
- Workshops for sharing experiences for coastal and fishing communities along the region, for the integration of these communities into the regional strategy

## 5.10. Coastal Fisheries and Interactions with Marine Turtles in French Guiana

Laurent Kelle[1] and Michel Anthony (Tony) Nalovic[2]

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French Guiana is located on the northeastern coast of South America, where major rookeries of leatherback, Green, and olive ridley turtles nest from January to August each year. Over the last decade, several ad-hoc observations suggested an important marine turtle incidental catch related to different fishing activities. In the region, shrimp trawling and longlining occur on the deeper fishing grounds of the continental shelf (>30m depth), while coastal gillnetting mostly exploits shallow waters (<20m depth). This latter fishery is very disparate in terms of fishing ground, fishing gear, and strategy. In 2005, a nationwide assessment of marine turtle incidental catches was performed through an interview-based survey, involving 39 fishermen located on different landing sites (Cayenne, Kourou, Sinnamary, Iracoubo/Organabo and Awala-Yalimapo).

There were 1604±578 interactions in 2004 and an estimated range of 1144±336 to 1558±504 interactions in 2005. The leatherback turtle appeared to be the most commonly caught (74.3% in 2004 and 81.8% in 2005). According to this assessment, large mesh-size nets, exceeding 2,000 m in length and 4 m wide, led to a significantly higher numbers of marine turtle incidental catches.

To better evaluate the real impact of such fishing practices on marine turtles, an on-board observer study was carried out in 2008. An eight-boat fishery located in Cayenne was specifically targeted because they use drifting gillnet of about 3,000 m in length, 90 mm mesh size, and 6-8 m height. Observations were conducted from April 2008 until August 2008, thus covering both the leatherback and olive ridley turtles' nesting seasons. For each on-board campaign, GPS location of fishing effort, duration of each shot, and description of catches (targeted and incidental) were gathered.

This study allowed the accurate description of fishing practices of this particular segment of coastal gill-net boats in French Guiana. Fishing trips lasted 8-15 days, with an average soak time for the nets of 6 hours for 1.4 average shots per day. A total of 87 fishing days were monitored, representing 20% of the total fishing effort. A total of 24 interactions with marine turtles were reported, with a higher occurrence of the leatherback turtle (15 catches), followed by the olive ridley and green turtles (5 and 4 captures, respectively). Based on this data, it is estimated that the eight-boat fleet have incidentally caught 96 leatherback turtles, 27 olive ridley turtles, and 17 Green turtles during the observed time period. About 86% of the leatherback turtles were caught at night, with a minimum of 20% entangled with the float lines, and a 60% direct mortality rate. Effective reanimation techniques allowed the live release of all hard-shelled turtles .

This study permits a better assessment of the links between coastal fishing activity in the region and interaction with marine turtles. Other specific components of the coastal gill-netters will be progressively studied, in order to expand and complement the understanding of the interactions between marine turtles and coastal fisheries in the Guianas.

## 5.11. Incidental Capture of Leatherback Sea Turtles *(Dermochelys coriacea*) in the Coastal Gillnet Fisheries of Trinidad and Tobago

Scott Eckert[1] and Anderson Inniss[2]

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The island of Trinidad is located approximately eight miles east of the South American coastline at the southern end of the Caribbean Sea. As part of the two-island country of Trinidad and Tobago, Trinidad supports one of the largest nesting colonies of leatherback sea turtles in the world. Currently 8,000 – 10,000 leatherback turtles nest annually along Trinidad's north and east coasts between February and August. Management of these nesting colonies is undertaken by community-based conservation organizations, which has led to a high level of expertise among such groups in data collection and management. Trinidad also supports an artisanal gillnet fishery along with vessels operating from small fishing depots and villages. This fishery targets a large number of midwater and demersal species, most of which have commercial value in local markets.

As might be expected with such a high concentration of turtles and gillnet fishers operating in the same area, accidental capture and killing of turtles by gillnet fishing is extensive. One estimate calculates that 3,000 leatherbacks are entangled annually and 30% of those die, while other studies confirm these values. Not only does this high level of turtle mortality threaten to reverse the recovery of the Critically Endangered leatherback sea turtle, it also severely threatens the capacity of fishers to sustain their economic livelihood. High levels of net destruction due to turtle entanglement often means that fishers are unable to work, and with the leatherback population growing at 6% per year, the problem facing fishers promises to get more difficult.

To develop a mitigation strategy, WIDECAST and the Trinidad and Tobago Ministry of Agriculture, Land and Marine Resources held a national consultation with stakeholders including fishers, natural resource policy and management professionals, sea turtle conservation project personnel and outside technical experts. A finding of this consultation was that there was a need to develop a program to test new fishing methods that could significantly reduce bycatch without causing economic loss to fishers. Toward this end, and with the input of all stakeholders and outside experts, WIDECAST initiated a program to test fishing methods that promise to return equal or increased fishery revenues, while also reducing leatherback bycatch rates to sustainable levels. Under realistic field conditions, experiments were designed and tests carried by stakeholders to evaluate various bycatch reduction options. Undertaken from 2006 to 2008, results of those activities will be presented later in this program. For this presentation we will focus on describing Trinidad's bycatch problem and the structure of our highly successful bycatch reduction program.

## 5.12. Assessing Effort and Bycatch in Small-scale, Coastal Fisheries: Results from Jamaica, Sierra Leone, Tanzania, Cameroon, and Nigeria

Rebecca Lewison[1] and Larry Crowder[2]

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[2] Duke University

Sustainability of small scale fisheries is a growing concern. Specifically with regards to bycatch, small-scale fisheries are also believed to result in high levels of sea turtle and marine mammal bycatch. To assess fisheries bycatch in small scale fisheries, two key pieces of information are needed – the amount of fishing effort and the frequency of encounter with bycatch species per unit of fishing effort.

However, small-scale fisheries typically have little data describing effort and catch. As part of a Project GloBAL's research program, we considered whether a large scale yet rapid and low-cost fisheries assessment could be effective as a means to gather this basic information. We tested an assessment approach in six countries (Sierra Leone, Cameroon, Nigeria, Tanzania, Comoros, and Jamaica) and one province (Sabah state, Malaysia). The purpose of this study was to develop and test a questionnaire-based protocol with the following objectives: 1) document bycatch of marine mammals and sea turtles in artisanal fisheries, 2) test the protocol in six pilot locations with the objective of determining if it was rapid, cost-effective, and reliable (produced reliable bycatch information), 3) document lessons learned regarding surveying fishermen to obtain fisheries-dependent catch data, and 4) communicate elements of our sampling design to help improve the utility of interview-survey data collected for small-scale fisheries. Here, we present preliminary findings from these assessment efforts and discuss important lessons learned and results from these pilot studies.

## 5.13. Sea Turtle Bycatch in Small-Scale Artisanal Fisheries of Uruguay

Cecilia Lezama, Karumbe NGO

Uruguay is located in the Patagonian Large Marine Ecosystem, one of the most extended and productive in the Southern Hemisphere. This ecosystem encompasses areas containing a wide diversity of marine organisms, which are exploited by fisheries of large economic and social importance for the region. These fisheries result in the incidental capture of sea turtles, one of several mortality sources for these endangered populations. Research conducted during past years has demonstrated that the Patagonian Sea is a foraging area for juveniles of *Chelonia mydas* (green turtle) and for adults and subadults of *Dermochelys coriacea* (leatherback) and *Caretta caretta* (loggerhead) that come from different breeding zones. Thus, mortality due to fishing activities may be depleting nesting populations elsewhere in the Atlantic.

In Uruguay, artisanal fishing is a small-scale activity that employs simple gears and depends on manual labor. In coastal areas of the Rio de la Plata Estuary and the Atlantic Ocean, fishermen use passive gears such as artisanal longlines and demersal gillnets,the latter showing higher levels of sea turtles bycatch in our country. Previous monitoring studies (2002-05) about the impact of the artisanal fishery in sea turtles populations indicated that *C. mydas* is the most frequently captured species, affecting mainly juvenile individuals all along the Uruguayan coast. Also *D. coriacea* interact with gillnets that operate inside the Río de la Plata Estuary. The incidental captures of leatherbacks in these shallow waters occurred mainly during the summer and associated with high jellyfish abundance, probably as a result of foraging incursions. *Bajos del Solís*, an important foraging ground for juvenile green turtles in Uruguay and also considered one of the most important fishing zones in the country, was identified as having the highest levels of bycatch of this species.

The association of environmental and operative variables with incidental captures was analyzed for this area. The results indicated that season, soak time and distance to the coast were the most important variables that explained the interaction. This was consistent with our observations as all captures occurred in shallow rocky areas and mainly during spring and summer. Using sample-based estimators, an annual incidental capture of 661 green turtles was estimated for this area. Another important percentage of mortality was found (47.6 % for 2002-03 and 38.0 % for 2004-05) due to the extended soak time of gillnets.

The extremely valuable juvenile life stage for the recovery and stability of populations mandated its inclusion in this area's conservation plans. As a result, an "Onboard Data Collection Program for Artisanal Fishery" (PROARTE), directed at fishermen, was implemented in *Bajos del Solís* to reinforce local participation in conservation efforts. In order to mitigate green turtles mortality, we encouraged fishermen to reduce gillnets soak time and to check the nets more frequently. Since fishermen are more likely to interact daily with sea turtles, it is critical to involve them in conservation activities. Finally, we considered the creation of Marine Protected Areas as an essential tool for the conservation of sea turtles to allow us to develop a better management of the fisheries, as well as involve fishermen as the main key implementers in the conservation of marine ecosystems.

## 5.14. Sea Turtle Interactions in Coastal Net Fisheries in Brazil

Neca Marcovaldi[1,2], Bruno B. Gifforni[1], Henrique Becker[1], Fernando N. Fiedler[1], Gilberto Sales[2]

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Brazil has more than 8.000 km of coastline and five sea turtle species occur regularly along the coast (loggerheads, greens, olive ridleys, leatherbacks and hawksbills). All of them are included in the Brazilian red list and at IUCN´s list. Full legal protection for all species occurring in Brazil was enacted in 1986. Among the different fisheries found in the country, the coastal net fisheries are the most complex group of fisheries due to its diversity and large distribution along the coast. According to "The National Action Plan to Reduce Sea Turtle Incidental Capture in Fisheries" - Tamar/Fishery Program (Marcovaldi et al., 2002), 17 different coastal net fisheries were identified in Brazil. Other relevant coastal fisheries interacting with sea turtles are pound net and corrals. These fisheries have evidenced interaction with sea turtles in different levels.

The first assessment was conducted for coastal gillnet and pound nets in the state of São Paulo and for the corrals in the state of Ceará. The methodology included: interviews with fishermen; spreadsheet forms filled out by the captains and the boat´s crew; and an on board observer program. These fisheries showed high interactions with sea turtles, namely juvenile green turtles for the coastal gillnets (2002 – 2007. n = 1,874 green; mean ccl = 40.3 cm), pound net (1991 – 2007. n = 4,517 green; mean ccl = 40.6 cm) and corrals (1993 – 2007. n = 670 green; mean ccl = 60,7 cm. Strandings might suggest indirect interactions with costal fisheries. In the areas where TAMAR is present, there have been more than 7,000 stranding records, of which green turtles are, by far, the most common in all places, except for Sergipe state, where adult olive ridleys are found stranded particularly during the nesting season. This is of special concern since long-term trend analyses have shown a 10-fold increase on this nesting population.

In 2008, the Brazilian Government created a technical working group, composed of representatives of fishermen and experts from different areas, including net fisheries, sea turtles, sea birds, cetaceans. The main objective was to improve the regulations for the different types of net fishing to mitigate the interactions between net fisheries and endangered species. Accordingly, TAMAR identified and proposed, "closed areas" for some regions, where high catch rates on foraging aggregations of juvenile green turtles (e.g. coastline of the state of Bahia) have been recorded. TAMAR is further seeking to increase sampling effort to coastal gillnets to reach robust CPUEs estimates; and to Identify critical areas for testing, adjusting and implementing proper mitigation actions. One such area is the state of São Paulo, where a study is underway to evaluate sea turtle catch rates in coastal gillnets between diurnal and nocturnal period. In addition to these strategies to mitigate the interactions with sea turtles, TAMAR has always prioritized integrating fishermen and fishing enterprises with sea turtle conservation by creating a sense of awareness with emphasis on reporting sea turtle captures, handling and adequate release of live turtles. TAMAR has been working with over 400 volunteer fishermen and its data base demonstrates that these fishermen have helped save more than 10,000 turtles incidentally caught in different fisheries during 28 years of cooperation.

### 5.15. Incidental Capture of Sea Turtles in Artisanal Fisheries of the Union of Comoros

C.N.S. Poonian[1,2], Melissa Hauzer[1], A. Ben Allaoui[3]

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The Union of the Comoros is host to internationally significant populations of sea turtles, all of which are potentially threatened by incidental catch in artisanal fishing gears. As part of a study by Project GloBAL (Global Bycatch Assessment of Long-lived species), an evaluation was conducted on artisanal fishing effort and bycatch of sea turtles and marine mammals in data-deficient areas. Questionnaire surveys were conducted with 409 out of the estimated 8,500 artisanal fishers in the Comoros, on the islands of Grande Comore (25/44 landing sites) and Mohéli (5/13 landing sites). Sea turtles (*Chelonia mydas* and *Eretmochelys imbricata*) were reportedly captured in large numbers, although it was not always clear if captures were accidental or deliberate. Lower rates of turtle capture were reported from Mohéli, possibly as a result of awareness-raising activities associated with Mohéli Marine Park. While the lack of comprehensive fisheries data for the Comoros and the difficulties associated with gathering precise empirical historical data from fishers make it unrealistic to extrapolate national bycatch figures, the information generated from this low-cost technique has revealed priorities for management recommendations and future research.

## 5.16. North Carolina, USA Assessment of Sea Turtle Fisheries Bycatch

Jeff Gearhart[1] and Blake Price[2]

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[2] North Carolina Division of Marine Fisheries

Commercial and recreational fishing operations throughout North Carolina, USA, employ a multitude of gears, ranging from hook and line to otter trawl. Many fisheries face finfish and protected species bycatch issues that necessitate gear modifications, changes to operation parameters, or require seasonal and area closures. In particular, threatened and endangered sea turtle populations, protected under the Endangered Species Act (1973), frequent North Carolina inshore and coastal waters and may interact with commercial and recreational fisheries.

The loggerhead *Caretta caretta*, green *Chelonia mydas*, Kemp's ridley *Lepidochelys kempii*, Leatherback *Dermochelys coracea*, and Hawksbill *Eretmochelys imbricata* are all found in North Carolina waters. However, sea turtle stranding reports and reported or observed interactions (in fishing gears) are most commonly the loggerhead, Kemp's ridley and green sea turtles, and nearly exclusively comprised of juvenile/sub-adults. Since 1999,state fishery managers have increasingly become concerned about protected species interactions in commercial and recreational fishing gears. That year, a mass stranding event along the Outer Banks, North Carolina prompted the National Marine Fisheries Service (NMFS) to close the sound to large mesh (> 4 ¼ " stretch) operations from 1 September through the 15 December of each year. This came with a significant economic hardship to the local communities and fishermen operating in the fall southern flounder *Paralicthys lethostigma* fishery. In order to maintain this economically important fishery since this closure, the North Carolina Division of Marine Fisheries (NCDMF) and NMFS have worked collaboratively to establish Section 10 Incidental Take Permits (ITPs). The ITPs allow limited shallow water large mesh gillnet operations through a Habitat Conservation Plan, which includes daily/weekly monitoring and reporting by NCDMF and the industry, increases NCDMF enforcement, minimizes interaction potential, and authorizes a threshold of sea turtle takes. This management regime has been successful in continuing protection of endangered/threatened sea turtles and allowing an economically viable fishery to operate. At-net mortality in this fishery remains approximately 25%.

This closure also prompted NCDMF to: research potential sea turtle bycatch reduction gears, establish attendance requirements in known hotspots, increase outreach and awareness of sea turtle bycatch issues and, most recently, begin the process of establishing a year-round commercial fishery observer program. The observer program has operated inshore continuously from 2004 to 2006, and from late 2007 through 2008, and was designed to gather real time catch and bycatch information that may be used to implement proactive management measures in advance of closures. Stable funding for this program has yet to be identified.

Finally, the Sea Turtle Advisory Committee (STAC) was formed under the North Carolina Marine Fisheries Commission (NCMFC) from 2003 to 2006 to identify interaction problems in inshore fisheries, and included management recommendations by fishery that may allow increased protection for sea turtle populations. Many of the STAC's final report's recommendations are currently in the process of being implemented (e.g., gear removal of pound nets during closed seasons, state enforcement authority of Turtle Excluder Device use in the shrimp trawl fishery, and increased outreach to the industry). As sea turtle conservation measures continue, and presumably populations increase, a continuous need for gear development and timely management measures will persist.

## 5.17. Sea Turtle Bycatch in Chesapeake Bay and Coastal Virginia Fisheries

Kate Mansfield, University of Miami

Four species of sea turtle are common to Virginia's waters: loggerhead, Kemp's ridley, leatherback and green. The Virginia portion of the Chesapeake Bay has a long history of coastal fishing activity. Currently, the Virginia Marine Resources Commission issues licenses for approximately 78 different fisheries active in Virginia's Bay and coastal waters. The gears associated with these fisheries are loosely grouped into eight gear categories:

- **Trawl:** currently prohibited in state waters (but allowed in federal). Trawls were an historic source of sea turtle bycatch in Virginia waters. Special permits are issued for trawl-based research activities in Bay waters.
- **Dredge**: including bottom raking devices that primarily target shellfish and mollusks
- **Gillnets:** including drift, sink, anchor and staked. Net mesh sizes range from a minimum of 5 cm bar to in excess of 30 cm bar, depending upon where net is set (local tidal velocities) and target species. Gillnets have a documented history of sea turtle bycatch (entanglement) in Virginia waters. Large (>15 cm bar) leader mesh sizes are most hazardous to sea turtles.
- **Seines:** including haul and purse seine. Mesh sizes are typically approximately 8 cm bar. Seine nets have a documented history of sea turtle bycatch (live entrapment) in Virginia waters.
- **Longlines:** including inshore trotlines. No bycatch data are available for the inshore trotline fishery.
- **Pots and Traps:** including crab, whelk eel and fish pots. Crab and whelk pots have a documented history of sea turtle bycatch (pot line entanglement) in Virginia waters.
- **Hook and Line:** there is a documented history of sea turtle bycatch in Virginia's recreational hook and line fishery.
- **Fixed Nets:** including pound, fyke and crab pounds. Pound net mesh sizes range from approximately 5 cm bar to in excess of 30-40 cm bar, depending on where the net is set, the tidal velocity in that region and potential for detritus to collect in net leaders. Pound nets have a documented history of turtle bycatch (leader entanglement or live entrapment in pound head). Large (>15 cm bar) leader mesh sizes are most hazardous to sea turtles.

There is no state-run fisheries observer program in Virginia; therefore, few bycatch data are available. While no fisheries have established take limits for sea turtles in Virginia, targeted gillnet and pound net fisheries are regulated by the federal government to reduce sea turtle and marine mammal bycatch. Regulatory methods in Virginia waters include: blanket prohibitions; timed closures (seasonal turtle residency); area closures; mesh size restrictions; tie down restrictions; caps on licenses issued/nets fished; caps on net length; soak time; mandatory net supervision; twine size restrictions; take restrictions; set depth restrictions. These regulatory methods are limited by "best available data," low or no observer coverage, low or no enforcement and, in some cases, are applied to only federal or adjacent state waters.

The fixed gear pound net fishery is historically a known source of mortality for sea turtles in the Chesapeake Bay. Two types of takes are documented in these nets: entanglements in the leaders (typically larger mesh leaders) and live entrapment in the open pound heads. In the 1980s, there were over 300+ active nets in the Bay, 175+ of which had the more hazardous large mesh leaders. Currently, there are less than 50-60 active nets in the Bay, less than 10 of which have large mesh leaders.

Long-term mark and recapture, satellite telemetry and recapture data from turtles captured in western Bay pound nets indicates that some turtles exhibit strong site fidelity to specific fixed nets both seasonally and inter-annually (Mansfield 2006). These data suggest that fixed gears may increase probability of interaction due to site fidelity behavior and high non-lethal take levels are likely in the open pound heads of Chesapeake Bay pound nets.

## 5.18. Range of Tools for Fisheries Bycatch Mitigation

Eric Gilman[1], Frank Chopin[2], Scott Eckert[3]

[1] International Union for the Conservation of Nature (IUCN)
[2] Food and Agriculture Organization of the United Nations (FAO)
[3] Wider Caribbean Sea Turtle Conservation Network (WIDECAST)

Approaches to mitigate (avoid, reduce, and offset) sea turtle capture and mortality in gillnet, pound net and other marine capture fisheries, are summarized in Table 1 (Gilman et al., 2006a,b; FAO, In Press; Gilman and Lundin, In Press).

Table 1. Practices to reduce the bycatch and mortality of sensitive species groups in marine capture fisheries, including coastal passive net fisheries.

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|---|---|
| Modifications to fishing gear and methods | Gear technology (changing the design of the fishing gear - e.g., altering net mesh size) and altered fishing methods (e.g., changing the depth of gear deployment or daily timing of fishing operations) can reduce bycatch. |
| Gear restrictions | Regulations prohibiting specified gear designs, in some cases with spatial or temporal measures, can be used to attempt to reduce bycatch (e.g., ban on large mesh ray drift gillnets in Malaysia, Yeo et al., 2007; mesh size restrictions in gillnets, Price and VanSalisbury, 2007; seasonal restriction on pound net leader use and designs, De Alteris and Silva, 2007). |
| Input and output controls | Input controls include limiting the amount of fishing effort or capacity (e.g., limiting vessel numbers of a specified size, prohibiting new entrants, instituting buy-back schemes, limiting gear soak time). Output controls include limiting catch through, for example, total allowable catch or quotas of target, incidental or discarded bycatch species (e.g., FAO, In Press; Gilman and Lundin, In Press). |
| Compensatory mitigation | Individual vessels or a fisheries association could meet bycatch mitigation requirements through compensation to a public or private organization to conduct conservation projects to address other anthropogenic sources of mortality. Management authorities could create a fee and exemption structure for the bycatch of sensitive species, similar to a “polluter pays” system. For instance, governments could reduce or withhold subsidies, charge a higher permit or license fee, or use a higher tax rate if bycatch thresholds are exceeded. Alternatively, the fee structure can provide a positive incentive, where a higher subsidy, lower permit or license fee, or lower taxes apply when bycatch standards are met. Compensatory mitigation programmes likely require 100% observer coverage, a substantial limitation. Problems with lack of performance and off-site and out-of-kind mitigation could occur when compensatory mitigation, a longstanding practice in U.S. wetlands management (Environmental Law Institute 2006), is applied to fisheries bycatch (e.g., conducting conservation activities at a nesting colony not part of the population interacting with the fishery, or conserving different age classes than affected by the fishery). The concept holds promise if used to compliment and not detract from actions to first avoid and minimize bycatch (FAO, In Press; Zydelis et al., In Press). |

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|---|---|
| MPAs | Spatial and temporal restrictions of fishing, especially in locations and during periods of high concentration of bycatch species groups, can contribute to reducing fisheries bycatch. Establishing protected areas containing sea turtle nesting colonies and adjacent waters may effectively reduce turtle bycatch and in some cases might be socially and economically acceptable to local communities (e.g., Peckham et al., 2008). The establishment of a representative system of protected area networks on the high seas also holds promise. However, this will require extensive and dynamic boundaries, defined, in part, by the location of large-scale oceanographic features and short-lived hydrographic features, and would require extensive buffers (e.g., Hyrenbach et al. 2000). Extensive time will likely be required to resolve legal complications with international treaties, to achieve international consensus and political will, and to acquire requisite extensive resources for enforcement. |
| Fleet communication | Fleet communication programs can report real-time observations of temporally and spatially unpredictable bycatch hotspots to be avoided by vessels in a fleet (Gilman et al., 2006b). Fleet communication may be appropriate in fisheries where there are strong economic incentives to reduce bycatch, bycatch rates of sensitive species are rare events and adequate onboard observer coverage exists. |
| Industry self-policing | Self-policing uses peer pressure from within the industry to criticize bad actors and acknowledge good actors (e.g., Fitzgerald et al., 2004). A fishing industry can create a program where information for individual vessel bycatch levels, compliance with relevant regulations, and other relevant information, is made available to the entire industry. This is especially effective where regulations contain industry-wide penalties if bycatch rates or caps are exceeded. |
| Changing gear | It may be commercially viable to change to a different fishing gear that results in a lower bycatch-to-target catch ratio than the conventional gear (e.g., replace Trinidad gillnet fishing with troll fishing using power take-up reels, Eckert and Eckert, 2005; Eckert et al., 2008). |
| Handling and release best practices | Much progress has been made to identify best practices to handle and release turtles captured in longline fisheries, and various tools and techniques are included in guidelines to remove fishing gear from captured sea turtles, reduce injury and promote post-release survival (e.g., U.S. National Marine Fisheries Service 2004; Gilman et al., 2006a; FAO, In Press). Some aspects may be applicable to coastal net fisheries, for instance, equipment (dipnets) to bring turtles onboard, general techniques for turtle handling while onboard, techniques to remove water from a turtle's lungs, removing as much gear before release, and use of line cutters. |
| Market-based mechanisms | Eco-labeling and other certification programs for marine capture fisheries, and employment of sustainable seafood sourcing policies by retailers and seafood buyers, provide large market-based and social incentives for some fisheries to meet sustainability criteria (e.g., FAO, 2008; Gilman, 2008). Fisheries in developing countries have been underrepresented in ecolabeling programs, in part, due to insufficient fisheries management frameworks, insufficient data, and high costs of assessment and maintaining certification; however the Marine Stewardship Council (MSC), the largest global eco- |

labeling organization for marine capture fisheries, has developed protocols for applying the MSC assessment process to data-deficient fisheries, and is now testing these protocols through pilot studies.

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## 5.19. Summary of Session 1 Discussion

**Characteristics of Coastal Net Fishing Gear and Methods that Affect Sea Turtle Capture and Prospects for Surviving an Interaction**

Participants discussed characteristics, designs, and methods of use of passive net (gillnet and trammel net) and trap (pound net, fyke net and stow net) gear, focusing on aspects that influence interactions with sea turtles. Participants identified a need for the standardization of gear terminology. A proposed classification scheme for coastal net fisheries was introduced. Participants' comments were used to modify and improve the classification scheme.

The mechanics of how gear captures both target and bycatch species include gilling, entangling and enclosing in a trap. Illustrations depicting gear designs were criticized for not capturing how complex the gear may be positioned and shaped depending, for instance, on variable environmental conditions or variations in the gear design. In other words, available illustrations do not provide good approximations of actual gear when soaking.

Hypotheses were discussed of why turtles interact with coastal net fisheries, including whether or not turtles see the gear, are pushed into the gear by currents, are attracted to floats and/or fish caught in the gear, highlighting that the state of understanding is limited.

Aspects of gear design, materials and methods that affect sea turtle survivorship after interaction with the gear were identified. For instance, surface-set gear tends to have a higher proportion of live caught turtles than demersal gear, as turtles can reach the surface to breathe during the gear soak in the surface gear. Lighter-weight gear tends to have higher turtle survivorship, again, because caught turtles can reach the surface to breathe during the gear soak. Pound nets with an open pound (trap) have higher turtle survivorship than closed traps, as the open traps enable captive turtles to reach the surface to breathe.

Section 6 contains two forms revised during the workshop designed to collect information on coastal passive net gear characteristics and fishing methods relevant for understanding interactions with sea turtles.

**Draft Classification Scheme for Coastal Passive Net Gear**

The following was proposed by Martin Hall as a classification scheme for coastal passive net fisheries, as amended based upon participants' comments.

- Surface drifting gillnet SDG
- Midwater drifting gillnet MDG
- Bottom drifting gillnet BDG
- Anchored surface gillnet ASG
- Anchored midwater gillnet AMG
- Anchored bottom gillnet ABG
- Staked gillnet StG
- Sweeping gillnet SwG

- Anchored trammel net AnT
- Staked trammel net StT
- Sweeping trammel net SwT

- Covered pound net CPd
- Uncovered pound net UPd
- Fyke net Fyk
- Stow net Stw
- Corrals Cor

**Indirect Effects on Sea Turtles from Coastal Passive Net Fisheries**
Participants identified several indirect effects of coastal net fisheries on sea turtles. Fishing gear can obstruct sea turtle access to critical habitat, including foraging and nesting areas and migration routes. Geomorphic features, such as the mouths of estuaries, were identified as spatial hotspots for capturing sea turtles and creating obstacles to migration. Coastal passive nets and traps can also cause ghost fishing and derelict gear may degrade habitat, with direct or indirect adverse impact on sea turtles. Additionally, coastal net fisheries may provide an unnatural source of food for sea turtles (turtles may depredate species of fish from coastal passive net fisheries that are not typical components of their diet). Coastal net fisheries may reduce predator population sizes, possibly representing a positive indirect effect for sea turtles, but causing complex and potentially adverse effects on the coastal ecosystem and hence sea turtles. Furthermore, individual turtles may be repeatedly captured in a coastal net fishery, causing adverse effects from the chronic stress.

**Target vs. Retained Bycatch vs. Discarded Bycatch; Managing all Target and Bycatch Species Interactions: Ecosystem-based Approach to Fisheries Management**
There were several examples of coastal fisheries that target sea turtles, where there is a market for turtle meat and other products, fisheries where sea turtles are retained bycatch, and fisheries where caught sea turtles are discarded. Illegal sea turtle catch and trade is problematic in many regions.

Participants discussed the importance of considering all species that are caught in coastal fisheries when making risk assessments and pursuing sustainable fishing practices. This includes managing all species groups caught as bycatch, instead of considering sea turtle bycatch in isolation, and managing species that are discarded as well as retained, to prevent the overexploitation of all affected species. Furthermore, the need for a well managed fishery was seen as a prerequisite before progress can be made in managing unwanted bycatch: If a management framework is not in place to ensure that overexploitation is not occurring, where there is a lack of controls on fishing effort, it is not possible to responsibly and sustainably manage bycatch levels.

The following definitions were generally employed during the workshop:

- Bycatch: Retained catch of non-targeted species or 'incidental catch', plus all discards;
- Target catch: Catch of a species or species assemblage primarily sought in a fishery;
- Non-target catch: Catch of a species or species assemblage not primarily sought;
- Incidental catch: Portion of non-target catch that is retained; and
- Discards: Portion of non-target catch that is not retained.

**Temporal and Spatial Trends in Turtle Interactions**
In some fisheries, seasonal and spatial patterns in sea turtle capture in coastal net fisheries have been documented. In some fisheries, it may be feasible to spatially and/or temporally separate coastal net fisheries and high densities of sea turtles. The example of the mouth of an estuary funneling sea turtles as a zone of high potential turtle interactions was identified as how the presence of a geomorphic feature can provide a basis for identifying a potential effective temporal or spatial marine protected area to effectively reduce turtle bycatch.

**Standardizing Sea Turtle CPUE**
Benefits of standardizing units for the reporting of sea turtle catch-per-unit-of-effort (CPUE) in gillnet and trammel net fisheries were highlighted, and alternative approaches were identified. Alternative turtle CPUE units identified were the number of caught turtles per: trip, set, unit length of net, unit area of net, unit area per soak time, and net weight. Catch per horizontal length of a net is only a suitable measure of CPUE if the net heights are similar, and if turtles are caught in the same horizontal part of the net. Other factors that affect turtle catch rates also

might be considered for inclusion in CPUE rates – such as the time of day of the soak: if turtle catch rates are higher at night vs. during the day, then comparing turtle CPUE for gear that does not account for the time of day of soaking is not accounting for this confounding factor. Effort is not effectively characterized by identifying the number of vessels in a fleet or number of fishers participating in a fishery. It is unwise and potentially very misleading to attempt to compare effort between gear types.

**Commercial Viability**

The importance of considering the effect of alternative turtle bycatch mitigation methods on the economic viability, safety and practicality of a fishery was discussed and identified as critical for success, particularly in fisheries with weak or no management frameworks and/or limited resources for monitoring, control and surveillance. Given the socioeconomic context of artisanal fisheries, it is critical to consider potential effects of alternative bycatch reduction strategies on fishers' social and economic welfare.

Cost-benefit analyses designed to predict economic effects from instituting alternative mitigation measures should incorporate various factors, including changes in CPUE of commercially important species (e.g., including sea turtles in locations where turtles are a target or important incidental catch species, such as in the Comoros), changes in time and cost required to repair and replace gear damaged from turtle interactions (e.g., in Trinidad, leatherback captures are so frequent that they present a challenge to the economic viability of the surface gillnet fishery, and therefore there is a high economic incentive to reduce turtle interaction rates), and cost to institute the mitigation practices.

In the North Carolina gillnet fishery, regulatory measures have created an economic incentive for the industry to accept 40% reductions in target species catch rates from using lower profile nets, as the alternative is to not fish in these areas; this context is unlikely to transfer to developing countries. In some fisheries, market-based influences from buyers employing sustainable seafood sourcing policies may also be a relevant factor.

**Artisanal Fishery Assessment through Social Surveys**

Positive and negative aspects of the rapid assessment methodology employed by the Moore Foundation-funded Project Global were discussed. Positive aspects included obtaining first-order information on artisanal fisheries where previously little or no information was available, providing a preliminary basis for determining whether bycatch of sensitive species groups is problematic and the relative risk of individual fisheries and regions. Several potential factors that result in reduced confidence in the findings were, however, highlighted, including:

- Fishers may not provide accurate information, perhaps because they want to conceal that bycatch occurs. They may do this due to awareness of the international sensitivity to the issue, resulting in respondents stating what they believe the interviewer wants to hear, they may wish to conceal bycatch levels from owners and/or operators, or they may suffer from 'survey fatigue'. There may also be imprecise recollection of rare events;
- It is difficult to identify participants in the fishery who will provide information that provides a suitable characterization of the entire fishery. For instance, some individuals may provide outlier perspectives and information. For example, in West Africa, where women maintain logbooks, if women were not included in surveys, much information would be missed; and
- Certain approaches proved to be ineffective, such as attempting to have fishers identify locations on maps.

The potential for placing observers on a limited number of vessels to validate information collected from fisher interviews was suggested as a low-cost validation approach. Rapid

assessment projects would benefit from the inclusion of experienced social scientists for assistance in developing rigorous survey designs. Long-term data series may be necessary to account for high inter-annual variability in gear used, gear designs, and other fishery characteristics.

## 5.20. Reducing Sea Turtle Bycatch - A Fishing Technology Perspective

Frank Chopin, Food and Agriculture Organization of the United Nations

Sea turtle bycatch in coastal and offshore fisheries, especially those that use gillnets, trawls, pelagic longlines, set nets and purse seines is believed to have a significant impact on sea turtle populations. Within the context of implementing responsible fisheries, reducing impacts on non-target species such as sea turtles, is now a policy for many States, as well as for an increasing number of regional and sub-regional fisheries management organizations.

Reduction of bycatch and discards is a priority activity for the FAO. Within the fishing technology service (FIIT), bycatch and discards are specifically addressed in the work program, "Impact of fisheries on the environment." In this context, much of the work to reduce sea turtle bycatch has been through the provision of technical assistance and awareness-raising on more selective fishing gear and fishing practices. These include the promotion of circle hooks in pelagic longline fisheries and the use of Bycatch Reduction Devices (BRDs) in tropical multispecies bottom trawl fisheries. In the case of trawl fisheries, much of the activity of FIIT between 2002 and 2008 was channeled through the GEF funded project, “Reduction of Environmental Impact from Tropical Shrimp Trawling, through the Introduction of By-catch Reduction Technologies and Change of Management (REBYC).” This five-year project involved twelve partner countries (Bahrain, Cameroon, Colombia, Costa Rica, Cuba, Indonesia, Iran, Mexico, Nigeria, Philippines, Trinidad, and Venezuela) and one regional organization, the Southeast Asian Fisheries Development Centre (SEAFDEC). A second phase project is now being planned.

While there are many factors that affect the outcome of fishing gear selectivity experiments, adoption of bycatch reduction technologies by industry has a high probability of success when: (1) the bycatch species is significantly different in size and behavior from the target species; (2) mechanical exclusion can be achieved with minimal loss of target catch and revenue; (3) industry plays a significant role in the development and testing process; and (4) fishing trials are properly planned and carried out using standard experimental protocols for evaluating fishing performance. In this presentation, we report on the work of Fishing Technology Service on turtle bycatch reduction and consider some of the constraints associated with reducing turtle catch in passive fishing gear, such as gillnets and set nets.

## 5.21. First Attempts to Categorize and Stratify Nets for Bycatch Estimation, and for Bycatch Mitigation Experiments

Martin Hall, Inter-American Tropical Tuna Commission

To produce good estimates of fishing effort, needed for assessment, for bycatch estimation and for other purposes, we need to understand what are the characteristics of the different types of nets that allow us to combine them (in a statistical sense to include in a stratum), or that make it necessary to keep them apart. The art of finding the right level of stratification lies at the basis of many fisheries problems: too many strata, and inadequate sample sizes; and too few strata and resulting erroneous results because an important source of heterogeneity in the data has been ignored.

The types of nets could be defined by a series of characteristics that may affect the way they catch the target or bycatch species involved. Among other things: a) the way they catch the species they capture (gilling, entangling, etc.); b) whether they are fixed or drifting; c) if they are set on the surface, mid-water or bottom; d) the mesh size; e) the materials used; f) the way they are hung, etc. As each of these components results in a division of the data set, and we may generate an unmanageable number of variations.

We will discuss the potential significance of the different criteria with regard to sea turtle bycatch, and explore ways to deal with the sources of variation.

## 5.22. Development of Sea Turtle Bycatch Mitigation Measures for Pound Net Fisheries: A Design Concept to Release Turtles Spontaneously

Osamu Abe[1] and Daisuke Shiode[2]

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Pound net gears can be classified into two types from the viewpoint of incidental capture of sea turtles -- namely with or without underwater fish bags or pocket nets. Turtles that can migrate into pound nets can swim and breathe at the surface freely, while turtles captured in the underwater bag cannot reach the surface to breathe and consequently die by drowning. To reduce incidental death of sea turtles by pound net fisheries, we examined net designs with a new device to release turtles spontaneously from the bag.

At the beginning, we examined a small pound net as a model case, which is operated in the shallow coral lagoon in the southern part of Japan. The pound net provided with a cone-shaped bag of 10m in length and 1.3m in diameter. The bag is set up to the sea bottom with an appropriate tension to keep its conic shape. We made a square hole with a flap (40 x 50 cm) at the upper part of the cone-shaped bag. The flap was hinged to the hole that was open to the outside. When a turtle caught inside the bag pushes on the flap, it will open to allow the animal to be released. An automatic closing system of the flap was created by having part of the flap at the hinge overlap the netting of the bag. The bounce of the netting's consistent tension would shut the flap automatically, after the turtle exits the hole. This bag was provided for funnel nets of 100cm peripheral length. Hence, sea turtles with less than 100cm carapace circumference length can migrate into the bag through the funnels. The maximum size of green turtle, *Chelonia mydas*, able to migrate into the bag was estimated to be 56cm in straight standard carapace length. Using this flap releasing device, 81% of green turtles of above sizes escaped from the bag. Similar results were obtained for loggerhead turtle, *Caretta catetta*, and hawksbill turtle, *Eretmochelys imbricata*. We also examined the escaping rate of tropical coral fish species captured by the same pound net and found that 96% of fish did not escape through the hole with the flap.

While such a flap releasing device was effective to release turtles from the small cone-shaped bag, most large pound nets feature a closed box-shaped pocket net of a much bigger size. In order to apply such releasing device to the large scale pound net, it might be necessary to direct sea turtles toward the device within the pocket net. In preliminary experiments, sea turtles put into the closed net began pressing their heads up against the upper net while time elapsed to allow them to come to the surface to breathe. This lead us to the idea of sloping the roof of the pocket net to induce the turtle to move to the highest places in the net where the releasing device would be equipped.

We performed tank experiments with experimental nets where the roof was sloped. We used three kinds of experimental pocket nets; 1) a box-shaped net of 8m square and 1m high (horizontal roof net); 2) a box-shaped net of 8m square and 1m high with a roof angled at 10 degrees toward the center (10 degrees slope net); and 3) 8m square pyramid with a roof angled at 20 degrees (20 degrees slope net). These nets were set in an experimental water tank (10m x 10m x 2.1m). Five loggerhead turtles in captivity (SCL: 42.8cm-50.0cm) were used for the experiment. Each loggerheads swam around the periphery of the net for about 5 minutes, and then started pressing their heads up against the upper net with time elapsing. This behavior of pressing up was seen near the periphery of the net, and the change of position in pressing up was scarcely seen in horizontal roof net and 10 degrees slope net. However, in the 20 degrees slope net, each loggerhead moved faster upwards to the apex of the net. These results suggest

that the sloped roof can induce sea turtles caught in large pocket nets to move toward the highest net position where the releasing device would be attached.

A releasing device for the box-shaped pocket net of large scale pound nets has been also developed. The design concept of this releasing device is the same as that for the small cone-shaped bag. The releasing device unit consists of 200cm squared flexible plastic net with the centrally-located turtle escaping hole (100cm x 100 cm) and the flap covering the escaping hole. Since the box-shaped pocket net is not fixed to keep the consistent tension of the netting, the automatic closing system using such tension to rebound the flap to close cannot be applied. Instead, the flexible plastic net surrounding the hole is expected to supply consistent tension for the flap closing system.

## 5.23. Alternative Leader Designs to Reduce Bycatch of Sea Turtles in Chesapeake Bay, Virginia Pound Nets

Henry Milliken[1], Joe DeAlteris[1], Ryan Silva[1], and David Chosid[1]

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In the Chesapeake Bay, fishermen use pound nets to harvest a wide variety of fish. NMFS observers monitoring this fishery have documented sea turtles impinged and entangled in pound nets set within the Bay. Because of the observed takes, in 2003 NMFS prohibited offshore pound net leaders in a section of the lower Chesapeake Bay from May 8 through June 30 of each year. The pound net design includes a "leader" that diverts fish into a "heart," which funnels the catch into a "pound." The leader consists of a series of stakes set perpendicular to shore with webbing strung between the stakes. The "heart" and "pound" are also made by hanging a series of stakes with webbing to create a funnel and a corral, called the "pound" that holds the catch. Most turtles were documented to be caught in the leader section. Following the gear restriction, NMFS worked with the fishing industry to develop a modified leader design to reduce sea turtle takes. The modified leader was similar in height to the traditional leader, but mesh was hung only in the lower one-third of the submerged portion. The remainder of the leader height was hung with vertical lines spaced 2 feet apart. It was anticipated that sea turtles could pass safely through the upper two-thirds of the leader and through the vertical lines, while fish swam into the lower portion of the leader and were diverted into the pound. Experimental studies supported this hypothesis. After two years of testing, only one turtle was taken in the modified net, while 22 turtles were taken in the traditional net. Fish catches were not significantly different between the modified and traditional designs. As a result, the NMFS enacted a rule allowing use of the modified leader during the time when the traditional leaders were prohibited.

## 5.24. Modified Gillnet Gear Lessons Learned from North Carolina, U.S.A. Demersal Gillnet Flounder Fishery

Charlie Van Salisbury[1], Jeff Gearhart[2], Blake Price[3]

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[2] U.S. National Marine Fisheries Service
[3] North Carolina Division of Marine Fisheries

Pamlico Sound, North Carolina is part of the second largest estuarine system in the United States providing habitat for numerous aquatic species. These resources are also used by the commercial and recreational fishing industries.

Pamlico Sound was closed to all large mesh commercial gillnet (targeting southern flounder *Paralicthys lethostigma*) fishing beginning in 1999 from 1 September to 15 December of each year. The closure was established due to increased observations of sea turtle strandings and subsequent observed takes aboard commercial gillnet vessels. This closure was designed to protect endangered and threatened species (Endangered Species Act 1973) of sea turtles frequenting North Carolina waters. The North Carolina Division of Marine Fisheries (NCDMF) maintains a limited shallow water fishery along the Outer Banks and mainland side of Pamlico Sound during the fall of each year through a habitat conservation plan operating under an Endangered Species Act Section 10 Permit. However, the deep-water region, once a productive fishery, remains closed. NCDMF conducted two previous studies, in 2001 and 2004, to identify a potential gillnet gear that can reduce sea turtle interactions, while maintaining flounder catches. A modified, low-profile gillnet performed well in these studies where flounder catches were maintained and no sea turtle interactions occurred. This recent study (2006) was a final follow-up designed to further test and evaluate the low-profile gillnet (test) configuration compared to the standard gillnet (control) historically used in this region. The 2006 results were combined with the two previous studies and this modified gillnet configuration effectively reduced sea turtle interactions ($p = 0.0027$), maintained acceptable levels of target catches (to the industry) and reduced overall bycatch. In addition to the applicability of this modified gear in the deep-water region of Pamlico Sound during the fall southern flounder fishery, the low-profile gillnet merits further examination in other fisheries where similar sea turtle bycatch issues exist.

## 5.25. Reducing Leatherback (*Dermochelys coriacea*) Sea Turtle Bycatch in the Surface Gillnet Fisheries of Trinidad, West Indies

Jeff Gearhart[1], Scott Eckert[2], and Charles Bergmann[1]

[1] U.S. National Marine Fisheries Service
[2] WIDECAST and Duke University

The single largest threat to the critically endangered leatherback turtle (*Dermochelys coriacea*) in Trinidad, is the incidental capture in coastal gillnet fisheries. Placing a severe strain on the ability of fishers to operate economically, the entanglement problem is so severe that many are unable to fish during the leatherback nesting season. It is estimated that as many as 3,000 entanglements occur each year in Trinidad and that as much as 35% of those entanglements result in mortalities (Fournillier and Eckert 1999; Eckert and Lien 1999; Lee Lum, 2003, Gass, 2005).

Traditional surface drift gillnets used along the northern and eastern coasts of Trinidad are 10 to 15 meters deep and are often fished in waters less than 25 meters deep. These nets are very effective at capturing a number of species, with king mackerel (*Scomberomorous cavalla*) and Spanish mackerel (*Scomberomorus brasiliensis*) bringing the highest price as the most sought after species. Mackerel tend to spend most of their time in the upper portion of the water column, which is why surface drift gillnets are the preferred gear. However, gillnets employed in this fishery may fish deeper than required to catch mackerel, thus resulting in bycatch of other species, including sea turtles. Reducing the fishing depth or "profile" of the net to a level that targets the most productive portion of the water column, the upper 3 to 5 meters, may maximize target catch, while reducing unwanted bycatch of lower value finfish species and sea turtles.

Trolling with a variety of artificial or cut baits has also been used traditionally in Trinidad fisheries, though it is far less common than surface-fished drift gillnets. While Trinidad fishers use outmoded and inefficient trolling methods that are not as economically effective as gillnets, trolling could provide a useful opportunity for turtle bycatch reduction as it does not catch sea turtles. If the efficiency of trolling could be increased, it may represent an economically viable and turtle-safe alternative to gillnetting during the sea turtle nesting season.

The objective of this program is to test turtle-safe alternative fishing methods that significantly reduce turtle mortality, and at the same time, improve fish catch. Our general approach has been to increase the efficiency of gillnets and trolling with the active participation of all stakeholder groups in Trinidad. Specific experiments test modified gillnets that fish only in the upper portion of the water column; examine the effect of lighting on nets; and study the effectiveness of modern trolling techniques using artificial baits and other equipment.

### Gillnet Experiments

Sixty fishing trips originating from the ports of Matelot and Toco were conducted during peak leatherback nesting between May and June 2007, while 90 trips were conducted from Matelot, Toco and Mayaro from May through August 2008. All trips were conducted on traditional fishing grounds along the northern and eastern Coasts of Trinidad. Nets were set at dusk and soaked up to 8 hours. For all experiments, a matched-pair experimental design was used with alternating control and experimental nets. The goal of the 2007 project was to determine if low profile nets of 50 meshes deep (i.e. 5 meters) would have performed as well as traditional nets of 100 meshes (e.g. 10 meters) depth. A total of 121 leatherback turtles were captured with only 2 mortalities. The experimental net captured 29 turtles, while the control net captured 92. Target catch was also reduced with the experimental net, catching 35% less king mackerel and

55% less Spanish mackerel. However, based on target and turtle CPUE, a portion of the target losses could be recouped by fishing equivalent area of net by using longer lengths of the experimental net, which should still reduce sea turtle bycatch rates. Results differed between ports with the experimental net reducing turtle bycatch by 11% in Matelot and 74% in Toco. We proposed that this difference could be attributed to lights used to mark nets in Matelot, which may have attracted turtles to a specific portion of the gear biasing our results. In 2008, we tested whether 50 mesh nets configured with long wavelength (i.e. red) monochromatic lights had the same catch rates as broader spectrum lights (e.g. white). There was no statistically significant difference in turtle catch rate between nets with white light (64) and those using red lights (70). However, fish catch rates were far higher in nets equipped with red lights.

**Trolling Experiments**

Trolling experiments were conducted in 2007 and 2008. Vessels were outfitted with outriggers, planers, fish finders, GPS, and bandit reels. In 2007, 4 vessels from 3 ports (Matelot, Toco, Balandra) were contracted to fish for 30 days each. Fish catch rates as well as economic return were evaluated. For 2007, fish catch rates in terms of total weight of fish caught were lower when compared to experimental gillnets; however in terms of value per effort, trolling was equivalent to gillnet fishing. This result was likely due to the higher proportion of high value mackerel catch in the troll fishery and the cost of net repair due to turtle damage in the gillnet fishery. For 2008, troll experiments continued in three ports (Matelot, Toco and Mayaro) and compared catch rates of two different sizes of trolling spoon. There was no significant difference in economic return between spoons. When trolling was compared to gillnet fishing, economic return for the experimental (i.e. red light) gillnet fishery was higher than trolling, while the control (e.g. white light) gillnet fishery was not significantly different.

This project has been well received by fishers and other stakeholders both in terms of execution and results. We have demonstrated that the use of nets that have a lower profile and that are set to target the depth of the preferred species provide good economic return, while at the same time reduce turtle bycatch. We have also demonstrated that trolling is a viable replacement for gillnets, and while it exhibits a slightly lowered economic return, its complete elimination of turtle bycatch means that this method could replace gillnets during times of high turtle abundance. For 2009, we intend to continue tests on gillnets as well as introduce incentives to fishers to replace traditional drift gillnets with trolling during part of the year.

## 5.26. Developing Visual Deterrents to Reduce Sea Turtle Bycatch: Testing Shark Shapes and Net Illumination

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Many nesting populations of Pacific leatherback, olive ridley, green, and loggerhead turtles have dramatically decreased. Estimated trends of Pacific leatherback populations in Costa Rica suggest that these turtles could soon become functionally extinct (Spotila et al., 2000). Contributors to this decline in sea turtle population include incidental capture of sea turtles associated with pelagic longline fisheries and various gillnet fisheries (Chan and Liew, 1996; Lewison et al, 2004; Peckham et al, 2007). Characterization of coastal fisheries in Baja California, Mexico suggests that small scale gillnet fisheries can have high sea turtle interactions potentially equal to or, in some cases, exceeding sea turtle interactions with industrial scale pelagic fisheries (Peckham et al, 2007; Peckham et al, 2008).

Experiments conducted in Baja California indicated that changing the visual cues associated with gillnets can could help in reducing sea turtle bycatch. Illuminating nets with battery-powered LED lightsticks reduced the catch rates of green sea turtles on turtle monitoring nets by 40% (Fig.1). These same nets used in a commercial bottom gillnet fishery targeting primarily elasmobranches and halibut species had no change in target fish catch rates (Fig.2). Taken together, our findings suggest the potential utility of net illumination as an effective sea turtle deterrent in a gillnet fishery that also maintains the economic viability of the fishery.

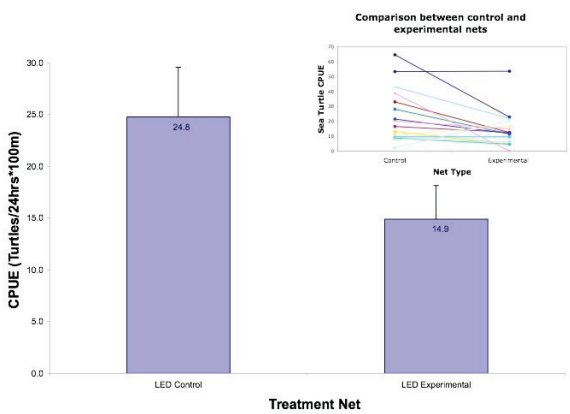


Fig.1 Comparison of sea turtle catch rates between illuminated nets and control nets. Turtle catch rates in illuminated nets were significantly lower.

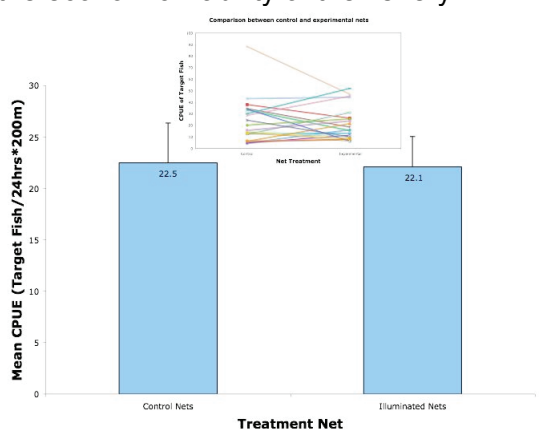


Fig.2 Comparison of target fish catch rates between illuminated nets and control nets. Catch rates did not significantly differ between net types.

Additional studies examining the effects of placing shark shapes near turtle monitoring nets resulted in sea turtle catch rates decreasing by 54% (Fig. 3). Sharks are a primary predator of sea turtles and observations with captive reared loggerhead turtles suggest that shark shapes trigger an escape response, indicating that the shark shapes could be useful as a sea turtle deterrent (Higgins 2006). However, when shark shapes were incorporated in gillnets used in a commercial bottom fishery, the targeted fish catch rates also decreased by 55% (Fig.4). Possible reasons for this decline in target fish catch include flight responses of the target species to the shark shapes or the shapes interfering with the net's ability to catch fish.

Nonetheless, these results are intriguing in that they provide evidence that sea turtles initiate escape behaviors in response to shark shapes and confirm a potential utility of a shark shape "scarecrow" technique to reduce turtle bycatch in other settings that have sea turtle interactions.

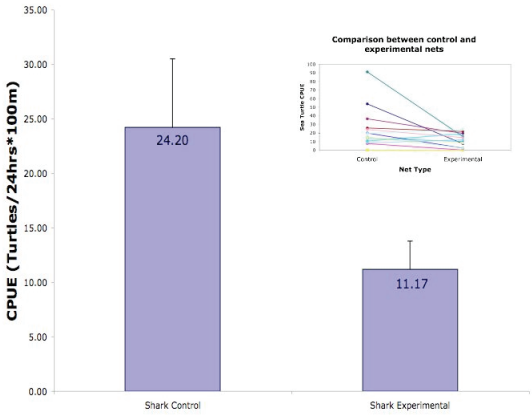


Fig.3 Comparison of sea turtle catch rates between control nets and nets with shark shapes. Catch rates in nets with shark shapes were significantly lower.

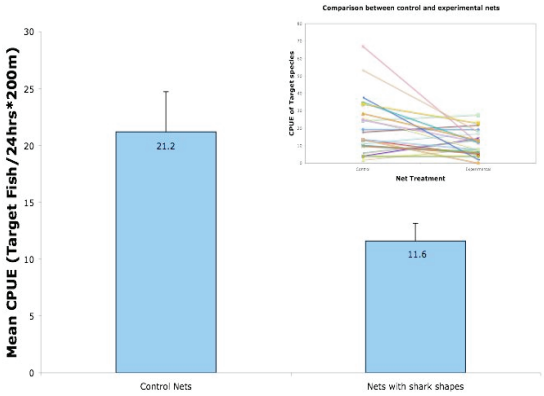


Fig.4 Comparison of target fish catch rates between control nets and nets with shark shapes. Catch rates in nets with shark shapes were significantly lower.

We currently believe that net-illumination is a promising technique that is likely to be adopted by some fisheries. This simple measure requires minimal effort on the part of fishermen, and based on the findings presented here, there are not likely to be substantial impacts to target species catch rates. While the shark shape "scarecrow" idea shows promise in reducing the rates of incidental sea turtle capture, the negative impact on target species catch rates and resulting loss of revenue associated with the shapes in their present form suggests that they would not be readily adopted in fishing operations.

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## 5.27. Loggerhead Bycatch and Reduction off the Pacific Coast of Baja California Sur, Mexico

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Incidental capture or bycatch in coastal gillnets results in high mortality of many vulnerable and endangered megafauna, including cetaceans, pinnipeds, seabirds and sea turtles. The overlap of intense gillnet fisheries with high-density foraging grounds of loggerhead (*Caretta caretta*) turtles at Baja California Sur, Mexico (BCS) causes some of the highest bycatch rates recorded worldwide and likely threatens the persistence of the North Pacific loggerhead population (Peckham et al., 2007). To address this problem, we have partnered since 2004 with gillnet fishers from BCS to develop, test and implement bycatch solutions including gear modifications and marine protected areas (MPAs).

The west coast of BCS represents one of Mexico's most productive fishing grounds. Halibut (*Paralichthys californicus*) and grouper (*Mycteroperca* sp.), among other valuable fish, are targeted by local small-scale fisheries using bottom set gillnets. Gillnets used to fish for these species have a stretch mesh size ranging from 20-30cm and are deployed with tiedowns in near-shore habitat of 5-40m depths during summer months.

Juvenile North Pacific loggerhead turtles spend decades in BCS waters foraging their way to maturity before migrating back to their natal beaches in Japan to reproduce. The Pacific coast of BCS represents a high use area for juvenile loggerhead sea turtles that forage at very high densities (Ramirez-Cruz et al., 1991; Nichols, 2003). Censuses of Japanese rookeries show declines in nesting females as high as 90% within the past three generations to fewer than 1,500 $yr^{-1}$, qualifying the population for critically endangered status (Kamezaki et al., 2003).

A community-based conservation campaign was initiated in 2004 to engage local fishers in mitigating and eliminating their bycatch (Peckham and Nichols, 2006; Hall et al., 2007). Through workshops conducted in 2004 and 2005, local fishermen proposed modifications to their traditional gillnets that could maintain or increase the profitability of commercially viable target species, while reducing or eliminating loggerhead bycatch. Fishing modifications proposed to reduce bycatch included shorter net soak times, elimination of net tiedowns, reduction of net height, and elimination of buoys on the net float line. From 2004 to 2008, we conducted controlled experiments to test reductions in net height and net tiedown length, and buoy removal. In addition to gear modifications, at the fishers' suggestion, spatial differences in bycatch intensity were tested to explore the viability of an MPA to continue fishing, while sparing turtles. Reducing soak times and eliminating tiedowns were rejected by fishers as unfeasible due to logistical and profitability concerns.

In 2004, we conducted controlled experiments to compare bycatch and target capture rates between low profile (1m height) experimental nets and control nets of traditional 2m height (Maldonado et al., 2006). Trials were controlled by pairing experimental nets with control nets in each net set. In 117 controlled sets observed in 2004, there was no significant difference in turtle bycatch between experimental (short) and control nets, and significantly more fish were caught in control nets.

In 2005, we conducted controlled experiments to compare half tiedown experimental nets (tiedown length 0.9m) versus control nets with tiedowns of 1.8m length (Maldonado et al 2006). In 129 controlled sets observed in 2005, there was no significant difference in turtle bycatch between experimental (half tiedown length) and control nets. However, many more

target fish by number and weight were caught in experimental nets. Each of the low profile net trials was discontinued due to low target catch in the case of half height nets and lack of turtle bycatch effect in the case of nets with short tiedowns.

In 2007 and 2008, we conducted controlled experiments to compare bycatch rates and landings between traditional (control) nets and buoy-less nets (without buoys on float line). Due to the difference in the soaking characteristics of bouy-less nets, experimental nets were set adjacent to control nets as opposed to tied together. In 35 controlled sets in depths greater than 32m, 47% fewer turtles were caught in buoy-less (experimental) nets (9 turtles) than in control nets (19 turtles). While mean bycatch rates were considerably lower in buoy-less nets (0.3 ± 0.5 turtles $set^{-1}$; mean ± SD) than in control nets (0.5 ± 1.3 turtles $set^{-1}$), bycatch rates were not significantly different (Wilcoxon paired rank: $Z = -1.537$; $p = 0.124$). Catch of target fish was very similar in species composition and quantity between the two designs, with 649 and 653 kg of fish landed in buoy-less and control nets, respectively. Target catch rates and variance were very similar between buoy-less (18.5 ± 19.9kg $set^{-1}$) and control nets (18.7 ± 21. 9kg $set^{-1}$). There was no significant difference in target catch rates between treatments (Wilcoxon paired rank: $Z = 0.571$; $p = 0.568$).

In contrast, in 30 controlled sets in depths shallower than 32m, only one loggerhead turtle was caught, so there was insufficient statistical power to compare bycatch rates. Target fish catch in depths less than 32m was considerably higher in buoy-less than in control nets (134 and 50 kg, respectively). Target catch rates and variance were also higher in buoy-less (4.8 ± 8.5 kg $set^{-1}$) than in control nets (1.8 ± 3.4 kg $set^{-1}$). Differences in catch rate between buoy-less and control nets were marginally insignificant (Wilcoxon paired rank: $Z = 1.774$; $p = 0.076$).

Results to date from the buoy-less net trials are promising. Further trials are required to determine whether buoy-less nets catch significantly fewer turtles. A challenge to conducting more trials is that due to increased awareness of the Pacific-wide impacts of their local bycatch, fishers are loathe to set observed gear in deep fishing areas where turtles are likely to be caught because they do not want to kill turtles. Furthermore, their higher catch rate of target species raises concern about the ecosystem impacts of buoy-less nets. According to local partners, the fisheries examined are increasingly overfished. Local fishers report that 1) their fishing grounds are saturated with gillnets; 2) despite steadily increasing fishing effort since (both number of boats and nets per boat), individuals' landings are decreasing (per capita and fleetwide); and 3) there has been little or no change in market value of target fish over the past decade, while operating costs including the price of gasoline have steadily risen.

In this context, fishers suggested we examine the spatial distribution of bycatch events. From 2005-2007, we opportunistically observed fishing crews of Puerto López Mateos BCS on 94 gillnet fishing day trips across a depth range of 5 to 40m. We observed a strong association between loggerhead turtle bycatch and fishing depth (Table 1). All loggerhead interactions occurred in depths greater than 32m corresponding to the inshore margin of the loggerhead high use area described in Peckham et al. (2007).

Based on both the decline of their fisheries and increasing concern over turtle bycatch, veteran fishers express interest in limiting their gillnet use in the loggerhead high-use area (depths greater than 32m) and, instead resuming hook and line fishing, exploring the profitability of trolling, developing linkages for sales of higher quality fish, and possibly renting or selling their fishing rights. Some fishers are hopeful that limiting gillnet fishing in depths greater than 32m would positively affect target fish population dynamics, though this possibility has not been investigated. In this way, establishing a fisher-lead MPA could benefit fisheries, while sparing turtles.

To reduce the use of gillnets in the loggerhead high use area, fishers would require resources for gear transitions and also for alternative livelihoods. Better fisheries management and environmental enforcement would be essential for effectiveness of such measures. In

November 2008, the Mexican government formed an expert working group of stakeholders, NGOs, and government agencies that is on track to implement solutions from 2009 forward.

Table 1. Observed bycatch rates of loggerhead turtles with variance and percent mortality by fishery and depth fished. Gillnet trips were observed from Puerto López Mateos, BCS 2005-8 (adapted from Peckham et al. 2008)

| Fishery | Trips | Turtles caught | Km net observed | Turtles/ km net | Turtles/ trip | SE | Range turtles/ trip | Percent mortality |
|---|---|---|---|---|---|---|---|---|
| gillnet (all depths) | 94 | 28 | 76.0 | 0.37 | 0.30 | 0.09 | 0-4 | 68 |
| gillnet (shallow < 32m) | 59 | 0 | 49.1 | 0.00 | 0.00 | | 0 | |
| gillnet (deep > 32m) | 35 | 28 | 26.8 | 1.04 | 0.80 | 0.22 | 0-4 | 68 |

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## 5.28. Summary of Session 2 Discussion

**Managing Bycatch, Reducing Discards**
There is growing international attention to the issues of managing bycatch and reducing discards, with recognition that ecosystem-based management principles and responsible fisheries conduct call for sustainable fishing mortality of all catch, requiring the effective management of all sources of fishing mortality, including both retained and discarded bycatch, and including unobserved mortalities. The focus to date has been on collecting information on and managing only landed target species. For example, Mr. Frank Chopin of the Food and Agriculture Organization of the United Nations (FAO) referred to a paragraph (76) in the United Nations General Assembly's resolution on sustainable fisheries adopted at its 63rd session (November 2008), which asks the FAO Committee on Fisheries to consider development of an International Plan of Action on discards. One of the countries responsible for drafting this paragraph has subsequently broadened the issue to "managing bycatch and reducing discards".

**Considerations in Extrapolating Results from Scientific Experiments**
Participants discussed the importance of obtaining assistance of a statistician at the planning stage in order to design an experiment, including defining the needed sample size and categories of information to collect. Many experiments are conducted in areas where turtle interaction rates are expected to be high, in order to provide sufficiently large sample sizes. This practice creates a bias, making extrapolation of observed interaction rates to other fishing grounds across the fleet and to other fisheries unjustified. There is also documentation of lower efficacy of bycatch reduction methods in commercial conditions compared to those observed in a scientific study setting, in part, because fishers do not fully employ the method in the prescribed manner.

**Characteristics of Coastal Net Fishing Gear and Methods that Affect Sea Turtle Capture and Prospects for Surviving an Interaction**
The coastal passive net gear categorization presented during Session 1 (Section 5.19) and forms identifying characteristics of fishing gear and methods that are believed to have a significant effect on turtle capture rates and disposition (alive, injured, dead) after the soak (Section 6) were revised by Martin Hall and Kate Mansfield based on comments from the workshop participants.

**Process Tools**
The poor state of understanding of why turtles are attracted to coastal passive net gear and the mechanisms causing capture and mortality were not seen as an obstacle to taking mitigation action. Examples of successful low-cost interventions were discussed, such as from studies in Trinidad, where complete understanding of the causes of observed changes in turtle and fish catch rates are less important than finding effective and commercially viable solutions. While improved understanding of why and how turtles interact with these fisheries will hopefully help to identify new solutions, this should not be construed as a prerequisite for taking action now to mitigate turtle fishery interactions. Lessons learned from the few artisanal coastal net fisheries where progress has been made in assessing and mitigating sea turtle bycatch should be tapped and transferred globally so that general process tools can be developed to be used as a starting point for activities in other fisheries. Section 5.31.1 presents a summary of the Session 3 breakout session, which focused on process tools to assess and mitigate sea turtle interactions in artisanal fisheries.

**New Gear Technology Promising Approaches**
Participants identified priority research needs for reducing turtle capture rates and increasing escapement, without compromising economic viability and practicality. Research priorities were identified, in part, based on the participants' presentations of lessons learned and remaining gaps in understanding. For instance, a modified roof design for use in box-shaped traps was shown to hold promise based on observations of captive loggerhead turtles; a next step is to incorporate a turtle releasing device and observe the escape rate of turtles and target fish species. The LED lightsticks used in the study presented by John Wang are cost prohibitive (US $33 each); trials using less expensive lightsticks, and of a range of colors (spectral frequency) is warranted (blue light is likely to be easier to be seen by turtles than green light). While demersal fish are not likely to be affected by illumination, pelagic fish may be; additional investigation into the effects of illuminated nets on the catch rates of pelagic fish is warranted. Using red and orange light might effectively help hard shelled turtles to see the gear and avoid reduced catches of pelagic fish, however, lightsticks are used to attract swordfish in longline fisheries, so it is unclear if the light would have a positive or negative effect on pelagic fish catch rates. It is possible that brightness is a more important factor affecting catch rates than color. Adding luminescent chemicals to monofilament line and rope may allow additional flexibility in how illumination could be incorporated into nets. For instance, this would allow for illuminating only the portion of the net where turtle interactions are highest. There was discussion of alternative materials to construct passive gears to facilitate turtles breaking free during the soak, and using stiffer material to increase turtles bouncing off the nets.

**Turtle Handling and Release Research Priorities**
There has been little focus to date on introducing equipment to fishers to improve practices for disentangling caught turtles in nets. Qualitative observations suggest that, in Trinidad, using red headlamps in place of white made it easier to disentangle leatherback turtles from gear because leatherbacks cannot see red and do not become as frightened when landed on the fishing vessel. Use of line cutters that are commercially available and used in pelagic longline fisheries might be suitable for releasing turtles entangled in nets, including turtles observed to roll-up in gillnets in Trinidad.

**Changing Gears**
There was a promising experience in Trinidad in introducing trolling as a replacement to surface gillnetting, which suggests that this might be a viable turtle bycatch mitigation strategy in other fisheries.

## 5.29. Using Bayesian Belief Networks to Evaluate the Relative Risk of Coastal Net Fisheries on Sea Turtle Stocks

Milani Chaloupka, Ecological Modeling Services

The FAO Code of Conduct for Responsible Fisheries (CCRF) calls for a sustainable use of aquatic ecosystems and requires that fishing be conducted with due regard for the environment. The CCRF promotes the conservation of biodiversity by minimizing incidental capture of non-target species, such as sea birds, marine mammals and sea turtles.

It is widely held that coastal net fisheries pose one of the main anthropogenic hazards for sea turtles (FAO 2004, FAO 2007, Peckham et al 2007, Chaloupka et al 2008). Yet the relative impact of coastal net fisheries and other anthropogenic hazards on the long-term viability of sea turtle stocks is not well known (Chaloupka 2007). The three main reasons for this limited understanding of the relative risks of coastal net fisheries are: (1) the lack of standard definitions of coastal net fishing effort (FAO 2007); (2) inadequate bycatch data due to limited or nonexistent observer coverage of the fisheries, especially in densely populated archipelagic regions (FAO 2007); and (3) inadequate analytical approaches for dealing with temporal and spatial effects for relatively rare bycatch events (Gilman et al 2008).

This limited risk characterization poses significant challenges for the design and implementation of any cost-effective bycatch mitigation technologies. I will briefly present one approach for better defining coastal fishery bycatch risk in data-poor and knowledge-vague settings. This probability-based approach is proposed as one structured way to evaluation the relative risks of hazards, such as coastal net and pelagic longline fisheries, coastal development and climate change to the long-term viability of sea turtle stocks (Chaloupka 2007).

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## 5.30. NFWF's New Solicitation for Proposals to Address Sea Turtle Bycatch and Tips on Fundraising

Michelle Pico, National Fish and Wildlife Foundation

The Sea Turtle Keystone Initiative builds on ten years of investment that began in 1998, when the National Fish and Wildlife Foundation (NFWF), in partnership with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration, created the International Sea Turtle Conservation Fund (ISTCF). Since then, NFWF sea turtle conservation efforts have expanded to include support through corporate partnerships with Shell Oil and Orvis Corporation. NFWF's sea turtle conservation efforts, with a primary focus on the western hemisphere, have worked to address the region's most critical threats to sea turtle survival, and to promote protection and management of important nesting beaches and foraging areas at index sites in Latin America, the wider Caribbean, and Canada.

Many of the projects supported under the ISTCF have addressed threats at nesting beaches. As NFWF develops the Sea Turtle Keystone Initiative, priority will be placed on projects whose activities will help realize the benefits of previous conservation efforts by minimizing or removing in-the-water threats to juveniles and pre-adults, including, but not limited to, directed fishing on turtles and incidental killing of turtles in non-turtle fisheries. Although we recognize that this is the least developed aspect of sea turtle conservation, and potentially the most challenging, we expect to be able to produce measurable population results within a 10-year period. We are in the early stages of this process and are reaching out to partners in the conservation community to employ a robust approach to developing the keystone strategy for sea turtles.

Based on interim prioritization that included expert input and internal deliberation around the four criteria NFWF is using for keystone initiative selection[1], NFWF is adopting an initial portfolio of nine sea turtle populations as the focus for its sea turtle conservation efforts and is soliciting proposals at www.nfwf.org/seaturtle (deadline February 13, 2009). This list of priority species is expected to change as new information becomes available, as NFWF's financial resources increase, and as conservation success is achieved.

While there is no magic recipe for fundraising, particularly in such a difficult economy, there are a number of ways in which applicants can coordinate and focus research needs and prioritize goals and strategies that may help them be more successful. Competitive applicants under NFWF's call for proposals and other similar solicitations may need to increase their focus on measurable outcomes and look for short-term milestones and objectives that will project longer-term conservation results. NFWF uses several tools for planning and articulating how projects fit into larger conservation goals, including logic frameworks and results chains (which applicants might find useful in preparing proposals). Proposals on sea turtle bycatch might also look to non-traditional funding sources to shake loose scarce dollars.

[1](1) Conservation need; (2) NFWF's capacity to successfully impact the situation; (3) ancillary benefits to people and the broader environment; and (4) cost effectiveness of the available investment opportunities.

## 5.31. Summary of Session 3 Discussion

**Relative Degree of Risk to Turtle Populations from All Mortality Sources**
The need for a risk-based decision analysis tool was discussed, in order to identify the relative degree of risk from the full suite of threats facing a turtle population. Difficulties in validating a Bayesian belief network were described, where in many areas a large number of model inputs are not based on empirical, quantitative data. Risk management involves a large degree of professional judgment and is by necessity subjective. However, this modeling approach is based on best available scientific information, and is needed to guide decision makers in where to focus limited resources (financial and technical). Furthermore, decision makers should account for likelihood of successfully mitigating individual anthropogenic turtle mortality sources when considering where to focus resources.

**Three Thematic Breakout Groups**
Following extended discussion, three thematic areas were selected for breakout group focus for the third, final day of the workshop: process tools, new gear technology strategies, and working in artisanal fishing communities. Summaries from these three breakout groups follow starting on the following page.

### 5.31.1. Process Tools Breakout Group

(Discussion notes taken by Eric Gilman, IUCN).

**Overview of Main Session Accomplishments**

Two main accomplishments achieved in this session were: (i) the identification of optimal information for assessments of sea turtle bycatch in coastal artisanal net fisheries; and (ii) the identification of principles and approaches for obtaining this info from artisanal coastal net fisheries. Combined, these provide a starting point for developing a generic decision tree for assessing turtle bycatch in artisanal fisheries.

**Assessment Information Needs**

The following was presented by Jeff Gearhart and Scott Eckert and modified based on the group's discussion, as a starting point for identifying the optimal, full suite of information needed to comprehensively assess sea turtle bycatch in coastal artisanal passive net fisheries. Participants recognized that it is unlikely in any fishery to obtain all of this information. The central aim of conducting the assessment by collecting this information is to determine if sea turtle bycatch is problematic in the fishery.

**1. Magnitude of the problem** in terms of

1.1. Damage to the fishery – e.g., gear damage from interactions, time to remove turtles and repair gear, lost fishing time, lost catch, any existing regulatory restrictions (e.g, temporal/spatial closures, gear restrictions)

1.2. Damage to turtle populations – are there population-level effects from this threat?

**2. Fishery Characterization**

2.1. Gear types used and gear characterizations (refer to Section 5.19).

2.2. Operations for each gear type

* Number/Size of Vessels
* Target Species – does this include turtles?
* Bycatch Species – are turtles retained or discarded? Are discarded turtles released alive or dead?
* Fish catch amount and species composition, and age class, for all landings AND catch (document discards levels too)
* Temporal effort
* Spatial effort and location of grounds
* Fishing technology employed (e.g., vessel monitoring system [VMS], global positioning system [GPS], engine power) – using available technology – and relevance to CCRF (are sustainable, responsible practices being employed – do people have equipment and awareness to address unwanted bycatch?) to understand willingness to change gear and methods

**3. Regulatory/Management and MCS framework** – is the fishery being managed, is there monitoring, control and surveillance (MCS), and how effective is the management and MCS?

3.1. Statutory

* Target Species
* Non-target species
* Effective/Ineffective

3.2. Self management, co-management (collaborative mgmt – fishing community & government)

3.3. No Management

**4. Social and Economic Structure**

4.1. Unified Fishery – Fisheries are organized and fishers work together
4.2. Dispersed Fishery- Fishers work independently
4.3. Economic structure and issues – cost of operations, salaries, ex-vessel values, what are markets for the catch
4.4. Number of participants in the fishery – number of households supported, etc.

**Fishery Assessment Process, Practices and Methods**

An important next step would be to identify which pieces of information are of highest priority to conduct bycatch assessments in artisanal net fisheries, elaborating on how the information can be used to guide mitigation interventions, and ultimately, to use the progress made during the breakout group to pursue development of a full logic framework to guide artisanal fishery bycatch assessments and mitigation activities. Participants commented that such a decision tree could be generic in nature, and would then need to be used as a starting point and tailored for fishery-specific application, based on the fishery-specific context.

Methods to collect the list of assessment information include:

(i) Analyzing existing observer and/or logbook data;
(ii) Collecting observer data, perhaps initially on index vessels in order to validate fisher interviews or simply to obtain a first order assessment of fishery and catch characteristics;
(iii) Conducting fisher interviews;
(iv) Conducting a risk-based framework using available literature and best professional judgment (see Section 5.29);
(v) Analyzing satellite imagery (e.g., to obtain estimates of the number of vessels by seaport);
(vi) Collecting assessment data as a secondary purpose through mitigation commercial demonstrations and experiments;
(vii) Comparing spatial locations of fishing effort and sea turtle abundance through Vessel Monitoring Systems and satellite tags, respectively; and
(viii) In fisheries where sea turtle bycatch management measures are in place, observing black markets for turtle products, observing how many sanctions resulted in conviction occurred in the fishery, and obtaining candid survey results from members of fishing communities can be used to assess compliance.

In conducting assessments, participants noted the importance of identifying fishing gears that do not have sea turtle interactions, with the potential to serve as viable alternatives to those with problematic turtle catch levels, was identified.

At-sea observations were seen as an optimal method for collecting information on bycatch levels and rates, but in some cases this might be cost prohibitive in order to obtain a representative sample of the fleet. Alternatively, it might be feasible to obtain observer coverage of a small portion of the fleet as an index of the fleet. Dockside assessments were seen as a relatively unreliable method to quantify bycatch levels (through quantitative measurements of landings) due to undocumented at-sea discard levels. Employing Vessel Monitoring Systems (VMS) on vessels enables observing the overlap of fishing effort with areas of high turtle abundance. However, this provides only indirect information on bycatch magnitude.

There was a lack of consensus in the breakout group regarding the utility of data from fisher interviews for characterizing or quantifying with any precision the magnitude of sea turtle or other bycatch magnitude. There was, however, general agreement that the findings from social surveys provide qualitatively useful information, and that, given available financial and human resources, validating fisher interview data is possible. Some participants suggested that methods for surveying fishers, such as conducted by Project Global, should be validated by conducting the survey in a fishery where empirical data are available. It is useful to obtain

inside information on whom in a fishery to interview in order to best characterize the fishery, so that responses are not heavily influenced by outliers of the fishing community. Social scientists with expertise in designing social surveys should be tapped to assist with the development of surveys for interviewing artisanal fishers. Survey design aspects to consider include:

(i) The optimal length of the survey (Project Global employed a short and long version of a survey to get two tiers of response details);
(ii) How to design the survey to overcome fishers' potential biases, such as pre-existing sensitivity to bycatch issues. For instance, do fishers illegally retain caught turtles, or other incentives to lie in their survey responses;
(iii) Have educational campaigns been conducted on sea turtle conservation and/or fisheries bycatch leading fishers to provide responses that they believe the interviewee wants to hear;
(iv) Have the fishers been surveyed previously, causing 'survey fatigue'; should interviewees be kept anonymous or not; and
(v) What are advantages and disadvantages of conducting group surveys.

Methods involving interviewing fishers might be best implemented by starting initially with simple, non-controversial questions, and gradually over time, gaining trust between the interviewer and the fishing community, to build up to discussing more complex and controversial issues. People familiar with the local fishing gear and colloquialisms and patois of the region should be included in the team developing surveys and conducting interviews, or as part of an observer program.

The importance of directly involving and engaging all stakeholders, and especially the fishing industry, throughout assessment and mitigation processes was highlighted. It was also seen as important to be transparent in why information is being collected and how it will be used. It was see as critical to provide feedback to the fishers, so that they understand how results are being used, and what the findings are.

Citing that much work has been conducted to identify practices and approaches to effectively working with artisanal fishers, and a number of artisanal fishery assessments have been conducted, participants identified a review of this body of literature as a relevant starting point for a generic logic framework. FAO 'frame surveys' in artisanal fisheries were cited as an example. These are rapid 1-4 day surveys to, for instance, count the number of vessels in a fleet, document vessels sizes, locations, types of gear, number of fishermen, etc. Some frame survey results are available from the FAO website. The Project Global rapid assessments are a similar approach.

Because in some fisheries gear designs as well as gear type may be highly variable temporally, this makes accurate fishery characterizations difficult to produce, and the accuracy of findings from assessments of short duration. Furthermore, long-term data collection is needed to observe and understand inter-annual variability relating both to turtle interactions as well as well as other parameters. A possible solution is to conduct periodic assessments as part of an ongoing, permanent program.

Larry Crowder expressed interest in spearheading the development of a generic decision tree or logic framework to guide bycatch assessments of artisanal fisheries.

**What is 'Problematic' Sea Turtle Bycatch**

There was discussion regarding what definition should be employed to determine if the magnitude of turtle mortality from a fishery interaction represents a 'problem'. For instance, does the level of turtle captures in the fishery have to cause a turtle population-level effect? In some States, domestic legislation addresses this question.

**What is an 'Artisanal' Coastal Net Fishery**

Assessments need to account for there being coastal net fisheries that are more industrial or commercial than artisanal. Different assessment and mitigation approaches may apply to these non-artisanal fisheries.

### 5.31.2. New Strategies Breakout Group

(Discussion notes taken by Michelle Pico, NFWF, and reported by Martin Hall, IATTC)

**Overview of Main Session Accomplishments**

Participants in this breakout session identified priority research needs to explore promising new approaches involving changes in coastal passive net fishing gear and methods to avoid and minimize sea turtle bycatch rates, and to increase the proportion of caught turtles that survive the gear interaction. To this end, the participants explored research needs for understanding why and how turtles and target species interact with the coastal net fishing gear, which can contribute to identifying effective and economically viable gear technology solutions to sea turtle capture.

**Universal Bycatch Reduction Approaches**

To identify potential effective turtle bycatch reduction methods, it would be useful to discuss this with groups that are 'experts' at catching sea turtles, such as researchers at the University of Central Florida, and the U.S. National Marine Fisheries Service Beaufort Lab. Conducting experiments in areas with high densities of sea turtles is useful to test potential mitigation strategies, as this provides sufficiently large sample sizes. Exploring alternative fishing gear with low or no sea turtle catch rates as an alternative to gear that result in high turtle catch rates is a potential universal solution. Improved understanding of how gear behaves during the soak is needed in order to understand the mechanisms for captures of turtles and commercially valuable species.

**Site-Specific Bycatch Reduction Approaches**

Site-specific analysis is necessary to assess economic losses to fishers from turtles being caught in the gear. Outreach and awareness is needed to augment fishers' awareness of the impact on turtles and alternatives: Net-type assessment sheets are a useful tool to provide 'metadata' on net fisheries.

**Why are Turtles Attracted to and Enter Pound Nets?**

There is a need for research on methods to reduce sea turtle attraction to pound nets, as well as approaches to reduce their entry. This is a priority for pound nets employing a closed pound, which results in a high proportion of caught turtles being drowned, and other closed trap gear. For example, participants identified the following as potential methods to reduce turtle attraction to and entry into pound nets:

(i) Employing shark shapes along the leader as tested in gillnets,
(ii) Reducing the number of floats or modifying float characteristics;
(iii) Removing catch more frequently in order to decrease the attraction to depredating turtles;
(iv) Employing a deflector grid to create an obstacle for turtles to enter the gear (such a study may have already been conducted in the northeast U.S.);
(v) Modifying baiting techniques (is bait used in pound nets?);
(vi) Increasing gear visibility, such as through illumination;
(vii) Iimproving the understanding of sea turtle visual physiology and behavior, in order to attempt to identify differences between target species and sea turtle visual spectrums and behavior;
(viii) Positive or negative correlation between the proximity of pound nets to shore and turtle catch rates;
(ix) Olfactory deterrents; and
(x) Positive or negative correlations between environmental variable (e.g., related to currents, tides, and other oceanographic parameters) and turtle catch rates.

**Maximizing Survival of Turtles that Enter a Pound Net**
It is a research priority to identify solutions to turtles drowning in closed pounds. Training fishers in best-practice turtle handling and release protocols would contribute to improving turtle survival. Expanding the research conducted in Japan with turtle releasing devices and modified trap roof designs could include:
(i) Sloping the trap bottom panel as well as the top;
(ii) Increasing the visibility of the turtle escapement device to turtles;
(iii) Incorporating a tube so that captured turtles can reach the sea surface in gear with closed pounds; and
(iv) Incorporating multiple turtle escapement devices in the trap.

**Why are Turtles Entangled in Nets, and Promising New Mitigation Approaches**
Qualitative observations and supporting evidence from research conducted by the Virginia Institute of Marine Science (Soraya Bartol) suggest that turtles can see nets during the daytime. It is a research priority to explore if and why turtles are attracted to nets. For instance, research is needed to determine if turtles may be:
(i) Attracted to the catch in the gear;
(ii) Attracted to the floats (most likely for leatherback sea turtles);
(iii) Attracted to some aspect of the net lines; and/or
(iv) Attracted to the same location as the fishing grounds for reasons other than the presence of the fishing gear and catch.

There is evidence that turtles are depredating catch from the nets. Some studies have found that loggerheads, kemps and some greens target the catch in pound nets. The mitigation approach will depend on the species complex, as gear visibility will not be effective at reducing capture for turtle species that are depredating the catch. Research is needed to determine if it is beneficial to make nets visible at night to attempt to avoid and reduce turtle entanglement. Research needs to address this question include studies of sea turtle gut contents of recently captured turtles to determine if they are depredating the catch, and placing sensors in turtles' stomachs to document their feeding behavior.

Potential strategies to reduce turtle entanglement in nets include:
(i) Reducing the number of floats;
(ii) Modifying float characteristics (e.g., size, color) and further trials of buoyless float lines;
(iii) Reducing the number of vertical float lines (likely an important factor affecting leatherbacks, such a study has been initiated in French Guiana);
(iv) Using timed release devices, as employed with right whales in the Northeast US;
(v) Removing catch more frequently in order to decrease the attraction to depredating turtles;
(vi) Employing shark shapes as tested in demersal gillnets – to investigate the effect on catch rates of other turtle species besides green turtles, and alternative attachment methods;
(vii) Changing baiting techniques;
(viii) Increasing gear visibility, such as using illumination;
(ix) Improving the understanding of sea turtle visual physiology and behavior, in order to attempt to identify differences between target species and sea turtle visual spectrums and behavior. For instance, are turtles and target species caught during different times of the day, enabling turtle bycatch mitigation by not fishing during predominant timing of turtle captures without adverse effects on target catch;
(x) Increasing the net hanging ratio (ratio of the net height to net width, where a smaller ratio will have a higher entanglement risk);

(xi) Positive or negative correlation between the proximity of gear to shore and turtle catch rates;
(xii) Positive or negative correlation between the orientation of nets to the shoreline and turtle catch rates;
(xiii) Using stiffer line, or increasing line tension to make a more taut net; (xiv) using smaller line diameter;
(xiv) Using smaller mesh size;
(xv) Eliminating tie downs;
(xvi) Reducing the vertical profile (net height);
(xvii) Reducing net area (e.g., replace mesh with vertical lines as done with pound net leaders in the Chesapeake Bay); and
(xviii) Exploring where turtles and target species are caught in the gear, to determine if it is feasible to modify the portion of the gear where turtles are caught without adversely affecting catch rates of target species.

**Reducing Mortality and Easing Disentanglement of Turtles Captured in Nets**
Strategies to increase the proportion of turtles caught in nets (including gillnets, trammel nets, and pound net leaders) that survive the interaction, and to facilitate the release of turtles captured in nets include:
(i) Setting gear at shallower depths so that caught turtles can reach the surface to breathe during the gear soak;
(ii) Augmenting the lifting of the net by adjusting the weighting design and/or anchoring design, so that caught turtles can lift the gear to the surface to breathe during the gear soak;
(iii) Increasing the hanging ratio and reducing the net profile (height) makes it easier to disentangle caught turtles;
(iv) Educating fishers and providing tools for best practice turtle handling, disentangling and release; and
(v) Using twine diameter and material to result in a breaking strength that allows turtles to break free of the gear and escape.

**Commercial Viability and Turtle Bycatch Mitigation Efficacy**
Development of a table describing the anticipated effect of alternative gear technology approaches to turtle bycatch mitigation on target species catch rates, practicality for crew, and crew safety, would be useful.

### 5.31.3. Practical Experience Working in Artisanal Fishing Communities Breakout Group

(Discussion notes taken by Doug Hykle, IOSEA)

**Overview of Main Session Accomplishments**

Participants in this breakout session identified practices and approaches for maximizing the effective direct participation of artisanal fishers in sea turtle capture assessment and mitigation initiatives, and clarified the importance of direct participation of fishers in fishery bycatch assessments and mitigation activities.

**Fishers Direct Involvement**

The importance of having direct participation of fishers in initiatives attempting to mitigate unwanted bycatch was highlighted:

(i) Fishers have a large repository of knowledge, which can be tapped to contribute to finding effective and commercially viable (economical, practical, safe) bycatch solutions; and

(ii) Fishers must be convinced that catching turtles is a problem and buy into the use of the mitigation practices in order to maximize the potential for fishers to adopt measures shown to be effective at reducing unwanted turtle bycatch,.

Given the state of most fisheries management frameworks, including limited resources for monitoring, control and surveillance, approaches shown to be effective in research experiments at reducing bycatch may not be employed as prescribed or at all by fishers if they are not convenient and economically viable, or better yet, provide operational and economic benefits. This is particularly true for economically marginal fisheries. Identifying commercially viable bycatch solutions, where commercial viability refers to both the effect on income and practicality of employment, including crew safety concerns, will maximize the likelihood of fishery uptake. Direct involvement of fishers in assessments, commercial demonstrations, and mitigation interventions will maximize the likelihood of identifying methods that are both effective at reducing unwanted bycatch and that are acceptable to the industry. Outreach activities, which raise artisanal fishers' awareness of why they should want to avoid catching and killing turtles, are needed, and on a continual basis due to the high turnover of participants in some fisheries.

**Obstacles to Overcome**

Fishers may be afraid that divulging information will rebound and be used against them. There may be difficulties in overcoming negativity surrounding existing 'bad press' regarding sea turtle bycatch. In other words, it is critical to gain fishers' trust in order to make headway in reducing sea turtle fishing mortality. Where effective frameworks for management and/or enforcement are not in place or possible, some form of local self-governance is important.

**Approaches**

It is important to attempt to understand the direct interests and constraints of fishers within their communities: there may be interest in addressing bycatch issues in general, without necessarily focusing specifically on sea turtles, which may be counter-productive. An approach to gaining fishers trust is to be identified as a "willing listener" on much wider themes and problems, and not focusing exclusively on bycatch. It is useful to collect information on community attitudes and demographics, and cultural aspects, through instruments such as advance surveys.

In some areas, there may be no direct incentive for fishers to want to increase sea turtle population sizes, such as in areas where turtles are not hunted, and where eggs are not eaten. In locations with this context, there is a need to identify alternative arguments that are relevant to the fishing community. For instance, the use of TEDs could be promoted as a means to

reduce fuel costs, decrease damage to nets, increase the value of catch, etc.). Or, for instance, reducing turtle bycatch may open up new markets, and possibly result in higher value for their catch, such as through certification against the Marine Stewardship Council principles and criteria or other eco-labeling program. In other words, helping fishers identify benefits of employing a sea turtle bycatch reduction practice is important.

There is likely to be a lack of consensus in opinion within a fishing community. It is important to acknowledge that the loudest voice may be of a vocal minority and not represent the opinion of the majority. It is important to identify fishers respected by the overall community, including individuals who are early adopters and mavericks that might be willing to change, and serve as a role model for the rest of the fleet. A lack of consensus within a fleet may result in there being insufficient industry peer pressure for broad use of sea turtle bycatch avoidance practices.

In many countries, fishers have very low expectations of national-level fisheries department staff that lack local-level authority. However, a dual approach is critical: it is important to engage the government as well as local fishing communities, even if the fisheries management authority is perceived as distant and ineffectual, in order to avoid potential long-term problems with the government.

Gaining artisanal fishers involvement and trust requires a long-term investment, often greater than 10 years. This is because it takes time to develop credibility and to facilitate access. It is important to provide fishers with assurance of how information they divulge will and will not be used; and for investigators to use discretion on their publication of findings. It is also important to not offer false hopes, such as in proposing alternative livelihoods when economic viability is uncertain.

In identifying suitable locations to conduct initiatives related to mitigating sea turtle bycatch in artisanal fisheries, considerations should include targeting known turtle bycatch hotspots, known enlightened fishing industry leaders, and the likelihood of successfully accomplishing changes in fishing practices that result in reduced turtle capture levels.

When initiating projects with new fisheries, it is helpful to involve people who were involved in previous successful projects in order to benefit from their lessons learned in working with artisanal fishers to mitigate bycatch.

There are existing resources available providing guidance on working with fishers, including an IUCN Techniques Manual (1999), a DVD with a compilation of case studies owned by Martin Hall, and a relevant book chapter by Kennelly, S.J. (Ed.), entitled *By-Catch Reduction in the World's Fisheries*. Springer Verlag, The Netherlands).

**Expertise Needed**

There is a need for experts with skills and experience in catalyzing behavioral changes in people in order to achieve sustainable fisheries and sea turtle conservation goals.

Social scientists should be members of research teams from the start in order to help understand social drivers and community dynamics. At a minimum, it is useful to have a short guide to follow, which might describe things to look for and lessons learned, but this would not serve as a substitute to having social science expertise onboard.

In some cases, it has proven useful to have outsiders involved, for instance, to demonstrate to the local fishing community and other stakeholders that sea turtles are a shared international resource, to augment or instill a stronger sea turtle conservation ethic.

Fisher-to-fisher technology transfer has been demonstrated to be effective at disseminating lessons learned on bycatch solutions in one fishery to other fisheries, where vessel operators from two or more fisheries participate in an exchange, when the right people are identified to participate.

## 6. CHARACTERISTICS OF FISHING GEAR AND METHODS RELEVANT FOR UNDERSTANDING SEA TURTLE INTERACTIONS, FORMS FOR (a) GILLNETS AND TRAMMEL NETS AND (b) POUND NETS AND FYKE NETS

Form a was prepared by: Martin Hall, Inter-American Tropical Tuna Commission; Takahisa Mituhasi, OFCF-Japan; Simon Chapilliquen, CEP-Paita Peru; Ricardo Guerci, Univ. Villarreal, Peru; Manuel Parrales and Liliana Rendon, WWF-Ecuador; Juan Miguel Carvajal, INCOPESCA, Costa Rica; Alvaro Segura, WWF-CentralAmerica, Costa Rica; Regina Sanchez and Mario Jolon, PROBIOMA, Guatemala; Lucas Pacheco, WWF-CA, Panama

Form a was designed by: Marlon Roman and Nickolas Vogel, Inter-American Tropical Tuna Commission

Form b was prepared by: Kate Mansfield, University of Miami; Martin Hall, Inter-American Tropical Tuna Commission; Takahisa Mituhasi, OFCF-Japan; Simon Chapilliquen, CEP-Paita Peru; Ricardo Guerci, Univ. Villarreal, Peru; Manuel Parrales and Liliana Rendon, WWF-Ecuador; Juan Miguel Carvajal, INCOPESCA, Costa Rica; Alvaro Segura, WWF-CentralAmerica, Costa Rica; Regina Sanchez and Mario Jolon, PROBIOMA, Guatemala; Lucas Pacheco, WWF-CA, Panama

## 6.a. **Form for Gillnets and Trammel Nets**

1. Type of net: Gillnet Trammel Net

Note: For trammel nets, complete separate forms for the interior and exterior layers, and indicate if the gear has one or two outside layers

2. Select one: Anchored Staked Drifting Sweeping

3. Select one: Surface MidWater Bottom

4. Dimension for each panel:
Length .....meters or fathoms
Length after hanging ..... meters fathoms
Hanging ratio
Height ..... meters or ..... meshes
Tie down line YES NO Height ……. meters

5. Number of panels fished: .....

6. Total surface net ( .....mt (length) by .....mt (height))

7. Mesh characteristics:
Mesh size: ..... cm or .....inches.
Twine material .....Nr .....Denier.....
Diameter (mm).....
Color .....

8. Float line characteristics:
Material .....Code Nr.....
Diameter (mm).....
Color .....

9. Floats characteristics:
Total number .....
Material .....
Color .....
Dimensions .....
Shape .....
Nr bridges between floats.....

10. Lead line characteristics:
Material .....Code Nr……
Diameter (mm).....
Color .....
Weight (kg per meter)
Unit weight (gr ..... or ..... nr per kg)

11. Main species captured ..

12. Main fishing ground: .....

13. Most common Fishing depth: .....bz

14. Fishing hours: …… .....

15. Bait in net? YES NO Species.....

16. Net patrolled? YES NO

17. Angle of net - coast: Parallel Perpendicular 45 degrees

18. Tide during set:

19. Beach slope:

20. Predation on catch by:
- Seals YES NO Species ..... Entangled? YES NO
- Seabirds YES NO Species ..... Entangled? YES NO
- Cetaceans YES NO Species ..... Entangled? YES NO
- Sharks YES NO Species ..... Entangled? YES NO
- Other .....

21. Additional information that you believe might be an important factor influencing sea turtle capture rates and mortality rates:

## 6.b. **Form for Pound Nets and Fyke Nets**

1. Type of net: Pound Net Fyke Net

2. Select one: Open Closed

3. Check all that apply: Leader/Hedge
Heart(s) (# )
Head/Pound (# )

4. Leader characteristics
4.1. Leader type: Staked mesh String Buoy (# of buoys )
4.2. Length: .....meters or fathoms
4.3. Depth 1 (start): .....meters or fathoms
4.4. Depth 2 (trap end): .....meters or fathoms Hanging ratio
4.5. Height: ..... meters or meshes
4.6. Total surface net ( .....m (length) by .....m (height))
4.7. Mesh:
4.7.1. Mesh size: ..... cm or inches
4.7.2. Twine material: .....Nr .....Denier.....
4.7.3. Diameter: ..... (mm)
4.7.4. Color: .....
4.8. Number of Stakes……
4.9. Stakes distance apart: …….m

5. Heart(s)/Funnels characteristics
5.1. Heart type: Staked mesh String Buoy (# of buoys )
5.2. Height: ..... meters or meshes
5.3. Total surface net: ( .....m (length) by .....m (height))
5.4. Mesh characteristics
5.4.1. Mesh size: ..... cm or .....inches.
5.4.2. Twine material: .....Nr .....Denier.....
5.4.3. Diameter: ..... (mm)
5.4.4. Color: .....
5.5. Number of stakes:……
5.6. Stakes distance apart: …….m

6. Pound/Trap/Head Characteristics
6.1. Select: Open Closed (box cone bag??)
6.2. Trap type: Staked mesh String Buoy (# of buoys )
6.3. Height: ..... meters or meshes
6.4. Depth: ……..meters or fathoms
6.5. Total surface net: (.....m (length)by .....m (height))
6.6. Mesh characteristics
6.6.1. Mesh size: ..... cm or .....inches.
6.6.2. Twine material .....Nr .....Denier.....
6.6.3. Diameter (mm).....
6.6.4. Color .....
6.7. Number of Stakes
6.8. Stakes distance apart…….m
6.9. Location: Latitude……Longitude……

7. Times fished/day: .....

8. Tidal stage fished: Ebb Flood Slack N/A

9. Main species captured: .....

10. Main fishing ground: .....

11. Most common fishing depth: .....bz

12. Bait in net? YES NO Specie.....

13. Net patrolled ? YES NO

14. Angle net - coast: Parallel Perpendicular 45degrees

15. Beach slope:

16. Leader Predation
- Predation on catch by:
- Seals YES NO Species ..... Entangled? YES NO
- Seabirds YES NO Species ..... Entangled? YES NO
- Cetaceans YES NO Species ..... Entangled? YES NO
- Sharks YES NO Species ..... Entangled? YES NO
- Other .....

17. Heart/Funnel Predation
- Predation on catch by:
- Seals YES NO Species ..... Entangled? YES NO
- Seabirds YES NO Species ..... Entangled? YES NO
- Cetaceans YES NO Species ..... Entangled? YES NO
- Sharks YES NO Species ..... Entangled? YES NO
- Other .....

18. Trap/Pound/Head Predation
- Predation on catch by:
- Seals YES NO Species ..... Entangled? YES NO
- Seabirds YES NO Species ..... Entangled? YES NO
- Cetaceans YES NO Species ..... Entangled? YES NO
- Sharks YES NO Species ..... Entangled? YES NO
- Other .....
- ***include depth of entanglement in all cases

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