SHARING OUR GULF

A CHALLENGE FOR US ALL

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SHARING OUR GULF
A Challenge for Us All

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It began with a goal in a research proposal. It was nurtured by discussions with Sea Grant personnel, graduate students, and those in the affected communities. But, ultimately, it came to fruition through the tireless efforts of one person....thus, this proceedings is gratefully dedicated to Jenny Magee Toups.

—DWO

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"All that we do is touched with ocean, yet we remain on the shore of what we know."
— Richard Wilbur

This conference is really about "how to solve marine problems." Even though I personally am very interested in endangered species, such as sea turtles, in this conference we have stepped back from specific situations to try to evaluate the larger concerns of our marine environments.

Our bays and lagoons, the Gulf of Mexico and even the Atlantic Ocean are actually "common" resources with no real owners.

In the "Tragedy of the Commons" mentality, early New England villagers abused the "common" pasture in the middle of town by putting just one extra cow each out to graze. It was thought that "surely, no one will notice, and if I don't use the grass, someone else will." It was not very long, however, until the "commons" pasture was overgrazed and useless to all as a resource. Our oceans are indeed huge, so it has taken us a much longer time to reach the point of overuse. But now, we are clearly there. We are messing up. Many marine resources, which are owned "in common," are now suffering from overuse in one form or another.

As a society that relies on the bounty of the Gulf of Mexico for income, food, recreation and a host of other things, we are well-acquainted with the struggles inherent in sharing such a resource. Recreational and commercial fishers vie for the same fish. Conservationists and businessmen fight over how much damage coastal industries actually do to the environment.

Conflicts in the Gulf of Mexico are often complex, and the 21st century promises only to intensify the situation. So many different people want to use the Gulf's finite resources. Can the Gulf stand the pressure?

Endangered species, global warming, freshwater loss, depleted fisheries, sea level rise and pollution are some of the problems that threaten the physical condition of the Gulf of Mexico. However, lack of communication, conflicting agendas and increasingly complex science are issues that threaten our ability as a society to effectively decide how to use our resources. Are we, as members of the Gulf of Mexico community, willing to work to improve the methods we use to solve resource-use conflicts?

The Sharing Our Gulf conference was an opportunity to come together and take stock of the marine environment in the Gulf of Mexico. The conference planners and I assembled a group of marine experts and resource users to give their interpretations of some of the most pressing issues facing the Gulf of Mexico; however, the audience participation and input were vital to the success of the conference. We invited participants to challenge the ideas that were presented; we invited them to meet at least one new person from a different discipline; we invited them to use the time at Sharing Our Gulf to listen and understand the diverse viewpoints that make up the Gulf of Mexico community.

The Sharing Our Gulf Challenge Goals

1. Look at Gulf of Mexico concerns from all viewpoints.
2. Provide a place in which people who really care can listen to each other.
3. Find common ground (ocean?) and shared interests.
4. Recognize our success stories and successful strategies and build on them.

Based on the intense level of interactions, the numbers of new acquaintances developed and the hope generated for the future, the Sharing Our Gulf conference was a tremendous success. Is the job done? No way. In fact, it is only just beginning. With the new century and new millennium upon us, we definitely want to project a new optimism, a willingness to pitch in and get involved and the beginnings of a plan of work and recommendations that we all agreed were of a high priority.

Dave Owens
Conference Coordinator and Proceedings Editor

"SHARING OUR GULF" RECOMMENDATIONS AND IDEAS FOR THE FUTURE

In 1998, the Year of the Ocean, the Texas Sea Grant College Program hosted an international conference called "Sharing Our Gulf." It was attended by a diverse group of people who live and work around the Gulf of Mexico. This conference resulted in frank discussions concerning Gulf of Mexico environmental, ecological, fisheries and economic issues. Participants reached the conclusion that current programs are not providing a way to effectively address the myriad of contentious issues that plague the Gulf. The group also agreed to form an ad hoc advisory group of users, naming themselves "Grupo Golfo," which means both "Gulf Group" and "Gulf glue." The advisory group drafted an initial list of priority recommendations, which have been loosely organized under four headings —Science and Management, Preservation, Education and Communication.

Science and management

The following are recommendations on inter-jurisdictional issues to be considered by federal agencies, including but not limited to the Environmental Protection Agency, Department of the Interior, Department of Commerce and Department of Defense:

1. Establish a co-management strategy for management of resources by the users:
   a. Identify user groups: fisheries, industries, environmental...
   b. Include international participation (Mexico, Cuba etc. where applicable)
   c. Establish funding system from this group to support diverse, unbiased, peer-reviewed science: Important issues that need to be addressed include:
   d. Determine fishing effort and the ecological effects of fishing on marine life in the Gulf of Mexico using direct methods
   e. Determine the ecological effects of bycatch
   f. Determine origin, transport and fate of materials that may contribute to phenomena such as hypoxic zones
   g. Determine biological effects of toxics on marine organisms, particularly as they relate to mortality and natality rates
   h. Continue to identify and designate ecologically important habitats for preservation, cleanup and protection
   i. Ensure interdisciplinary composition of councils, task forces, etc. — get the people with interests in a particular area or resource together for discussions
   j. Involve stakeholders in national regulatory processes, publish dates for legislative hearings and related meetings in industry and scientific newsletters
   k. Establish a system in which resource managers are accountable for strategy decisions
2. Form "Grupo Golfo" — users, educators, researchers from Mexico, the United States and Cuba

Preservation

1. Support organized/planned development (including firm allowances and restrictions) of coastal areas Gulfwide, in line with coastal management provisions.
2. Develop incentive-based and basin-specific strategies for improved water quality.
3. Protect ecologically important coastal and marine areas from future degradation through a process similar to EPA's Outstanding National Resource Water designation program.
4. Continue to encourage all users to discard trash appropriately and to comply with all provisions of MARPOL Annex V.
5. Determine and evaluate new zoning strategies in order to better protect the remaining areas of undeveloped coastlines and habitats.
6. Develop a wetland acquisition plan based on fair market value of ecologically important coastal habitats.
7. Emphasize preservation rather than restoration, if possible, yet encourage restoration where needed.
8. Limit subsidies such as Federal Emergency Management Assistance or flood insurance for coastal and barrier island reconstruction.
9. Encourage stewardship partnerships between private (NGO) and federal/state organizations.
10. Identify, reinforce and reward good marine programs and encourage new environmental efforts.
11. Personalize bodies of water and their inhabitants by placing signs along roadsides or bridges that identify the local marine life (or lack thereof).

Education

1. Target educational programs at all levels of understanding using system models and other appropriate teaching aids
2. Develop marine-oriented, in-service workshops for K-12 teachers as well as pre-service materials for use in colleges or universities.
3. Incorporate marine examples into learning objectives for all subjects in K-12 classrooms.
4. Organize a future meeting to set goals to issue statement with support from schools, industry, etc.
5. Develop interactive CD-ROM programs, such as "SIM-GULF: How the Gulf affects you."
6. Encourage emphasis on the Gulf as an ecosystem, ecosystem as a provider, and as an indicator of system health rather than just as a body of water.
7. Increase public awareness of the commercial and environmental value of the Gulf of Mexico, its products and resources.
8. Encourage more creative watershed education in Gulf as well as in inland states.
9. Develop balanced profiles of various Gulf of Mexico users and define roles and responsibilities of government agencies and regulators.
10. Produce a flowchart of jurisdictions and decision-making processes from each management body.

Communication

1. Compile and distribute a directory of experts by topic, including those people in government/academia, industry, non-government organizations, etc.
2. Develop a national public relations campaign on Gulf impacts that affect everyone. This campaign would include:
   - public service announcements
   - billboards (avoid jargon)
3. Develop a directory of websites, listservs and newsletters representing Gulf of Mexico concerns.
4. Support improved communication, in layman's terms where possible, and promote bilingual publications.
5. Increase user and scientific involvement in development of management schemes.
6. Develop a media education program that fosters improved media relations.
7. Encourage academic and agency researchers to include an outreach component in their efforts and to provide a vehicle for this component.
8. Encourage the appointment of a scientific review board and conformance to accepted scientific ethics.

Funding options

1. Shell Oil Marine Habitat Program
2. Sea Grant College Program
3. National Ocean Service
4. National Marine Fisheries Service
5. Environmental Protection Agency
6. Gulf of Mexico Program
7. Private Donations
8. Non-government organizations
9. Minerals Management Service
10. Department of Defense

Summary

Participants in the "Sharing Our Gulf" process now petition the director of the Texas Sea Grant College Program to invite the director of the Gulf of Mexico Program and that Program's Policy Review Board to join in a discussion of these recommendations and joint concerns. The next step would be to approach Congress, if appropriate, to re-initiate legislation to protect and study the Gulf of Mexico under the auspices of the existing Gulf of Mexico Program and the Sea Grant Programs in Texas, Louisiana, Mississippi, Alabama and Florida. Ultimate;y, we all want to also see much more interactive participation with Gulf of Mexico users from Mexico and Cuba.

STATUS REPORTS: HOW WE USE THE GULF

HABITAT CHARACTERIZATION OF THE GULF OF MEXICO CONTINENTAL SHELF—AN OVERVIEW

Benny J. Gallaway, president
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Introduction

The Gulf of Mexico is an oval sea covering an area of about 3.9 million square kilometers. It has a maximum depth of about 4,000 meters, and consists broadly of a Continental Margin and Abyssal Plain. The Continental Margin can be further divided into shelf and slope portions, grading into the Abyssal Plain. This talk focuses on the continental shelf physiographic region. The continental shelf varies greatly depending on location—from 280 kilometers off southern Florida to a minimum of about 10 kilometers at the Mississippi River delta. Broad carbonate shelf platforms occur off Florida and the Yucatan Peninsula; sediments of terrigenous origin blanket the shelf outside these regions. Rocky outcrops and reefs are restricted in spatial extent in comparison to soft-bottom habitats. Given this basic physiography, let us proceed with characterizing the major habitat features of the Gulf, the western Gulf in particular.

Hydrography and circulation

Oceanic water enters the Gulf from the Caribbean Sea through the Yucatan Channel (about 160 kilometers wide and 800 meters deep) and exits the Gulf through the Florida Straits. Both openings are located in the southeastern sector of the Gulf. This characteristic, combined with the fact that freshwater runoff from roughly two-thirds of the United States and more than half of Mexico empties into the northern and western sectors of the basin, serves to divide the continental shelf of the Gulf into two major provinces: a carbonate province (with sediments rich in carbonates from marine invertebrates) to the east, and a terrigenous province (with sediments consisting primarily of eroded soils from the Mississippi watershed) to the west.

In the western Gulf, patterns of physical oceanographic variables that are ecologically significant tend to be complex, with strong annual, along-shelf, and across-shelf variability. Offshore of Louisiana, the Mississippi River and its estuaries discharge significant quantities of fresh water onto the inner shelf. This seasonally variable freshwater discharge, carrying its load of sediments and contaminants (including nutrients), is a major contributor to environmental effects on local ecosystems. The picture is further complicated by the fact that the region of greatest oil production density also is offshore of Louisiana, in this same zone of complex oceanographic variables.

Circulation over the shelf in the northern Gulf has a strong seasonal component. On the average, a shelf-constrained circulation pattern occurs. During most of the year over the inner shelf, currents are directed downcoast in the northwest. During mid- to late summer, however, this pattern can reverse, starting near the U.S.-Mexico border and flowing upcoast, possibly because of changes in the orientation of the mean wind-stress vector relative to the curving coastline.

Fresh waters enter the Gulf of Mexico from rivers draining over two-thirds of the land mass of the contiguous United States (85 percent of the total freshwater input) and over one-half of Mexico (15 percent). Most of the Mexican discharge enters the Gulf in the southern sector. River discharge into the Gulf is dominated by the Mississippi and Atchafalaya rivers (65 percent) and declines east and west of the Mississippi delta. Whereas the combined annual runoff (low-salinity surface water from rain and snowmelt) from the Mississippi and Atchafalaya rivers is equivalent by volume to only 0.1 percent of the annual volume of oceanic water that enters the Gulf in its southeastern quadrant, it represents 10 percent of the volume of water over the continental shelf in the western Gulf. During periods of peak river discharge in spring, the effect of the runoff is conspicuous as far west as Matagorda Bay, Texas, and is sometimes discernible southward to the U.S.-Mexico border.

The result is a vast, river-dominated system of low to moderate salinity encompassing the bays, sounds, and nearshore waters of the north-central Gulf, extending seaward to approximately 20-meter (or roughly 10-fathom) depths. To the west, low-salinity estuarine habitat is restricted to the semi-enclosed bays of western Louisiana and Texas, where freshwater inflow exceeds losses to evaporation (positive-flow estuaries). A band of moderate-salinity nearshore water is found seaward of these estuaries, becoming more restricted to the southwest, and generally disappearing south of Matagorda Bay. This extensive estuary-nearshore complex constitutes the White Shrimp Ground Biological Assemblage. A different assemblage of marine organisms is associated with the shelf seaward of this zone to depths of approximately 100 meters, or 50 fathoms. This higher-salinity association is known as the Brown Shrimp Ground Biological Assemblage.

Habitats and biological communities

As explained above, the Gulf of Mexico can be divided into eastern and western subregions on the basis of physical and biological attributes. In the western Gulf, the major habitats of the continental shelf are estuaries (embayments with fringing coastal marshes and/or seagrass beds, and adjacent shallow nearshore waters), soft-bottom shelf habitats from the mainland to 20-meter depths, soft-bottom shelf habitats between 20 and 100 meters deep, natural hard-substrate (bank or reef) features, and offshore petroleum-related platforms.

The river-dominated estuaries of the western Gulf are fringed by coastal wetlands, especially in the Louisiana and East Texas regions. These wetlands provide cover and food for marine organisms during early developmental stages, and generate large quantities of organic matter that migrates into the adjacent bays and sounds. The bays and sounds are used as rearing grounds by older developmental stages of marine organisms, and in turn export significant amounts of organic material into the nearshore Gulf. In Louisiana, there is an extremely large interface between wetlands and bays. In addition, the bays and sounds are not only expansive in area, but have broad openings onto the continental shelf. Westward beyond East Texas, wetlands are not as extensive as in Louisiana, and the openings of the bays are greatly constricted. This feature may partially account for the dense aggregations of marine organisms (including sea turtles) that occur around the mouths of passes of the positive-flow estuaries of western Louisiana and Texas.

Seagrass beds, like coastal wetlands, are one of the most productive benthic (i.e., associated with the sea bottom) habitats in estuaries and nearshore waters of the Gulf. Seagrass habitats are most extensive in nearshore waters of the eastern Gulf, from the Florida Big Bend region to Florida Bay. This region contains about 68 percent of the total seagrass acreage found in the Gulf. The remaining 32 percent of the total 2.52 million acres covered by seagrass occurs in Gulf estuaries, mostly along the Florida and Texas coasts. Although they can be locally extensive, seagrass beds exist only in isolated patches and narrow bands in estuaries between Mobile Bay, Alabama and Aransas Bay, Texas. In these regions, coastal wetland habitat predominates, whereas seagrasses are restricted by low salinity, high turbidity, and high wave energy in shallow waters.

On the basis of data describing both soft- and hard-substrate communities, three characteristic faunal assemblages are represented in waters of the western Gulf shelf: the white shrimp ground assemblage (inner shelf), the brown shrimp ground assemblage (intermediate shelf), and the outer shelf assemblage.

The estuarine-dependent white shrimp ground assemblage is generally delimited by the 20-meter depth contour except near the Mississippi River delta, where the shelf is narrow and the community extends into deeper water. Commercial and recreationally important species characteristic of the white shrimp ground assemblage include white shrimp (*Penaeus setiferus*), Atlantic croaker (*Micropogonias undulatus*), Gulf menhaden (*Brevoortia patronus*), seatrout (*Cynoscion* spp.), and red drum (*Scianops ocellata*). The endangered Kemp's ridley sea turtle (*Lepidochelys kempii*) is also found in this habitat.

The brown shrimp ground assemblage of the western Gulf extends from 20-meter to 100-meter depths. The foremost commercially and recreationally important species include brown shrimp (*Penaeus aztecus*) and red snapper (*Lutjanus campechanus*). The numerically dominant fish, however, is the longspine porgy (*Stenotomous caprinus*), a small species with a short lifespan and high fecundity.

Species from both soft-bottom assemblages are characterized by small size (most less than 20 centimeters long), short lifespan (one to three years), high annual mortality rates (90 percent or more), and high fecundity and extended spawning seasons. Historically, these attributes are believed to have enabled the communities to withstand high rates of exploitation without detrimental effect. In contrast, many of the commercially and recreationally important reef species and pelagic predators of the continental shelf are typically larger, longer-lived, and characterized by lower annual mortality rates than the soft-bottom forms described above. Consequently, they are much more susceptible to over-exploitation.

Most of the benthic shelf and slope habitats of the western Gulf of Mexico consist of soft sediments. Rocky outcrops, shell ridges, or other high-relief features are uncommon. The most conspicuous natural features of topographic relief found in the western Gulf are the Pinnacle Trend, at the outer edge of the Mississippi-Alabama shelf between the Mississippi River and DeSoto Canyon, and a series of mid-shelf and shelf-edge banks that occurs west of the Mississippi River offshore of Louisiana and Texas. Reef features in the eastern Gulf are found in the Florida Middle Grounds, and the Tortugas. Florida reefs are Caribbean in origin whereas the western Gulf reefs more closely resemble reefs in the southern Gulf of Mexico.

In the western Gulf, natural reefs constitute only 1.6 percent, or 2,780 square kilometers, of the total shelf substrate, which is dominated by clays, silts, and sands producing a soft bottom. In comparison, the total area of artificial reefs provided by offshore petroleum industry platforms in the western Gulf has been estimated to be about 12 square kilometers, or roughly 0.4 percent of the area of natural hard substrate. Platform reefs differ from natural reefs in that the platforms span the entire water column (the vertical distance from the sea bottom to the surface), whereas natural reefs do not. Rather than state that artificial reefs in the form of offshore platforms constitute about 0.4 percent of the total hard bottom of the region, it may be more accurate ecologically to say that they comprise 100 percent of a new and distinct introduced habitat.

BUSINESS/INDUSTRY AND THE NORTHERN GULF OF MEXICO

Jim Kachtick, Environmental Manager
Occidental Chemical Corporation

The Gulf of Mexico is often called "America's Sea." It is a unique natural resource that has an important relationship with the numerous business/industrial activities located both onshore and offshore. In regard to how their activities relate to the Gulf of Mexico, industries in this region can be divided into three segments:

- Industries whose activities and successes are directly affected by the Gulf's water quality and aesthetic characteristics.
- Industries that are largely unaffected by the Gulf's aesthetic qualities, but whose activities can impact the environmental well-being of the Gulf.
- Industries that use the Gulf of Mexico for navigation, raw materials, cooling water and transportation of inputs and products, and whose activities can impact the environmental well-being of the Gulf.

This paper will focus on the third sector of industry, which includes chemical manufacturing, oil refining, oil and gas exploration, commercial shipping, mining, power generation and boat building. Because of the location and cost advantages, these industries are often enhanced by their proximity to the Gulf and its bays.

Chemical manufacturing

Every state in the Gulf region, as in the nation, is dependent on chemical industry products to support its manufacturing, agriculture, service and other industries. All five Gulf states host some form of chemical production.

Much of the chemical industry converts petroleum products, natural gas and other naturally occurring materials into a wide variety of basic chemicals. These basic chemicals are then converted by other sectors of the chemical industry into chemical intermediates and final chemical products such as plastics, synthetic fibers and rubber. In turn, these products are fabricated by many different industries into thousands of essential industrial and consumer products.

Much of the growth in the basic chemicals and petrochemicals segment of the industry has been concentrated along the Gulf Coast, where petroleum and natural gas raw materials or feedstocks are available. Much of the nation's basic chemical production is concentrated in this area, with Texas and Louisiana producing over 70 percent of all primary petrochemicals.

Chemical shipments from companies located in the five states on the Gulf of Mexico are valued at about $80 billion/year (27 percent of the total in the U.S.). Exports of chemicals from these states exceed $14 billion/year (11 percent of the total chemical exports from the U.S.). These same companies operate 2,000 chemical manufacturing facilities in the region with a combined payroll of about $7 billion/year (an average annual wage of $45,000). Other industries in these Gulf States that rely on chemicals indirectly as their inputs employ about 3.2 million workers (18 percent of the total workforce in the region).

Based on the fact that releases of toxics to the environment (TRI) and hazardous waste generation by the chemical facilities in the Gulf Region have had a downward trend over the last decade while production/sales have increased significantly, it can be concluded that the chemical industry has learned to respect the Gulf of Mexico as a valuable ecosystem and has acted accordingly. As members of the Chemical Manufacturers Association (CMA), companies with facilities in the Gulf Region participate in the Responsible Care Program, abide by its 10 principles of management and have implemented it six codes, with their comprehensive management practices.

Oil and gas

The Gulf of Mexico contains about 38 percent of the known U.S. petroleum reserves and nearly 50 percent of the known U.S. natural gas reserves. The oil and gas industry has two primary segments, both of which interface significantly with the environmental aspects of the Gulf:

- Refining and distribution
- Exploration and production

Refining and distribution is a well-established segment whose inputs come not only from domestic sources, (including the Gulf of Mexico's Outer Continental Shelf) but are also imported from foreign countries (often through the Gulf of Mexico).

Most oil refiners belong to the American Petroleum Institute and participate in its STEP Program, which is similar to the CMA Responsible Care Program.

Exploration and production have a long tradition on-shore, primarily in Texas and Louisiana. In Texas, 215 out of 254 counties have oil and gas operations. In Louisiana, all 64 parishes have oil and gas operations. In recent times, exploration and production activities have moved to the Outer continental Shelf (OCS) of the Gulf of Mexico. Currently, more than 90 percent of the OCS oil and gas production in the U.S. comes from the Gulf. Revenues from federal leases in the Gulf of Mexico totaled $111 billion from 1993-95.

New technologies are opening the Gulf of Mexico to drilling in deeper and deeper water. These include:

- Remote-operated, deep-sea robotics vehicles
- 3-D seismic, computer-generated data
- New, modern supply boats

This increase in activity is having a significant, positive economic impact on the region. In 1995, deep-water wells in the Gulf produced 950,000 barrels of oil daily; by 2000, daily oil production from deep-water wells in the Gulf could reach 2 million barrels.

In 1991, the Safety and Environmental Management Program (SEMP) was initiated as a joint project of the American Petroleum Institute (API) and the U.S. Minerals Management Service. This program has developed strategies and methods for dealing with hazards in all aspects of off-shore oil and gas operations. While this program is voluntary, over 100 companies (99.9 percent of all OCS production) are SEMP participants.

The primary environmental impacts of oil and gas activities on the Gulf of Mexico and its bays are wetlands alterations, marine debris, platforms as marine habitats and introduction of produced waters. In Louisiana, the state with the most significant wetlands loss, the direct impact of oil and gas operations on wetlands has decreased from 767 acres in 1982 to 77 acres in 1997.

It is estimated that 6-15 percent of the marine debris in the Gulf of Mexico is from water-based sources, with oil and gas operations contributing less than 5 percent.

Each of the 4,000 or so off-shore platforms in the Gulf of Mexico function as a reeflike habitat for marine organisms, which is a positive impact. Each year, about 100 platforms are removed, about 70 percent using explosives. An issue is the potential direct kill of marine species around these platforms during demolition. Another issue is the use of removed platforms as artificial reefs.

The introduction of produced water, both near-shore and in the open waters of the Gulf, is an issue that is currently being addressed at both the federal and state levels.

Transportation

Gulf ports handle about half of the U.S. import/export shipping tonnage. Four of the nation's busiest ports are on the Gulf coast. The Gulf of Mexico has the world's second largest marine transportation industry.

The Port of Houston is the nation's top port on foreign tonnage and is second in total cargo tonnage. The city of Houston gross annual product equals that of Hong Kong at $165 billion/year. In 1995, Congress approved $500 million to deepen and widen the Houston Ship Channel, which connects the port to the Gulf of Mexico via Galveston Bay. The resolution of environmental concerns related to this project is a good example of successful cooperative efforts between diverse interests.

Conclusions

While industry is often characterized as a "polluter" of the environment, including the Gulf of Mexico, it should be kept in mind that every person and the organizations to which they belong are in fact "polluters" to some extent. The act of living and the combustion processes that sustain us all result in some form of pollution.

The critical question to be answered is whether we are individually and collectively "responsible polluters" who are seriously trying to minimize our negative impacts on the environment. As far as the Gulf of Mexico is concerned, I believe the evidence shows that industry in this region is trying hard to be "responsible" in minimizing its impacts while interfacing in all the various ways with this ecosystem.

Recommendations

1. All of us should celebrate the achievements resulting in demonstrated improvements in the environmental well-being of the Gulf of Mexico.
2. The problems and concerns continuing to challenge us should be addressed in a rational way.
3. We must decide collectively on appropriate pathways to solve the remaining problems as well as any emerging concerns.
4. Solutions should embrace emotion/passion while being based on good science and sound economics.
5. We should look to such existing models of cooperation and consensus-building/problem-solving efforts as the Gulf of Mexico Program, the National Estuary Program and the Houston Ship Channel's Beneficial Uses Group.

The final question before us is "Can this forum provide another successful model?"

FISHES, SEA TURTLES AND MARINE MAMMALS OF THE NORTHERN GULF OF MEXICO: A HEALTH ASSESSMENT

Andre M. Landry, Jr., professor,
Texas A&M University at Galveston

Introduction

Fisheries of the Gulf of Mexico operate in the ninth largest water body in the world and target more than 50 species whose annual landings exceed 1.5 billion pounds valued at $680 million dollars. The Gulf produces 40 percent of this country's commercial fishery yield, which in itself surpasses the cumulative yield from the South and Mid Atlantic, Chesapeake Bay and Great Lakes. While the shrimp fishery is the Gulf's largest and most valuable fishery, this region also supports nearly one-third of the U.S. recreational marine fishing activity.

Status of the Gulf's fisheries can be put into some working perspective by comparing them with those of the United States as a whole and with one other region. There are 717 fisheries stocks managed nationwide by various regional fishery management councils, with approximately 12 percent of these stocks regarded as overfished. Regional fisheries such as those under the jurisdiction of the North East Fisheries Management Council have nearly 50 percent of their stocks overexploited. On a positive note, the Gulf currently only has four species or about 6 percent of its stocks regarded as overfished. Overall, fisheries of the Gulf are in good shape; however, there are critical concerns regarding their constituent stocks.

Shrimp fishery of the Gulf

The Gulf shrimp fishery started in the late 1800s but had its major development after World War II. Today's fleet of inshore and offshore vessels exceeds 13,000 boats. One salient trend is the recent reduction in Gulf vessels from about 7,000 in 1984 to about half of that today. Nevertheless, shrimp stocks continue to hold their own, with 1996's landings surpassing those during the early 1990 to represent 60 percent of the Gulf's entire fisheries economy.

The Gulf's shrimp fishery is based on six constituent groups of shrimp - pink shrimp stocks off west Florida, white, brown and seabob stocks of the northern and western Gulf, and rock and royal red stocks of deeper Gulf waters. Three species - pink, white and brown shrimp - constitute nearly 90 percent of the Gulf's estimated 220 million pounds harvested annually from near and offshore waters. This fishery is a resilient one. Virtual population analyses used to evaluate the status of constituent shrimp stocks indicate there is no clear relationship between harvest of the parental stocks and its impact on recruitment into the fishery. Instead, the environment seems to play an all-important role in determining population strength of these stocks. This relationship can be seen in the case of pink shrimp during the late 1980s and early 1990s when poor water quality conditions in Florida Bay and the Dry Tortugas reduced annual landings. However, with improved hydrological practices in place since 1992 pink shrimp landings have exceeded previous annual peaks. Another environmental perturbation of concern to shrimp resource managers is hypoxia or dead bottom areas of the Gulf. While hypoxia may not directly determine population strength of shrimp stocks, it may impact critical habitat, shrimp distribution as well as harvesting practices and potential.

Today's Gulf shrimp stocks are not considered overfished. This fact can be seen in annual landings of constituent species. Although cyclic, they have all held there own across time, with recent increases in annual landings for several stocks. While the health of shrimp stocks is considered very good, there is much concern about the impact of the shrimp industry on other stocks. The crux of this concern is the incidental bycatch of other species, whereby 4.3 pounds of finfish are caught for every pound of shrimp landed. This bycatch, particularly that taken in the open Gulf, is perceived as having a detrimental impact on red snapper stocks.

Red snapper of the Gulf

Red snapper (*Lutjanus campechanus*) form the basis of a fishery in conflict and one considered overfished. The demise of the red snapper fishery began with a reduction in annual commercial landings from 7 million pounds during the mid-1960s through the mid-1970s to fewer than 3 million pounds in 1997. Similar reductions have occurred in the recreational red snapper harvest wherein cumulative landings of 10 million pounds during the first half of the 1980s declined to one-fifth of that in the latter half of that decade. By the end of 1997 this fishery had to be closed by the National Marine Fisheries Service (NMFS), much to the ire of constituent fishermen and the recreational industry.

At the root of this issue are complex questions with incomplete answers. Information on red snapper mortality due to directed commercial and recreational harvest is relatively available. Significant information voids exist, however, when addressing mortality associated with incidental harvest especially that in the shrimp fishery. While an estimated 35 million juvenile red snapper killed as shrimp bycatch is much lower than that of other short-lived species, such as Atlantic croaker and spot, this estimate, when integrated into red snapper life history, has been deemed sufficient by NMFS to label the stock overfished and at peril due to potential recruitment losses. Answers to complex management questions regarding red snapper will only be available when information on early life history of this species is gathered, especially that related to natural mortality and habitat preference of juvenile constituents. Compounding this issue are concerns about red snapper management strategy. Many fishermen feel there are plenty red snapper in the western Gulf and these stocks, unlike their depleted counterparts in Florida waters, should be managed separately. Lastly, there are differing opinions between NMFS and the Gulf of Mexico Fishery Management Council as to management strategy.

Recent findings indicate that red snapper stocks may be improving, especially in light of five consecutive years of increased recruitment into the fishery. One concern here is just what is the real rate of improvement. Recovery from an overfished status will theoretically occur when a spawning potential ratio (SPR) of 20 percent is attained within the stock. Current estimates of SPR are well below this level and, as such, NMFS has mandated a 50 percent reduction in bycatch-related fishing mortality to be achieved through integration of bycatch reduction devices or BRDs into the shrimp fishery. Much controversy surrounds the NMFS mandate for BRDs as well as its current management strategy regarding commercial and recreational red snapper harvest. At the heart of this latter issue is NMFS' decision to release only 6 million pounds of the estimated 9.12 million pounds of the total allowable catch (TAC) of red snapper for commercial and recreational harvest. The decision to release the remaining 3.12 million pounds of red snapper TAC will be based on whether BRDs effectively cut the loss of potential recruits to shrimp bycatch by one half.

Sea turtles of the Gulf of Mexico

Five species of sea turtles utilize Gulf waters. These include four hard shell varieties — the loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys olivacea*), green (*Caretta mydas*) and hawksbill (*Eretmochelys imbricata*)sea turtles. Their fifth counterpart is the leatherback. All five species are federally protected, with this protection ranging from the loggerhead being threatened across its range to the endangered triumvirate of the Kemp's ridley, hawksbill and leatherback. The Gulf's sea turtle assemblage exhibits a disparate distributional pattern and, as such, mandates different levels of human concern.

Hawksbill Sea Turtle: The ornate hawksbill's use of Gulf waters is limited tropically by its being a coral reef-hard bank inhabitant that prefers sponges, and nests on tropical islands. As such, hawksbill are typically limited to subtropical sectors of the Gulf like the Florida Keys and southern Mexico where essential habitat and/or exploitation are growing concerns. The hawksbill's 3 percent contribution to stranding totals along Gulf shores is probably indicative of its limited use of our waters.

Leatherback use of Gulf waters, like that for the hawksbill, is limited, but in this case, pelagically by its being an oceanic wanderer preying upon jellyfish communities throughout the water column and nesting on tropical beaches. It occurs primarily in the offshore Gulf where perceived threats include ingestion of debris and impact from oil exploration activities. The leatherback is one of those offshore Gulf users for which new information is becoming available through deep-water surveys such as MMS and Texas A&M University at Galveston's GULFCET program. Data from this program indicate that leatherbacks are quite common in the deep Gulf and are the dominant sea turtle in this habitat. The leatherback's preference for deeper Gulf waters may explain, in part, its failure to contribute more than 2 percent of the sea turtle strandings across this region.

Green Sea Turtle: Green sea turtles are an excellent example of the impact of overexploitation on Gulf stocks. This species was the subject of a directed commercial fishery operating in Florida and Texas during the late 1800s. Annual green turtle harvests of 22,000 kg resulted in this fishery's collapse by 1900 and essentially eliminated the adult stock from northern Gulf waters. Current green turtles stocks are limited to subtropical sea grass meadows of the west Florida peninsula and the Laguna Madre of Texas, which they use as nursery and foraging grounds. In-water capture by this author along Texas and Louisiana shores seems to indicate that green turtles are probably the dominant inshore species found in subtropical environs of the Gulf. The south Texas green sea turtle assemblage is a relatively stable stock of overwintering individuals comprised of post-pelagic juveniles who use jetties and sea grass meadows as developmental grounds. These greens establish strong site fidelities to jettied environments, such as those at Brazos Santiago Pass, where they prey on encrusting algae until about 40 cm carapace length. They then move into sea grass meadows where they remain until the onset of sexual maturity.

Another positive note about green turtles in south Texas is their being an apparent fibropapilloma-free stock. Although it appears that pre-adult assemblages are remaining modestly stable in population size, some concern exists that there are few adult greens encountered in Gulf waters and no known major nesting sites.

Loggerhead Sea Turtles: Of increasing importance to resource managers is the status of loggerhead turtles and whether they can still be called the Gulf's most abundant sea turtle species. Strandings, often used as indices of abundance, seem to indicate that loggerheads deserve their dominant status. Cumulative stranding statistics seem to indicate that loggerheads constitute nearly half of the Gulf's sea turtle assemblage. Annual stranding statistics also appear to echo the perception that loggerheads are still tops. However, Kemp's ridley strandings during three of the last five years have surpassed those of the loggerhead and, the question of this latter species' population status remains more uncertain.

Another index of loggerhead health is what is happening on the nesting beach. Loggerheads have two major nesting assemblages in the U.S. Gulf. The South Florida beaches, by exhibiting 64,000 nests annually or nearly 91 percent of this reproductive activity, house the world's second largest loggerhead nesting assemblage. This assemblage is considered stable and possibly increasing. The Florida Panhandle assemblage is much smaller and of unknown population status.

Data from in-water surveys conducted by this author along the Texas and Louisiana coast since 1991 indicated that the loggerhead, although considered the Gulf's most abundant species, does not use near-shore white-shrimp ground habitat as extensively as does the Kemp's ridley. Aerial observations by NMFS in association with petroleum platform removal operations indicate that loggerheads are more common offshore, especially along open continental shelf waters. Estimates of post-pelagic loggerhead populations made by the Turtle Expert Working Group indicate that eastern Gulf stocks are larger than those in the Western Gulf and that these combined stocks are no match for those in the Atlantic.

Kemp's Ridley Sea Turtle: The Kemp's ridley has traveled a road to near destruction. Our knowledge of this travel began in 1947 with a nesting assemblage of more than 40,000 females being overexploited at their only nesting beach at Rancho Nuevo, Tamaulipus, Mexico. Here nesting females were slaughtered for their meat. Eggs were poached for their aphrodisiac quality and their hide used for leather goods. By 1950, this uncontrolled exploitation on the nesting beach reduced the nesting population to around 10,000 females who then were subject to incidental capture and death in the developing Gulf shrimp fishery. The 1985 ridley nesting stock had been reduced to around 700, an all - time low.

There seems to be a prescription for wellness that has beneficially impacted ridley stocks. This prescription began in 1966 with Mexico's protection of the Rancho Nuevo nesting beach. Another apparently successful remedy was applied in 1978 when the U.S. joined with Mexico to better protect the nesting beach through systematic surveys, nest translocation and egg and hatchling protection. Last but not least, turtle excluder device (TED) technology was initially integrated into the shrimp fishery in 1989 in an attempt to increase survival of ridleys at risk to incidental capture in trawls.

There are encouraging signs of potential recovery of the Kemp's ridley appearing both on the nesting beach and at sea. The nesting beach has yielded exciting reproductive successes for this species. These reproductive successes come in the form of increasing number of nests and similar increases in egg and hatchling production.

Encouraging at-sea trends for ridleys include: stable to increasing catch per unit of effort statistics since 1993, possible increases in survival rate at least in the form of increasing carapace length frequency of subadult and adult ridleys. Strandings, although viewed by most people in a negative way, are also on the rise. This rise would not be possible if there were not increasing numbers of ridleys available to fall prey to natural and man-induced mortality.

Marine mammals of the Gulf

Marine mammal stocks represent conservation-related extremes associated with nearshore and offshore assemblages. One of these extremes comes in the form of bottlenose dolphins, a prolific and human-adaptable stock. We have all seen the highly social bottlenose dolphin in our bays and Gulf. Of great contrast to these abundant dolphin stocks are the endangered manatees, a slow, herbivorous grazer suffering from human influence. And the last of these extremes are the dolphin and whale assemblages of the deeper Gulf, which are receiving a great deal of attention.

Bottlenose Dolphin: There are about 30 marine mammal species that utilize Gulf habitats. The most ubiquitous of these species is the bottlenose dolphin, which exhibits rather healthy inshore and offshore populations because they feed on almost anything and display behaviors enabling them to adapt to man and his activities. Dolphins are frequently seen in our busiest shipping lanes, often bow-riding the wake of large ships. They frequently interact with our marine industries, even to the point of becoming domesticated. An excellent example of this interaction is that of dolphins feeding behind shrimp boats. Dolphin interaction with man has generally not been detrimental to these stocks. Abundance off the Texas coast is considered high - often estimated in excess of 10,000 to 15,000 dolphins.

Bottlenose dolphin strandings are common in the western Gulf and seemingly cyclic; however, many of these are very old constituents or aborted neonates. These strandings are most frequent during late winter and early spring when environmental stress is greatest. Mass strandings are often associated with environmental anomalies like 1990's severe cold spell or recent outbreaks of pathogens, including the mobilla virus.

Gulf Manatee: Gulf manatee stocks are in peril due to reductions in essential habitat such as sea grass meadows in the eastern and southern Gulf. The Florida manatee is believed to consist of approximately 2,000 individuals while its antillean counterparts in the southern Gulf probably number fewer than 300. Their social behavior and a propensity to congregate next to warm water discharges and springs have gotten them into trouble. Manatees' curiosity also has put them in the path of boaters, which often results in their deaths. Being on the ecological cold edge of their Caribbean distribution also has not helped the manatee's status in the Gulf. Despite these foreboding statistics the Florida manatee may be experiencing a slight population increase.

Cetaceans: There is a paucity of information on cetaceans of the deeper Gulf, especially as it relates to human effects on reproduction and survivorship in these offshore stocks. Growing ecological concerns precipitated by a revitalization of the oil industry have resulted in the conduct of surveys characterizing these deep-water assemblages. One recently completed study of deep Gulf cetaceans is the aforementioned GULFCET study funded by MMS and conducted by TAMUG and the NMFS Pascagoula Lab. This program's research findings are extremely pertinent to whales and dolphins inhabiting waters 100 to 2,000 m deep and ranging from the Florida-Alabama border to that along Texas and Mexico. Aerial, shipboard & acoustic survey protocols were used to identify and enumerate these offshore species.

GULFCET cruises determined that there are at least 20 cetacean species that seasonally utilize deeper Gulf waters. This assemblage is estimated to be about 19,000 members strong and is comprised of historically unknown but newly considered common populations of small and large cetaceans as well as very rare species. These offshore stocks are dominated by about seven species occurring in notable abundances and/or group sizes. One of these is the melon-headed whale. Pantropical spotted dolphin are considered the most abundant offshore cetacean while species such as the striped dolphin and bottlenose dolphin are being found in much higher abundance than ever imagined. GULFCET also has found depth-dependent distributional patterns for many of these species which in the future may help define management strategies applied to offshore industries such as that for oil and gas.

In closing, I am happy to report the first Gulf sightings of six humpback whales in the Desoto Canyon earlier this year. Information of this kind, when combined with technologically advanced management strategies, will ensure that the sun never sets on our natural resources nor the industries which depend on them.

SUSTAINING RETURN FROM GULF OF MEXICO FISHERIES

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The 1996 amendments to the Magnuson-Stevens Act are known as the Sustainable Fisheries Act (SFA). Making the policy of sustainability operational is the challenge for all involved in fisheries management. The legislation and the challenge were spawned when prophecies of environmental doom reached a maximum yield. A thought-provoking article in The Economist (December 1997) portrays forecasters of doom as invariably wrong. The basis for the conclusion is partially that forecasters fail to understand the way a market system gives incentives via price hikes and their stimulating effect on beneficial technologies. Markets for goods created by environmental legislation such as mitigation banks and discharge credits have been a means of doom avoidance.

Viewing SFA in a proactive sense, it is sustainability we want for fisheries. Avoidance of doom alone will evidently not be a benefit to the nation. National policies have been more aggressive in seeking sustainable benefits from other common property resources. Most notable are forest policies and, to a lesser extent, public grazing lands. Each increasingly manages for sustainability of economic and social benefits of use. Thus, the conservation process of savings and investment facilitates the sustaining of utilization levels for consumers. This is what SFA should bring to us in the Gulf of Mexico, sustainability of benefits. We should be sharing stocks. The work, the challenge, begins when we avoid **overfished** conditions. Essentially the effort is one of limiting the **effects** of harvester's action with the least threat to their independence.

Achieving more benefits and paying attention to sustaining them must occur under new directives (SFA) and state agency actions. Agency deliberations will deal with fisheries as changes in the Gulf over the recent past. My change list includes: 1) the effect of electronics, which increased fishing power and narrowed the range between most and least skilled fishermen, 2) growth in marine angling, particularly the for-hire industry in estuarine areas, 3) increased participation and effectiveness of public interest groups, 4) increased participation and effectiveness of commercial interest groups of anglers, 5) lessened effectiveness of commercial interest fishers, 6) information/data needs outstripped budgets, 7) the failure of seafood ex-vessel prices to keep pace with inflation, 8) ethnicity changes in the harvest sector and 9) all uses of fish have become touted as commercially by significant by interest groups.

These changes only partially represent forces that fostered agency and management restructuring to deal with future needs to sustain benefits from resource utilization. Sharing of fish stocks was established via capture as if on a frontier. A frontier in the sense that direct allocation, an agency action, was absent. When competitive-based sharing becomes unacceptable to at least one share group, agencies are called on to bring civilization to the frontier. Fortunately, for the Gulf of Mexico Fishery Management Council's (GMFMC) authority, five are overfished and the remainder are of unknown condition. Rebuilding overfished stocks and avoiding the overfished condition, do involve allocation over time. The future of this process is one of design, test, reaction, measurement and redesign. Career fishery managers may think they have been there and done that. NOT! SGA is an indication the process has been too near term biased. Rebuilding is a long-term experience. Allocation is not sharing.

How will we as people with assigned responsibilities, managers and those involved by choice, endeavor to hit the moving target of improved sustainable benefits? The six groupings that follow are offered to stimulate thought in regard to this question.

Success and repeating history

Restoring overfished stocks and avoiding overfishing are clearly valued as set forth in SFA. There are many other factors necessary for the benefits to be sustainable. If not addressed as fundamentals, the history of resource misuse could be reestablished. The commitment to avoid the past will involve the allocation of unpalatable medicine necessary for a cure. The newly arrived National Standard 8 can be misread in this regard:

> Conservation and management measures shall, consistent with the requirements of the Magnuson-Stevens Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fisheries resources to fishing communities in order to; 1) provide for the sustained participation of such communities and 2) to the extent practicable, minimize adverse economic impacts on such communities.

Managers must take into consideration the importance of fishing to fishing communities and thereby minimize adverse economic impacts. This focus, however, must not interfere with conservation goals. Otherwise it would be used to avoid conservation measures, that is , repeat history. Conservation obligations of Councils, National Standard 1, come first. It is not risky to conclude that short run negative impacts with high probability of occurring should not overlook that losers in the near term can also be among those who gain in the long run. There has been a policy failure to assure those making the most investment, negative impacts in the near term will have preferential benefits when they arise.

Controlling effort by making it inefficient has been a trait of plans to achieve a biological goal. National Standard 8's focus should include tallying beneficial impacts of sustainable stocks. Allocations may initially need to be based on near-term shares. Yet this should not be anything more than a means to allow time to evaluate alternative allocations of benefits from a recovered stock. The cost of downsizing is real. Downsizing may be for attaining management buyouts is a recognition of this opportunity. There was no language suggesting that those opting out will be sold reentry permits as stocks and benefits become sustainable.

Bycatch reduction: Good thought, perhaps false hopes

National Standard 9. Conservation and management measures shall, to the extent practicable: 1) minimize bycatch and 2) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

The seaway to riches is paved with good intentions. The effort to make this national standard (no.9) operational by the deadline will itself cause rough waters. To approach it purely as an engineering problem of reducing bycatch to the maximum extent practicable has the best prospect of success. However, this is not the success desired! The prospect of identifying some reduction measure is directly linked to another fishery. When bycatch reduction becomes fishery independent, i.e. not clearly linked to a fishery or fisheries, the payoff in something other than protein preserved units is lost. Data would never be adequate, valued science budget resources would be poorly directed and false hopes raised in such a situation. Some payoff must be quantified so the extent practicable can be identified. Practicality must include more than physical components of the problem.

Allow for non-harvester shares

Perhaps this is the most public of the public interest groups. Non-harvesters share in paying for fisheries monitoring, enforcement and management. They are at the public testimony podium looking for something more than fisheries management has delivered. Managers have no easy task here, because actions may mean more than results in this situation. The types of issues non-harvesters. They can demonstrate intent by: 1) assuring explicit attention to restoring overfished stocks, 2)resisting management measures that lead to overfishing, 3) generating benefits from fishery harvests whether taxed or not and 4) adhering to essential fish habitat (EFH) provisions of law as a means of producing habitat benefits that non-harvesters may use.

Manager diversity

Social correctness will affect management council composition. Currently, NMFS denotes council members as **commercial, recreational** or **other**. The **other** designation will expand in the future to incorporate public interest groups. Commercial and recreational interest groups have been aboard since the inception of the council process. Public interest groups have been involved with councils through advisory panels and scientific committees. Participation of public interest groups in the development of SFA yielded noteworthy results. The focus on significance is that such groups have been building the structure and rules of fisheries management. This is a change from the previous route of public testimony at species specific hearings and comments to the federal register. Public interest groups will want to play in the house they rehabilitated. More diversity at the critical vote casting position of decision making is inevitable.

Fishing's future is "limited"

Magnuson-Stevens and SFA signify that the future of fisheries management will occur in a changed institutional setting. Building sustainable fisheries necessitates the comprehensive review of limitations on fishing. Historically the Gulf fisheries are replete with access limitations. The outlawing of gear in some areas such a gill nets, longlines, fish traps and the harvest of live rock are limitation. Fishing's future will be even more "limiting" as a result of numerous converging actions:

1. Federal alternatives now include fleet capacity reduction programs. Provisions include four funding sources for buyout programs. License limitation programs for Texas' inshore shrimp fishery and blue crab fishery are in place. License buyout programs were initially small but now are receiving more funds.
2. License or permit limitation initiatives are developing in fisheries under council purview. The devil as some people view it is in the details. Oh, if only we could attain the benefits without changing the way individuals pursue resources! The details spawn the need for endorsements, transferability provisions, qualifying periods, income thresholds and more. The initiatives in 1998 include evaluation of license limitation in the for-hire industry.
3. The secretary of commerce established a task force to study the historical role of the federal government in subsidizing fleet capacity. It can be concluded this identification is not under way so as to strengthen said efforts. The effort is thorough. For example, the treatment of crew as independent contractors, thereby relieving captains of employment taxes, is being discussed as a possible subsidy.
4. The current moratorium on establishment of new individual quota (IQ) programs will strengthen this management tool's future use, not inhibit it. The National Research Council IQ committee and NMFS' East and West Coast IQ advisory panels are dragging the issue over rocky bottom. Most people involved in the process will emerge to form a pool of knowledgeables. They will know that IQ programs are only a means to an end. The IQ discussions invariably involve other limited access alternatives. The access of crew to quota, licenses and permits has arisen. If vessel owners hold dear to the claim of crew as independent contractors working for a share of the catch, the same sharp members of a profession can argue for crew to be included in limitation programs. Think of the complexities! In June 1998, the National Marine Fisheries Service had a two-week open season for crewmembers in the halibut and sablefish IQ program. This included loans for up to 80 percent of the cost of purchasing quota.
5. Federal fishing fees are being considered. Gulf states have limited experience with fishery fees other than licensing. Severance taxes raise a small amount of revenue in Louisiana. Marine anglers have no license costs in the Exclusive Economic Zone (EEZ). Federal license and permit fees are constrained to administrative costs of processing applications for commercial fishers. Thus, the use of additional fees to defray management, enforcement and monitoring (MEM) costs from commercial harvesters has been avoided. There are changes in the wind. The FY1999 NMFS budget submission to Congress included a request to authorize a landing fee. Fees on commercial landings may eventually result in a calm sea, signifying status quo. However, the justification for fees could be different from supporting MEM. Consider fees when actions of a council or agency facilitate a harvest process unattainable by harvesters operating without the power of government. The Gulf council's cooperative closure of the EEZ off Texas is an example. Traditional independent shrimp harvesters and processors had government produce economic benefits which, acting as independents, they could not achieve. The benefits of the annual Texas closure are documented. Where is the government's direct share? Rather than withdrawing money for overhead support (MEM) through inequitable fees, the emphasis should be fees relating to gains not possible without the actions of government. The wealth inevitably created by license limitation and quota programs is another destination worthy of evaluation.
6. Eventually a dichotomy in new effort management and privilege-based fishing approaches must be evaluated. The newborns, EFH and bycatch reduction, convey an ecosystem orientation to management. Privilege-based fishing has historically proceeded on a species basis. Harvesters could view these newborns as complexities in what heretofore has been a within-fishery evaluation of limited access pros and cons.

Plan for growth in harvester demand

This is a place for the often maligned socioeconomic analysis. Agencies and various interest groups that manage for unchanged shares contribute to a caretaker management approach. The future of angler participation, seafood consumption, population growth and coastal economic development can be forecast. However, the supply side of fisheries issues receives almost exclusive attention. Harvesters have been routinely characterized as having near-term needs that orient management to provision of near-term benefits and less than risk adverse decisions. Understanding harvester motivations and reactions to management measures will improve conventional impact analysis and assist people in accommodating growth in harvester demand.

Summary

The low prospect of attaining sustainable yields has been delineated by scientists (Ludwig 1993). There remains a need to strive in imperfect, piecemeal steps to approach the target set forth in legislation. A high enough level of resources would make agency share distribution less necessary. Preventing a negative, overfishing and overfished stocks, may provide an improvement. The role of scientific models and associated data is not to produce irrefutable conclusions. Science will take us only so far. Decisions as to appropriate harvest levels and shares will incorporate the imprecise results of scientific analyses. The people making human element to be the most perplexing aspect of sharing the Gulf's fishery resources. There is no escape from dealing professionally with shareholders.

TEDS, BRDS, AND THE FISHERIES

SHRIMP TRAWL BYCATCH - A VIEW FROM INDUSTRY

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Designs and techniques used by shrimpers since the beginning always had as its purpose to remove as much of the bycatch as possible so as to produce a cleaner catch and thereby reduce bycatch and increase efficiency. These include the fisheye that is currently certified by the National Marine Fisheries Service (NMFS) as a bycatch reducing device; slots cut on either side of the bag to allow fish to escape, the cannonball shooter that has been used especially in the bay fishery for decades and others. The need for reducing bycatch was recognized and addressed by industry long before even the creation of the National Marine Fisheries Service or its predecessor agency. My good friend, Steven Charpentier of Louisiana who has spent over fifty years shrimping in the Gulf of Mexico and is a valued member of the Gulf of Mexico Fishery Management Council Shrimp Advisory panel, relates his use of the fisheye as a bycatch reduction device (BRD) for decades now. The point being made here is that the device that is being forced on the shrimp industry is one that was developed by industry and that device has been traditionally used as an excluder of fish other than juvenile red snapper. Juvenile red snapper has always been a very small part of shrimp trawl bycatch. In fact, in a shrimp trawl bycatch characterization study conducted using NMFS observers in the early 1990s, juvenile red snapper constituted .009 percent of the total bycatch caught in the trawls.

As you can see, my focus on bycatch is on the interaction between the shrimp trawl and juvenile red snapper for it is here that most of the controversy is centered, and as most of you know, the battle ground has now moved to the Federal Court system where the next phase will unfold.

On page 18,142 of the Federal Register/Vol. 63 no. 71/Tuesday, April 14, 1998/Rules and Regulations it states "NMFS points out that the shrimp trawl fishery removes about 88 percent of the red snapper population. The remaining 12 percent is the basis for the spawning stock and the directed fishery."If this statement is accurate then one has to make the assumption that in order to accomplish this; the shrimp fleet must operate in 100 percent of the habitat in which red snapper live. Common sense tells us that shrimp trawls are not operated over coral or other reefs (natural or artificial), shell ridges, sunken ships, rock formations, within a one-mile radius of the 4,000 or so oil rigs in the Gulf of Mexico, nor over any of the thousands of "hangs" that are charted in the Gulf. Since recent studies have shown that red snapper become obligate to structures as early as age 1, it is not unlikely; it's impossible for shrimp trawls to remove a number even reasonably close to the 88 percent claimed by NMFS.

To understand the impact on red snapper stocks by the directed fishery one needs to review the history of its management by the council and NMFS.

Listed below is a chronological order of events:

1984 - Red snapper first placed under Federal management. The Gulf Council noted that the number of recreational fishermen - had increased by 286 percent between 1970 and 1979 and that red snapper were over-fished throughout the management area due to directed fishing by recreational fishermen, who were the primary users, commercial fishermen, and incidental catches in other fisheries.

A minimum size limit of 12 inches in fork length was proposed but no annual quotas were instituted. When the final regulations were issued, NMFS deferred implementation for 18 months for the "headboat" fishery. Moreover, the regulations allowed each recreational fisherman, for each trip on a headboat, to retain up to five, under-sized red snapper as an incidental catch allowance. NMFS also exempted trawl vessels from the minimum size restrictions, citing the following rationale:

"The Gulf Council recognizes that incidental catch of snappers by trawls is a significant problem and encourages the development and deployment of gear that will reduce the incidental catch of finfish. The vast majority of red snapper taken in directed trawl operations for shrimp and groundfish, however, are very small in size-many less than two inches in length. Since fish of that size have an extremely high rate of mortality, very few would ever be achieved by affording protection to sub-adults, i.e. fish that are 10-12 inches total length. Accordingly, a minimum size limit on the directed hook-and-line fishery, both recreational and commercial, would produce substantially greater benefits to the stock than would restrictions against trawlers, especially since nearly all fish taken by trawl are dead when brought aboard."

1986 - NMFS extended the size limit exemption for headboat vessels

1990 - From 1990 to the present, the quota or TAC for the directed red snapper fishery has been increased in quantum leaps while the fishery remains severely over-fished. Additionally, the recreational sector has until 1997, substantially exceeded their quota every year prior to 1997.

On the subject of economics, NMFS estimated that the required BRD would result in a shrimp loss of 3 percent, cost the industry $40 million annually and cause nearly 10 percent of the fleet to go out of business. Industry scientists place the shrimp loss at 9 percent, costing the industry $100 million annually and the percentage of vessels leaving the fleet would be commensurately higher.

The shrimp vessel owner in the western Gulf has faced declining shrimp catches in the last four years, increased safety and fishing regulations, ever-increasing operating expenses and now must deal with another hole in his net - knowing full well that this requirement will reduce bycatch to less than half and experience three times the loss of shrimp estimated by NMFS.

Finally, as we approach the 21st century, as we continue to work toward solving the mandate of National Standard 9 in reducing bycatch and all other efforts to improve and enhance the fisheries of our nation, one overriding question desperately needs to be addressed and answered - who shall lead and who shall follow; is a government agency a servant or a master?

BIOLOGICAL AND ECONOMIC IMPACTS OF A LIMITED ENTRY PROGRAM IN THE BAY AND BAIT SHRIMP FISHERY

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Shrimp are spawned in the offshore waters of the Gulf of Mexico. The newly spawned shrimp are then carried inshore, by tidal action, to the fresh water estuaries along the Gulf Coast as zooplanktonic larvae where they develop into juvenile shrimp. The juveniles then begin their migration into the bays, and then to the offshore gulf where the process repeats itself. This cycle takes one year.

Bait, bay, and gulf vessels fish for juvenile and/or adult shrimp. Bait vessels harvest live shrimp from the bays along the Texas coast for use by recreational fishermen. Bay vessels harvest shrimp, for human consumption, in the Texas bays and near offshore waters of the Texas coast. Gulf vessels harvest shrimp for human consumption in the near and far offshore waters of Texas.

Unfortunately, like other open access fisheries, the shrimp fishery has been over capitalized. To counteract this problem, the 1995 Texas Legislature passed legislation expanding the authority of the Texas Parks and Wildlife Department (TPWD) to include limited entry through license limitation of the bay and bait shrimp fishery. This legislation: 1) directs the TPWD not to issue new licenses for commercial bay or bait shrimp fishing, 2) makes licenses transferable, 3) allows the TPWD to buy and retire licenses, and 4) places limitations on vessel length and horsepower to limit capital stuffing. Such changes in the regulatory framework of the fishery will not only effect the bay and bait inshore shrimp fisheries, but also the Gulf shrimp fishery through the dependence on a common shrimp stock.

The object of this analysis was to determine the economic impact of the Texas bay and bait shrimp limited entry program on individual fishermen. The general bioeconomic fisheries simulation model (GBFSM) (Grant and Griffin) is modified to account for capital stuffing and buyback of licenses by the TPWD. The bait shrimp fishery is not included in this analysis because of the lack of economic and biological data available for this fishery.

The number of bay licenses issued in 1996, the first year of limited entry, were 1,420. This number does not represent active full time vessels in the fishery, but rather all vessels. There are a number of individuals who hold licenses, but fish part-time or sports fishermen wanting the larger poundage limits associated with a commercial shrimp license. Further, a number of individuals, who were eligible, obtained a license although they were currently not fishing. It is possible that some of these individuals obtained licenses as an investment.

To raise funds for license buyback, TPWD is allowed to assess surcharges on the license fees paid by bait shrimp dealers, wholesale and retail fish dealers, wholesale and retail truck dealers, shrimp house operators, and commercial gulf, bay and bait shrimp fishermen. Because bait shrimp fishermen are not considered in this study, only half of the surcharge collected is used to buyback bay licenses. Half the amount collected in 1996 from all sources, except bay and bait fishermen, was $36,138. Additional funds equivalent to a surcharge per bay license times the number of licenses outstanding at the beginning of the year are added to the $36,138. These combined surcharges represent the annual funds available for buyback of Texas commercial bay shrimp fishing licenses. If all funds available for buyback in a given year are not used, they are rolled over for use in the following year.

Methodology

GBFSM is a policy analysis model developed specifically for the Gulf of Mexico shrimp fishery. When a management policy is imposed on the model, the biological submodel calculates the changes in days fished, effort, and shrimp landings. The economic submodel then calculates the monetary impact on shrimpers by calculating costs, revenues, and rent for each vessel class in each geographic area based upon the biological effects of the management policy. Limited entry, vessel buyback, and limitations on vessel length upgrades are incorporated into GBFSM by the addition of a license limitation submodel.

Effort is measured in terms of full time equivalent vessels (FTEVs). A full time equivalent vessel is defined as a vessel, which fishes eight hours a day, five days a week. The average number of full time equivalent vessels needed to catch the average yearly bay shrimp harvest between 1991 and 1995 is 1,131 vessels. In the bay shrimp fishery, the 289 excess fishing licenses (1,420-1,131) represent excess capacity (over capitalization).

The TPWD determines a value they are willing to pay for fishing licenses based on vessel length and number of years the license has been held. Fishermen submit sealed bid prices to the state for the amount they are willing to take to surrender their license. These sealed bid prices are determined by GBFSM in two different ways depending on whether there is excess capacity in the fishery. In the early years of the simulation, excess capacity in the fishery results in the typical open access condition of zero average net returns to fishery participants. Under excess capacity, randomly assigned bid prices, based on the actual distribution of bid prices from the second round buyback conducted by the state, are used. As time passes in the simulation, a sufficient number of licenses will have been removed to eliminate excess capacity. At this point, the fishery is assumed to be composed of FTEVs and the present valuation of expected future rents to shrimping are used to generate license bid prices.

Policies Analyzed

In addition to analyzing the current limited entry legislation for the Texas bay shrimp fishery, two policy alternatives are examined. The first examines changes in the license surcharge. A Texas commercial bay shrimp license currently costs $175, with an additional $25 surcharge giving a total cost of $200 per year. The effect on the limited entry program of larger surcharge amounts ($75, $125, and $175) is examined.

Second the legislation creating the license limitation and buyback program allows third parties to donate funds to TPWD for the purpose of license buyback or to operate as agents to buyback licenses for the TPWD. The alternatives examined are: 1) $500,000 per year additional funds are available during the first five years of the program, and 2) $500,000 per year additional funds becoming available during the five-year period after excess capacity has been removed.

Results and discussion

Base Line Scenario ($25 surcharge)

FTEV remains constant at 1,131 through year 15. In year 16, the excess capacity in the fishery has been removed and additional licenses purchased by TPWD have the effect of lowering the amount of FTEV in the bay shrimp fishery. Similarly, rents remain at their open access value of zero until year 16 when reductions in FTEV cause catch per unit of effort to rise and rents to become positive. By year 50 the FTEV is reduced to just over 800 and rent to bay vessels is $2.6 million per year.

The Texas offshore fishery shows no change from its open access equilibrium until year 16 when changes in the bay fishery cause offshore FTEV to rise. This rise in FTEV is in response to a larger amount of shrimp migrating out of the bay fishery because of decreasing number of FTEV in the bay fishery. As rents offshore become positive, gulf vessels enter the fishery. Increased number of landings cause the number of FTEV to increase which causes rents to decrease and become negative. FTEV offshore oscillates upward to catch the continuously increasing amount of shrimp entering the Gulf, but rents oscillate around zero due to open access in the gulf fishery. By the end of the 50th year more then 200 additional vessels have entered the Gulf shrimp fishery off Texas.

As licenses are removed from the bay shrimp fishery, the average price of a retired license increases from just under $4,000 in year 1 to over $17,000 in year 50. Because of rising license prices, a decreasing number of licenses are purchased each year.

Increased License Surcharge:

When the license surcharge is increased, the number of bay fishery FTEVs falls below the initial 1,131 value in year 9 when the surcharge is raised to $75, in year 7 when the surcharge is $125, and year 5 when the surcharge is $175. In the $25 base scenario, the number of FTEVs did not fall below 1,131 until year 16. At year 16, the number of FTEVs is 1,126 at the $25 surcharge level, 954 under the $75 surcharge scenario, 865 under the $125 surcharge scenario, and 827 under the $175 surcharge scenario. As time progresses beyond year 16, the differences in the amount of FTEV remaining in the bay shrimp fishery among the three larger surcharge amounts tend to diminish. At the end of the 50-year time frame all three alternative surcharge quantities yield FTEV numbers significantly smaller than under the base scenario. The FTEV numbers are lower because more funds are available to buyback licenses under the larger surcharge scenarios.

Positive rents in the fishery correspond to decreases in FTEVs under the four surcharge scenarios. Total rents in year 16 under the four-surcharge levels range from $55,000 under the $25 surcharge to $2,649,000 when the surcharge is $175. Rents, for the three larger surcharges, have tendency to converge in later years. Rents under the baseline $25 surcharge are distinctly lower than the other three scenarios.

Increasing the surcharge amount gives TPWD a larger budget to buyback licenses. Larger budgets result in higher demand for the fixed number of licenses and consequently higher prices for licenses. Successively higher surcharges result in higher license prices. For successive $50 increases in the surcharge, the decrease in the amount of time it takes to remove excess licenses only falls by two years. The incremental reduction in the time necessary to remove excess capacity from the fishery is because of the increase in the average price of a license under the two larger surcharge scenarios.

Funds Donated From Other Parties

When $500,000 per year additional funds are donated immediately (years 1-5), effort in the bay shrimp fishery falls to 895 FTEVs by year 5. If the additional funds are not available until year 16, a similar rapid decrease in effort occurs in years 16-20 such that 837 FTEVs remain in year 20. At year 20, the number of FTEVs in the fishery when additional funds are used immediately is 793. As time progresses beyond year 20, the number of FTEVs converges between these two scenarios. At year 50, the number of FTEVs in the fishery is 711 when additional funds are made available immediately and 722 FTEVs when additional funds are available in year 16.

Rents in the bay shrimp fishery become positive in year 3 when additional funds are available immediately. A rapid increase in rent occurs during the first five years to $2,129,000. When funds are withheld until year 16, rents remain at the open access level and then rise rapidly in years 16 through 20 to $2,445,000. After year 20, rents for the two alternatives are very similar to each other but are consistently higher than the base scenario.

License prices also rise at a faster pace when additional funds are made available immediately. After year 20, however, license prices under the two scenarios converge. In either case, after the additional funds are provided, license prices are higher than in the base scenario.

Conclusions

These results indicate the license limitation and buyback program can reduce the FTEV in the Texas bay shrimp fishery. While it appears under license limitation, additional shrimp will escape to be harvested by offshore fishermen, the offshore fishery will continue to exhibit the typical characteristics associated with an open access fishery which means FTEV offshore will rise, while rents oscillate around zero.

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SIGNIFICANT ISSUES IN GULF OF MEXICO FISHERIES

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Introduction

The management of fishery resources in the Gulf of Mexico has undergone significant changes since the Magnuson Act was first implemented in 1976. A major reason for these changes has been the realization that many of the highest demand and most valued fishery resources are overfished and immediate steps were needed to effectively manage and conserve these marine resources. The unwanted bycatch of some species in particular has raised the concern of many because of the waste involved and because bycatch alone can greatly affect other directed fisheries and related industries. The bycatch of sea turtles and red snapper in Gulf shrimp trawls has resulted in management actions to reduce this bycatch through the use of special devices on the trawls. The regulations and supporting scientific information requiring the use of these devices have stimulated considerable controversy throughout the Gulf mainly because of the perceived extra cost, labor, and shrimp loss caused by their installation and use.

Turtle excluder devices

The turtle excluder device (TED) regulations were promulgated under the Endangered Species Act (ESA) in June 1987 only to meet a firestorm of resistance from the shrimp industry.

The regulations were based on an extensive amount of information gained from observers on shrimp trawlers and gear research by the National Marine Fisheries Service (NMFS) in cooperation with a number of Sea Grant organizations. This information indicated there was a significant take of sea turtles by the shrimp trawl fisheries in the Gulf of Mexico and South Atlantic, but that TEDs were effective at reducing this take. Amendments to the ESA in 1988, however, required a delay in implementing the TED regulations and called for a review by the National Academy of Sciences of the science upon which the regulations were based. This study concluded that the NMFS estimates of sea turtle mortality by shrimp trawlers were low, possibly by as much as a factor of four, and that TEDs were an effective way to reduce this mortality (National Research Council 1990). The door was thus opened for a phased-in approach to requiring TEDs in virtually every shrimp trawl in the Gulf of Mexico and South Atlantic. This phase-in was completed in 1994.

However, in 1994, excessive sea turtle strandings in the western Gulf of Mexico and South Atlantic prompted examination of the TED regulations. Compliance seemed good, yet the stranding numbers exceeded anything previously recorded. Compliance was evaluated through the use of gear specialists accompanying Coast Guard boarding parties, and the possibility of some TEDs being less effective than others was addressed through special studies involving scuba divers observing interactions of headstarted sea turtles with shrimp trawls equipped with various TED designs and installations. These evaluations and studies demonstrated there were problems with some of the existing TED designs and installations especially in areas where turtles were subjected to multiple captures and with some of the enforcement effort. Improved enforcement was addressed in cooperation with the Coast Guard and several state agencies through a revised and improved training program. Additionally, a special NMFS TED Enforcement Team was formed equipped with special boats and other equipment to allow enforcement officers to board shrimp trawlers with less opportunity for prior detection.

The less effective TED problems were addressed through designation of special sea turtle conservation areas in the Gulf and South Atlantic. These areas were where most of the strandings were occurring and where specific gear restrictions, such as shortened flaps on bottom opening hard TEDs, should be effective at reducing the strandings. Soft TEDs also were prohibited past 1997 because of turtle tangling problems, although an interim rule was published in early 1998 that allowed the use of a significantly modified soft TED in a limited number of trawl designs and sizes. Overall, the reaction of the shrimp industry to the revised regulations and enhanced enforcement efforts has been good.

Red snapper and Bycatch Reduction Devices

Red snapper are a popular and valuable fishery in the Gulf of Mexico. They are, however, seriously overfished. Sources of fishing mortality include a large bycatch of juvenile red snapper in shrimp trawls and the directed commercial and recreational fisheries. The bycatch of red snapper has been the focus of a major cooperative research program since 1992 that has involved participation by the shrimp industry, directed red snapper fisheries, state agencies, and environmental organizations. The study was required by the 1990 re-authorized Magnuson Act, which had also prohibited the Gulf of Mexico Fishery Management Council and NMFS from promulgating any red snapper bycatch regulations for three years. The three years was later extended an additional year.

Red snapper first came under management by the Gulf of Mexico Fishery Management Council in 1984 when the fishery management plan for reef fish was approved. This plan did little for red snapper except to recognize there might be an overfishing and a bycatch problem, and to set bag and size limits for the fish. It was not until the 1990 assessment that the seriousness of the overfishing problem was fully realized, and bycatch was identified as being a significant contributor to the problem (Goodyear and Phares 1990). The congressional moratorium prevented the Council from dealing with bycatch initially so most of the management measures dealt with the directed fisheries. In late 1996 after the moratorium had expired, the Council voted to implement Amendment 9 to their shrimp management plan, which required NMFS-certified bycatch reduction devices on most shrimp trawls in Federal waters west of Cape San Blas, Florida. The criterion specified for certification was a 44 percent reduction in red snapper mortality compared to a base 1984-1989 period. The final rule requiring BRDs was implemented May 14, 1998 following a 30-day cooling-off period.

The Magnuson-Stevens Act of 1996 contained a number of requirements related to red snapper including an external peer review of the research results used by the Gulf Council to formulate their management plans. This review was completed in 1997, and the results were presented to the Gulf Council in January 1998. Essentially, the review concluded there were some deficiencies in the databases, but the science was adequate for sound management decisions (MRAG 1998). Furthermore, the peer reviews recommended the bycatch and total allowable catch (TAC) for red snapper be reduced.

The Gulf Council, however, voted to maintain the red snapper TAC at 9.12 million pounds. They based their vote on a belief that new information presented to the Council by NMFS on BRD performance (Watson, et al. 1997) justified keeping the unchanged TAC because BRDs would reduce juvenile red snapper bycatch mortality by 60 percent instead of the 50 percent level advised by NMFS. At the higher reduction level, the most recent 1997 red snapper stock assessment indicated that TAC could be allowed to stay at 9.12 million pounds and still achieve a 20 percent spawning potential ratio by 2019, which are the recovery level and date specified in the management plan (Schirripa and Legault 1997). The secretary of commerce, however, subsequently published an interim rule that accepted the Council's recommended TAC, but reserved a portion of it until September 1, 1998 when it would be determined if it was reasonable to expect BRDs to perform at the

60 percent or higher level. The data for this determination would be collected from the middle of May 1998 to the middle of August 1998 as part of a larger research program designed to address this particular question along with responding to a number of the database needs raised during the 1997 peer review. If bycatch reduction was at least 60 percent, the full reserve of 3.12 million pounds would be released. If the reduction was between 50 and 60 percent, then only a proportional amount of the reserve would be released.

Besides the interim rule outlining how the red snapper TAC would be handled in 1998, two more interim rules were also published. These rules certified two additional BRDs that appeared to have improved bycatch reduction potentials and placed several mandatory requirements on the shrimp fleet to accept observers, logbooks, and vessel monitoring electronically. These particular requirements were made mandatory because of strong recommendations from the peer review panel to use randomized sampling in the bycatch and BRD evaluation studies.

Summary

Bycatch continues to be a significant problem in the Gulf of Mexico. It is not a problem just limited to the shrimp fishery as all fisheries experience some bycatch. With the shrimp fishery, technological modification of the trawl gear appears to be a logical management option for a number of the bycatch species. Other approaches, however, have been and should continue to be considered. With a number of the other fisheries, the solutions to bycatch problems may have to be found in more drastic approaches such as individual and fleet quotas and closed areas and seasons.

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PROBLEMS AND SOLUTIONS CREATED BY USE OF TEDS AND BRDS IN THE GULF OF MEXICO

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Introduction

Considerable transition has occurred in the offshore shrimp fisheries of the Gulf of Mexico during the last three decades. Loss of foreign fishing grounds and expansion of resource management measures are but two factors that have greatly influenced and impacted the traditional shrimp fishery. Although these changes have affected certain operators, the southeastern shrimp fishery continues to land more than $500 million in product and remains the most valuable fishery in the United States .

During recent years fisheries throughout the world have been placed under indictment for overexploitation. Although concerns regarding overfishing of shrimp occasionally are expressed, the penaeid shrimp fishery in the Southeast differs from all other marine fisheries in North America because of its annual cycle. Commercially important shrimp in the Gulf of Mexico are able to reach sexual maturity and spawn within a year. Because of rapid growth and a high degree of fecundity (shrimp spawn hundreds of thousands of eggs), the resource has maintained population stability throughout its exploitation. Environmental conditions in the nursery grounds (estuaries) during periods of larval and juvenile shrimp recruitment seem to impact annual shrimp numbers more than any other variable. It is interesting to note from the following table (Fig. 1) that an exceptional shrimp crop may be followed by be a very poor one and vice versa. Landings may vary from year to year, but production has remained fairly constant over the past several decades.

Although the shrimping industry has enjoyed a long-term sustainable fishery, other dilemmas, especially bycatch, have posed major obstructions to the industry and have required a significant amount of effort by managers and fishers in addressing

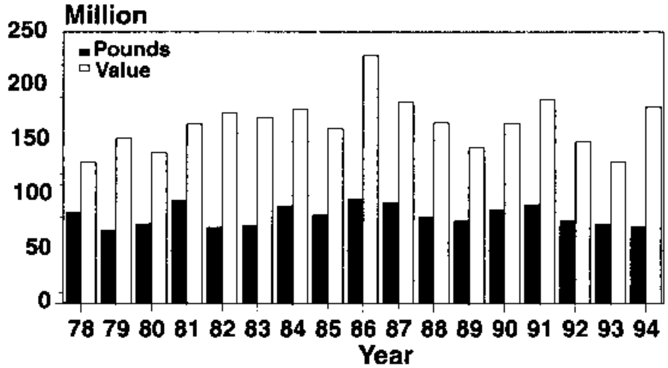


Figure 1 - Landings and Ex-Vessel Value of Live Shrimp (live weight basis)

these concerns. Endangered sea turtles were a major issue in the shrimping industry during the 1980s and concerted efforts focused toward conserving sea turtles impacted by trawls. In the 1990s, bycatch has become a major environmental concern not only to the Gulf shrimping industry but to fisheries throughout the world. The shrimping industry is now confronted with major challenges regarding finfish exclusion from shrimping nets, and problematic areas still exist with the use of both Turtle Excluder Devices (TEDs) and Bycatch Reduction Devices (BRDs).

From a positive standpoint, recovery of the Atlantic Kemp's Ridley turtle (*Lepidochelys kempi*) appears to be undergoing exciting progress, and recent studies indicate remarkable increases in loggerhead sea turtles (*Caretta caretta*) encountered in the wild. The following discussions expound on the use of TEDs and BRDs in the Gulf shrimp fishery and define some of the challenges that still exist for refining these gears.

TEDs

No issue has been as contentious to the Gulf shrimping industry as TEDs. The shrimping industry expressed tremendous concern regarding use of TEDs for sea turtle conservation in the mid- and late 1980s. Since that time, some progress has been made relative to establishing usable gears that protect sea turtles and allow industry to continue to harvest shrimp. The National Marine Fisheries Service (NMFS) and Sea Grant have worked closely with industry in developing and certifying TED types that are more acceptable to shrimp fishermen. Today, a shrimp fisherman has a variety of devices from which he can select for use in trawls, and efforts are being directed to certify more gear types.It has become apparent that certain TED-types are more effective in different fishing areas. A particular TED that works well for one fisherman may not be acceptable to another. A shrimp fisherman fishing in the South Atlantic may be able to utilize a style of TED that would in no way be effective for shrimp retention in the western Gulf of Mexico.

Years of trial and error have ultimately resulted in TED styles that are more practical for fishermen in a given locale. This should not imply that problems do not exist. Several dilemmas impacting shrimp loss through TEDs continue to plague the shrimping industry. Shrimp loss is associated with all designs of TEDs, but certain phenomena exist, which at times, result in catastrophic deficits. One of these problematic areas relates to angle changes in bottom-excluding rigid TEDs (the most popular deepwater excluder). A weak spot exists in the area of the escape hole. It is common for large objects or volumes of mud to enter into the trawl. When the weight of heavy objects or mud is lodged against the deflector bars of the TED, the meshes of the webbing adjacent to the TED are subjected to tremendous strain. This often distorts or tears the netting and changes the angle of the deflector grid. When the angle of the deflector bars is altered, much of the trawl catch is directed out of the escape hole of the TED. This recently occurred during cooperative Industry/Sea Grant work being performed offshore, and it cost the vessel at least $800 of shrimp catch for a night. It should be noted that it required an experienced crew about one and a half hours to reinstall the grid at a corrected angle. This occurrence is one of the most problematic to industry. Attempts are being made to utilize "rib" lines to reinforce the grids. A number of operators are converting to extra-large grids in hopes that it will assuage the angle dilemma. Thus far, nothing appears to completely solve this problem.

Another concern regarding TEDs relates to seaweed and other debris. In the spring of 1998, heavy rains caused flooding in Louisiana. This flooding deposited large quantities of freshwater vegetation offshore. Numerous fishermen reported significant losses of shrimp because of clogging problems on the grids of the TEDs. Some fishermen indicated losses of more than 50 percent until the vegetation abated. Similar experiences have been encountered when annual deposits of Sargassum seaweed appear on the shrimping grounds. To date, we have no effective means to address the clogging issue of TEDs even though it has been a periodic problem since their use was initiated.

In spite of these problems, the majority of industry continues to utilize TEDs. Compliance rates indicated by the U.S. Coast Guard appears to be at the 99 percent level. An even more positive note is seen in the increase of Kemp's ridley nests in Mexico - its primary terrestrial habitat. The average of 800 nests per year from 1978-1988 has now grown to just over 3,000 in 1998. Hopefully, this trend will continue and optimism will prevail.

BRDs

Notwithstanding concerns regarding worldwide overfishing, bycatch may be the largest environmental issue relating to fisheries in the 1990s. The southeastern shrimping industry is one of the many fisheries that has been identified as having a problem with non-targeted finfish species. Substantial efforts have been directed toward investigating and solving the bycatch problem in the offshore shrimp industry.

In the early 1990s, a concerted effort was directed toward

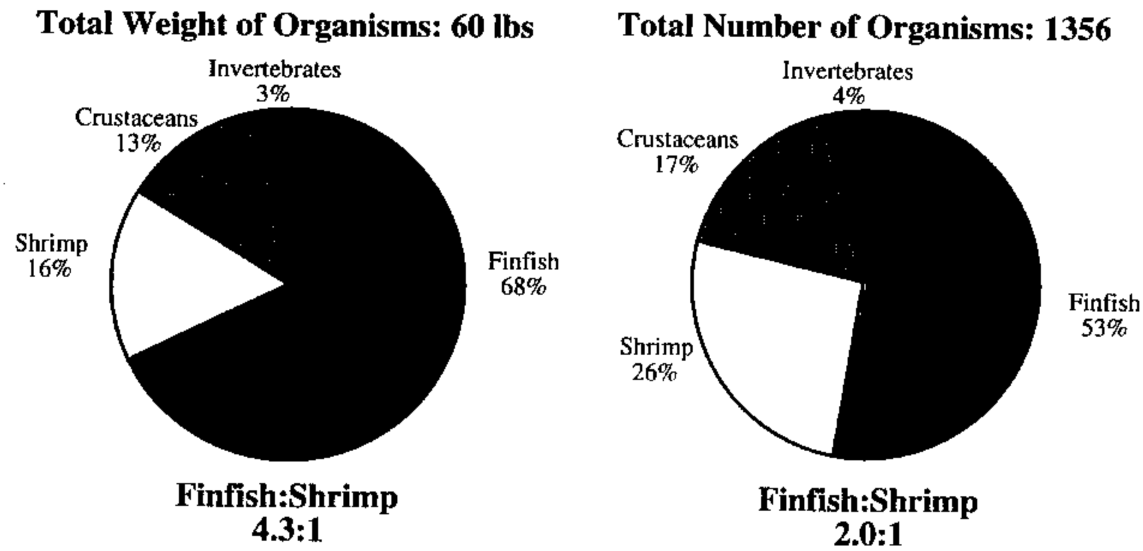


Figure 2 - Average shrimp trawl catch per hour in the Gulf of Mexico

characterizing the catch of offshore shrimping operations. A scientific protocol was developed by NMFS to standardize procedures for these investigations. Certified NMFS and industry observers (through the Texas Shrimp Association and Gulf and South Atlantic Fisheries Development Foundation, Inc.) were deployed throughout the fleet to document bycatch during actual fishing conditions. This cooperative effort between industry and government has clearly been the most significant in the history of the southeastern shrimp fishery. Thousands of tows have been recorded and analyzed. This has resulted in the most comprehensive data base ever established for shrimp trawl bycatch. Figure 2 indicates a summary of these investigations. The catch composition was established as 4.3:1 ratio of finfish to shrimp by weight and 2.0:1 by number.

Of particular concern to fisheries managers regarding shrimp trawl bycatch is the incidental take of juvenile red snapper in the offshore shrimp catch. Presently, the red snapper resource in the Gulf of Mexico is a particular problem. At one time, stock assessments of these fish indicated severe overfishing. The extreme pressure of both commercial and recreational fisheries is further compounded by the incidental harvest of numerous small snapper in Gulf shrimp fishery trawls. Research indicates juvenile red snapper to be highly susceptible to capture in shrimp trawls. While large quantities of these juvenile fish are not usually harvested in individual tows, the Gulf of Mexico Fisheries Management Council indicates that collective capture by the trawlers fishing in the Gulf has a definite impact on recruitment of this species. Estimates from 1993 relate that approximately 35 million juvenile red snapper were incidentally harvested by gulf shrimp trawlers.

Mandates to reduce the take of juvenile snapper in the shrimp fisheries were enacted in 1998. This follows considerable effort directed toward developing, evaluating and certifying workable BRD-types for the shrimp fishery. The Harvesting Branch at NMFS's Pascagoula Laboratory has evaluated almost 100 BRD prototype designs for feasibility . From these candidate BRDs, extensive tests have been conducted that are segmented into various phases of development, i.e. proof-of-concept, operational testing, BRD certification, etc.

Industry, through the Gulf and South Atlantic Fisheries Development Foundation, Inc. and Sea Grant, has been instrumental in testing these gears through cooperative at-sea efforts. Operational testing aboard commercial fishing vessels with trained observers has been extensive. BRDs are installed into at least one trawl and compared to a control net -- with no BRD -- under actual fishing conditions. Thousands of comparative tows have been conducted.

With the onset of the 1998 shrimping season, only two BRD types have been tentatively approved for bycatch reduction in federal waters of the Gulf of Mexico. These gears are the fisheye BRD and the Jones/Davis BRD (Fig. 3).

Both of these gears have potential for the reduction of larger juvenile red snapper (year class 1). The fisheye BRD has been shown to reduce take of these small fish by as much as 40 - 50 per cent. The Jones/Davis BRD has been more effective with snapper reduction (up to 70 percent), however it is a more complex gear and has been prone to clogging in areas containing seaweed, soft jelly or other debri. Under these unfavorable conditions, shrimp losses can be excessive.

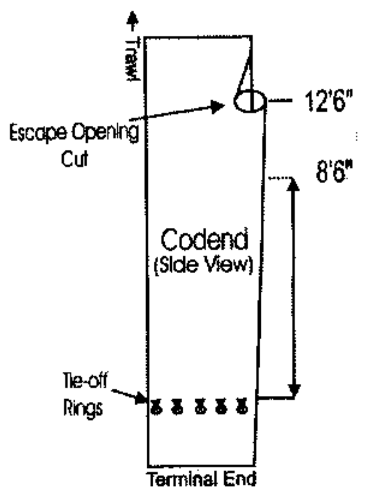
Only minimal success has been achieved in reducing the very small (year class 0) red snapper with any BRD. Because of their weak swimming abilities, these fish have presented a dilemma with attempts to exclude them from the catch. Biologically, they are less important than their year class -1 counterparts because of high, natural mortality rates.

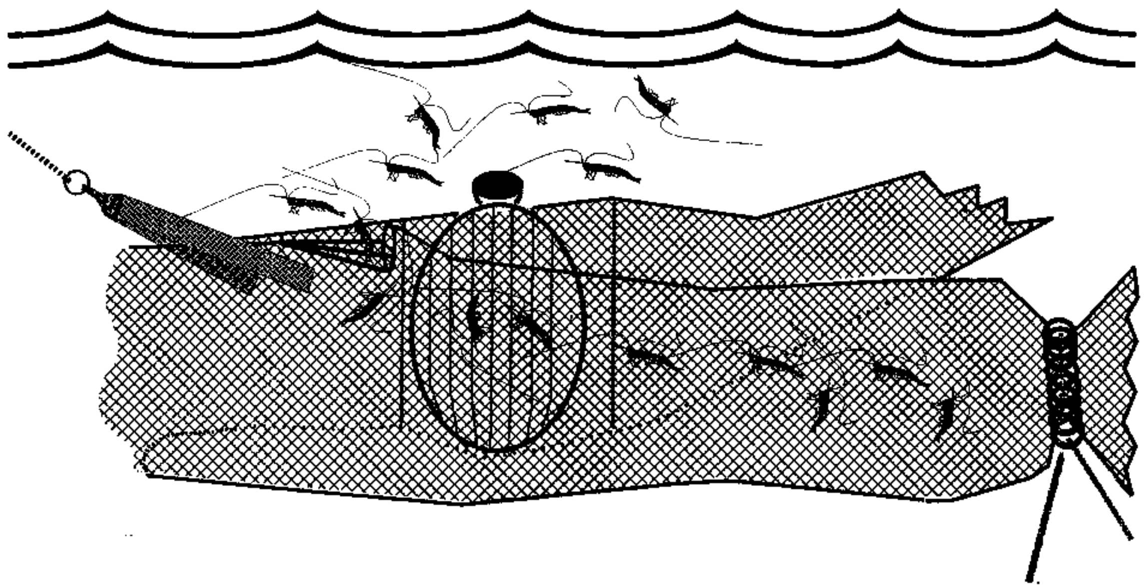
In some cases, very favorable performance from both gear types has been experienced. Conversely, conditions can prevail that contribute to excessive shrimp loss. Factors that have been identified relate to:

- low/restricted tow speeds < 2.3 knots
- slow winch retrieval
- small cod ends (80 - 100 meshes)
- much required turning
- strong tides
- debris, crab traps, jellyfish
- choker straps
- BRD too far back
- rough weather

Studies conducted by Texas Sea Grant have involved placement of high-tech underwater video recorders near the fisheye BRD. During tows on the fishing grounds, observations have been made regarding these factors contributing to shrimp losses. A major area of shrimp loss was identified during gear retrieval. Shrimp were seen flushing from the bags during this time. Through modification of retrieval systems, a solution to this type of shrimp loss was identified.

Much opportunity exists for the development of BRD technology. In spite of dedicated efforts to develop BRD types, progress has been slow. Gears that have proven to successfully remove finfish from the trawls have also been found to contribute to unacceptable shrimp losses. Because offshore shrimping is primarily conducted at night,finfish exclusion also is hampered (it is generally thought that fish can more easily escape through a BRD during lighted conditions). The small sizes of red snapper which interact with shrimp trawls further complicate the issue because of their weak swimming abilities. Despite these impediments, coordinated efforts continue to be directed toward achieving gear that effectively removes unwanted bycatch from the trawls while retaining the shrimp catch.





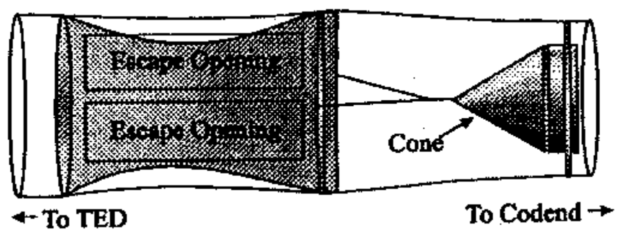


Figure 3 - Bycatch Reduction Devices.
Jones/Davis BRD (top left); installed BRD (top right); fisheye BRD (right).

MEXICO'S BAN ON THE TURTLE FISHERIES

SUCCESS STORY - MEXICO'S BAN ON THE TURTLE FISHERIES

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Introduction

Sea turtles are remarkable animals: they take decades to mature and may live for half a century or more; they migrate and disperse over vast areas of the planet, living in a wide variety of environments, from dry land to high seas - in many societies they are highly charismatic. Today, there is no legal fishery for turtles in the Gulf, so why spend part of our limited time on a very restricted topic - Mexico's ban on sea turtle fisheries - when there are so many other complex, pressing issues to consider during of Congress, and these complicated animals appear to have no direct relevance to human well-being? Understanding the history of the human-sea turtle relationship in the Gulf will provide a valuable frame of reference as well as benchmarks for understanding how we got to where we are with marine resources in the Gulf of Mexico. If we act wisely, using what has happened in the past as a lesson, we should be able to avoid many problems in the future.

Perceptions of the Gulf of Mexico

The first thing to reflect on is just what we mean by the Gulf of Mexico. There are several ways to perceive this term: a restricted body of water shared by Mexico and the U.S.A.; an indentation on the south-east of the North American Continent; or a body of water connected with the Atlantic Ocean, via the Caribbean. Clearly, the Gulf of Mexico is all of these, and sea turtles will help to explain why this is so, and why this issue is relevant.

Historic use of sea turtles along the Gulf and Atlantic coasts of the U.S.A.

There were once important fisheries for sea turtles throughout the Gulf of Mexico and all along the Atlantic coast of the U.S.A. All but one of the native species are recorded in government fisheries statistics, involving at least 10 states, from Massachusetts to Texas, including Puerto Rico, and the use of at least 10 different types of gear (Witzell, 1994 a & b). As many as 1,300 tons of turtle landings were reported in a single year, and the average annual value over a period of nearly a century was about 10 tons (Witzell, 1994b). If the average sea turtle weighed 50 kg, this would indicate as many as 26,000 turtles in a year, with a long-term average of 200 a year. However, as with any fisheries figures, these catch statistics must be interpreted with caution; in nearly all cases turtle landings are underestimates. Remarkably, the records indicate that New Jersey had nearly half as many landings as Louisiana - although the latter ought to have far more sea turtles than the more northern state. Texas provided almost 17 percent of the total, and nearly all of this was from two years - 1890 and 1897. Landings from the state of Florida are nearly 75 percent of the total.

Sea turtles were a source of meat, oil and tortoise shell, and they provided local subsistence at an affordable price, being important in the economy and culture of many coastal communities in the U.S.A. (Witzell, 1994b). Indeed, 150 years ago soldiers in Florida complained about the monotony of eating sea turtle meat (Samek, 1998). Some fisheries, such as in Texas, were intense but short-lived. By the end of the 19th century, there were numerous warnings of declines, but few, if any, restrictions were put on the exploitation of these reptiles. When local stocks became decimated, turtle fishermen went to Latin America for turtles. In the case of Florida, they went to the West Indies, Nicaragua and Costa Rica; in the case of Texas, they went to Tampico, Mexico (Witzell, 1994a & b; Samek, 1998).

Sea turtle fisheries were legal in the U.S.A. until 1975, when the Endangered Species Act (ESA) was implemented. However, the ESA did not end exploitation, and there has been a continuing black market for meat and eggs, especially in Florida, including rings of poachers, some with a level of organization comparable to that of drug traffickers. Today, there are clear laws protecting sea turtles in the USA, but many state and federal officials - including judges - are inadequately informed about these laws and why they exist (Samek, 1998).

Sea turtles in Florida, and elsewhere in the U.S.A., are now on the increase; and remarkably, these animals have now become a valuable resource that is not directly consumed. In 1993, some 10,000 people participated in organized turtle watches in just the state of Florida (Samek, 1998). Direct (illegal) exploitation, indirect exploitation (namely incidental capture), and habitat destruction are still problems. Yet, there has been a clear evolution of the relationship between people and sea turtles in the United States: from the growth of a commercial fishery, to intense exploitation, then decimation of local stocks, importation of foreign stocks, strict protection of the resource nationally and now recovery and non-consumptive utilization. This all bears on the past and present status of sea turtles in neighboring Mexico, for not only are the sea turtle stocks shared, but economic, social and political events in the U.S.A. have a direct and profound impact in Mexico.

The situation in Mexico

The government of Mexico has provided legal protection for various species of sea turtles for decades, but the 1990 ban (the subject of this paper) is the most broad-sweeping measure ever taken; it was of great consequence, with important benefits as well as risks. The ban provides a legal reprieve for sea turtle populations which have been subjected to decades of heavy exploitation, and many of which have undergone drastic declines. Socially, the ban drives home the need for all members of Mexican society to take drastic measures to protect marine resources; yet, passing broad-reaching laws without adequate means of enforcement, risks undermining credibility and civilian collaboration.

There is a strong temptation to discuss the sea turtle situation in the Pacific, since there the numbers are much larger and more dramatic. However, this conference is about the Gulf of Mexico, and two case studies that are especially relevant are Kemp's ridley turtles, which nest in the state of Tamaulipas, and Hawksbills, which nest in the Yucatan Peninsula. The increases in nesting records for both species over the past few years are reason for optimism. Yet, these trends apparently have nothing to do with the 1990 ban, and there are clear problems with the way in which the protective laws have been implemented.

Kemp's Ridley Nesting Population: Kemp's ridley is the sea turtle most typical of the Gulf of Mexico: post-hatchlings and adults of this species, as well as virtually all nesting, are restricted to the Gulf. This, the most endangered of all sea turtles, provides a clear example of how a species that has declined drastically, perhaps to 100th of its former size, can stage a recovery.

In 1947, the main nesting beach was discovered from a cine film of a massed nesting; an estimated 40,000 turtles were on the beach at one time then. By the 1980s, less than 800 turtles were nesting in an entire nesting season. There has been strict control of the nesting beach for more than three decades; a bi-national, multi-institutional endeavor for the past two decades, with thousands of man-hours, and hundreds of thousands of dollars (Marquez, 1994; Frazier, in press). Now the nesting population seems to be in the early phases of recovery (TTEWG, 1996).

Major events related to the status of these turtles include more than beach protection; there have been significant developments offshore of the nesting beach. As inshore shrimp fisheries were decimated, the brown shrimp (*Panaeus aztecus*) fishery expanded, and concurrently Kemp's ridleys declined. This was followed a decade later by dramatic changes in fishing activity in Mexican waters: implementation of the Exclusive Economic Zone led to a reduction of U.S. shrimping in Mexico. Trawling efficiency devices (or turtle excluder devices, "TEDs"), were also developed and implemented during this period (Frazier, in press).

Kemp's ridleys are typical of the Gulf of Mexico, but they are not limited to it. Juveniles occur regularly along the Atlantic seaboard of the U.S., as far north as New York and Massachusetts. They have been found in European Atlantic waters, and some individuals may circumnavigate the North Atlantic before returning to Mexico to nest. Hence, recovery of the population nesting in Mexico is dependent on the situation in waters of the eastern U.S.A. and possibly even western Europe.

The increase in Kemp's ridley nesting began before the 1990 ban was enacted. How much legal, or illegal, exploitation of Kemp's ridley has occurred during recent years is unclear. U.S. customs records show that between 1983 and 1989 - when the species was fully protected in both Mexico and the U.S.A. - skins were supplied to a very active market for exotic animal skins (Teyeliz, in prep.). However, by 1990, illegal trade in Kemp's ridleys seems to have at least dropped to a barely significant level - again, before the 1990 ban took effect. Nonetheless, this ban has served to fortify earlier legal protection for Kemp's ridley.

Hawksbill Turtle: The Yucatan Peninsula forms the southern shore to the Gulf of Mexico, and it is one of the most important nesting areas for hawksbill, or tortoise-shell, turtles in the world. Records of nesting hawksbills have greatly increased over the past few years; remarkably, the increase seems to begin in 1990.

This change occurred within a regional context, which needs to be understood. For most of this century, there has been an intense harvest of hawksbills in Cuban waters. The tortoise-shell was exported widely, to numerous countries in Europe and the U.S.A., but during the last decade, nearly all of the tortoise-shell in Cuba has been exported to Japan. Immediately after the Japanese stopped legal importation of tortoise-shell, the harvest in Cuba dropped from more than 250 to less than 50 tons (Carrillo et al., 1997). At the same time as exploitation was declining, nesting records of hawksbills in the Yucatan Peninsula began to increase (Pronatura, 1998). Hence, there is a clear inverse relationship between the reduction in the Cuban harvest and the increase in nesting records in Yucatan. Little is known about the migratory movements of hawksbill turtles in Cuba and Mexico, but during recent years, it has become clear that these turtles can move large distances, and there have been several records of movements between Mexico and Cuba.

So, as in the case of Kemp's ridley, the apparent increase in the Yucatan hawksbill population is not directly attributable to the 1990 ban. Indeed, hawksbill turtles in Mexico have been legally protected since 1971, even though this law has rarely been enforced.

Records of traffic in sea turtle products in Mexico and the U.S.A.

Even a cursory look at traffic records shows that a large number of sea turtle products continued to be traded in Mexico well after the 1990 ban. Since the late 1960s, Mexico has been a major world supplier of sea turtle skins, most of which have come from olive ridleys in the Pacific. By the 1980s, this market dropped well below former levels, but skins and manufactured articles continued to be exported until at least 1995 (Teleyliz, A.C. in prep.).

There is no question at all that there is ongoing illegal killing of sea turtles, and in some cases it may involve significant numbers of turtles. For example, in just one village in Baja California Sur, estimates indicate that two to five tons of turtles are caught per week, which may be as many as 800 to 2,000 turtles per year (Teleyliz, A.C. in prep.).

A major part of the manufactured materials made from turtle skins is cowboy boots; and there is clearly a thriving market for turtle-skin cowboy boots both within Mexico and from Mexico to the U.S.A. This market occurs despite national laws in both Mexico and the U.S.A. and also in contravention to international treaties such as CITES (Teleyliz, A.C. in prep.). Remarkably, even the most endangered of all sea turtles, Kemp's ridley, is included in this illegal trade. For example, over the past few years, skins and manufactured articles of this turtle have repeatedly been confiscated during export from Mexico into the U.S.A. Apparently, there have been no further records after 1990. Given that the US Customs Department may apprehend less than 10 percent of the illegal trade, and this figure only considers illegal imports into one country. The volume of black market is clearly much greater than the official numbers of seizures (Teyeliz, A. C., in prep.).

Even the hawksbill, strictly protected in Mexico since 1971, is the basis of an on-going black market. Between 1976 and 1990, nearly 10 tons of tortoise-shell are known to have been exported from Mexico, with nearly twice as much reported to have been imported. It appears that Mexico may serve as a regional (illegal) clearing-house for tortoise-shell. In addition, hundreds of skins and manufactured articles of hawksbills have been confiscated on being exported from Mexico to the U.S.A. For the reasons mentioned above, the true volume of the black market must be much greater than the numbers indicate (Teyeliz, A. C., in prep.).

Economic and political realities

Major budget cuts (due especially to the fall in petroleum prices) as well as intense problems with forest fires in Mexico, have left less than the usual financial resources available for conservation, enforcement, and other related activities (CTURTLE, W. J. Nichols, 4/28/98). Further economic pressures are global in scale. With neoliberalization in full swing, many former government assets and functions are now being sold or ceded to the private sector. As an example of the neoliberalization of the Mexican environment, people and organizations who do conservation and research on sea turtle nesting beaches must now file for a federal concession to the beach property, which requires extensive documentation and development plans.

The Secretary of Environment, Natural Resources and Fisheries (SEMARNAP) has publicized a proposal to modify national legislation to allow for commercialization of endangered species, including sea turtles. SubSecretary Villalobos is quoted as stating that bans do not contribute to the recovery of endangered species, and what is needed is for the communities directly involved in the use of the resources to receive benefits and become responsible for the stewardship of the resource (CTURTLE, Teyeliz, 5/5/98). Clearly, all of this translates to intense pressure to terminate the ban and resume legal exploitation of sea turtles and their habitats.

Conclusions

As has been seen, simply passing a decree banning exploitation does not automatically change consumption practices - especially in subsistence-level and underprivileged communities that have a long history of turtle exploitation. There are clear costs in such a comprehensive prohibition, for it can discredit federal authorities in the eyes of rural communities, to say nothing of adding one more sweeping law for which enforcement is nearly impossible. For example, coastal inhabitants of the states of Michoacan, Guerrero and Oaxaca are convinced that sea turtles are disappearing because ex-President Carlos Salinas de Gortarri sold the fishing rights to Japanese interests. The coastal inhabitants of Mexico reason that the tremendous investment in sea turtle camps throughout Mexico is to grow more turtles so that the Japanese will have more to catch (Barragan, pers. com.).

The ban on sea turtle catching did not improve collaboration with fishermen; indeed, some conservationists consider it a lost opportunity to enlist support of fishers. In some ways, it sets up a situation of more conflict, pitting officials (some of whom are known to benefit directly from the illegal turtle fishery) against fishermen (who have a long tradition of consumption and commercialization of sea turtles).

Clearly, the ban was an end to the large, governmentally approved quotas that occurred in the Pacific, routinely allowed - despite scientific advice - because of intense political pressure. Important as this may be, it is not directly relevant to the Gulf of Mexico. More relevant to the Gulf, the ban removed a major loophole for illegal traffic in turtle products.

Since all traffic is now banned, traffickers have no way of hiding an illegal product together with a potentially legal product.

Given the long life span of sea turtles, the success of the ban can only be evaluated after at least 10 to 15 years. Any changes in numbers of turtles before that period would be difficult to attribute to a ban on harvesting.

Finally, it has to be understood that sea turtles are threatened by far more than direct exploitation. In the case of the Gulf of Mexico, there are diverse, serious threats, some of which may surpass the intentional taking of sea turtles. The construction of an intercoastal waterway between the United States and Tampico would have tremendous impacts on coastal environments critical for Kemp's ridley. Increased mechanized fishing activities (especially trawling) as well as pollution and coastal development also are of grave consequence to sea turtles. Sea turtle conservation must be multifaceted and integrative, and in many cases, bans on certain activities must be part of the overall conservation strategy.

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EVOLUTION OF THE TURTLE FISHERY AND ITS CONSERVATION

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In México we have 10 of the 11 kinds of sea turtles, and nine of them have breeding populations. Only the Pacific Loggerhead, *Caretta c. gigas*, does not nest in our beaches, and the Flatback of Australia (*Natator depressus*) is absent. All of them have special particularities, but two, at the present, have the highest contrast in abundance, the Olive Ridley (*Lepidochelys olivacea*) and the Kemp's ridley (*L. kempii*) at present the most and the least abundant in the western hemisphere. The extinction of the species is a natural process that occurs in geological periods, and history is full of examples before the man-kingdom appears in the world, but man is the only creature that accelerates such a slow process.Then we will analyze specially the management and abundance of these two very important species, with special emphasis on the Kemp's ridley of the Gulf of Mexico.

In general, the sea turtles have distinct biological traits that are important for their administration as a resource. They are tropical and subtropical dwellers, have high fecundity and high mortality, slow growth rates and delayed maturity -- between one or two decades -- and because of this life cycle, **in the sea** they have high vulnerability to massive fisheries (bycatch), like: trawling, longlines, gill-nets, etc. They are also affected by contamination (oil, chemicals, light, wars, etc.) and debris or littering with high content of plastics and **on the land** the quality of the nesting beaches are affected by multiple factors. Finally, the turtles are also directly harassed by poaching, with the economic targets being their skin, meat and eggs.

The sea turtles have been exploited for centuries, but less than 40 years ago the international market was expanded extraordinarily, in such a way that in no more than two decades nearly all the important colonies were depleted. On the international scene, the fishery in México grew rapidly (Figure 1) from two to 14.5 thousand tons (over 90 percent from Pacific Olive Ridley), between 1963 and 1968 and then rapidly decreased to less than half by 1970. Consequently, some of the populations were markedly depleted. To correct this situation, between 1971 and 1972 a total ban was declared (Figure 2). After that, the fishery was reorganized and since 1973 permits were allowed only to fishermen who were organized into unions. At the same time, protection was increased through a "big net of turtle camps" on the nesting beaches. In spite of such a large effort, the poaching of eggs and adults continued, and many other populations were decimated with the consequent loss of the majority of beaches bearing big breeding arrivals, called in Spanish "arribazones."

Besides multiple regulations, started in the '20s, with the prohibition of egg consumption, catch closures, minimum carapace size, etc., one of the most important actions has been beach protection through "turtle camps," which started in 1966, after a short training in Tortuguero, Costa Rica, in 1964, under the guidance of Dr. Archie Carr. However, the very first "camp" was settled in Isla Mujeres and directed by M.C. Dilio Fuentes, in 1963. After surveys, most important nesting beaches in the country were recognized in 1966: at Rancho Nuevo, Tamaulipas and at Boca de Pascuales-Apiza, Colima, turtle camps were established. The next year the number of camps increased with the establishment of Playón de Mismaloya, Jalisco, Piedra de Tlalcoyunque, Guerrero and La Escobilla, Oaxaca. After this start, each year more camps have been installed, and nowadays, the INP has 12, the INE 11 and at least 40 more are settled by universities, state institutions and NGOs.

Currently, for the study and protection of the Kemp´s Ridley, there are three camps in Tamaulipas, which cover more than 120 km of beach, including two additional, small "satellite camps" in La Pesca and Altamira. In Veracruz, where the green turtle *C. mydas*, the loggerhead, *Caretta caretta*, and the Kemp's ridley nest, several turtle camps also are installed. The hawksbill, *E. Imbricata*, green and loggerhead also nest in the Yucatan Peninsula, and all of them are protected through official or private turtle camps.

As mentioned earlier, many of our populations have been depleted, but it is important to comment that after three decades of beach protection, several populations have shown positive trends. Two of them pertain to the Ridley group. The first, the more abundant, is *L. olivacea*, which in 1997 deposited over 900,000 nests in a seven-kilometer beach in the Pacific coast (Figure 3, page 28). The other in the Gulf of México is the most endangered (*L. kempii*), which laid 2,340 nests in 1997 (Figures 4). Other species in the Atlantic have less than 5,000 nests per year, but *C. mydas* and *E. imbricata* are also showing positive trends in their abundance.

In spite of the fact that in Mexico a subsistence and traditional use for the marine turtles has existed, especially in communities of the Pacific coast, like the Seri, Pómaro and Huave Indians, a total ban on all turtle harvesting all along the country has been applied since 1990. As a result of the protection, the ban and other facts, the recovery of populations like the "Olive Ridley" in La Escobilla, Oaxaca, has occurred in numbers so big that they surpass the historical records. Unfortunately, such abundance is a cause for disagreement now in the neighboring communities, since they are not permitted further exploitation. Consequently, frequent smuggling of eggs occurs during big arribazones. The current abundance of eggs forces one to reflect on the possibility of a rational use, considering that at least 70 percent of deposited eggs are lost by natural mortality (a rough figure for 1997 -- 63 million eggs, or over 2,200 tons of protein). Consequently, we are compelled not only to recover and protect but also to consider use of such resources, especially for those people still living in the area who still have nutritional problems.

Accordingly, considering the diversity and comparative abundance of turtle populations, it is not wrong to say that México is one of the most important countries in the world for sea turtles. As a consequence, the government continues to worry about how to solve the future relationship between turtles and man.

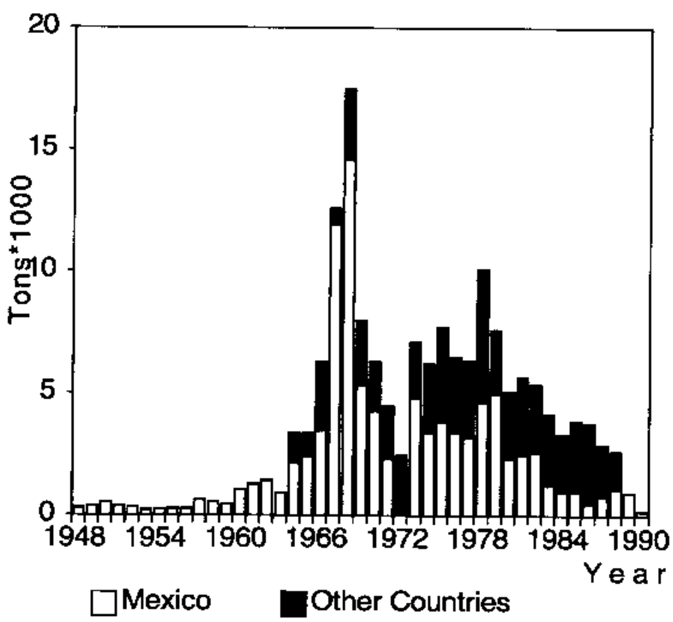

Fig. 1.- Comparison between sea turtles capture in México and the world

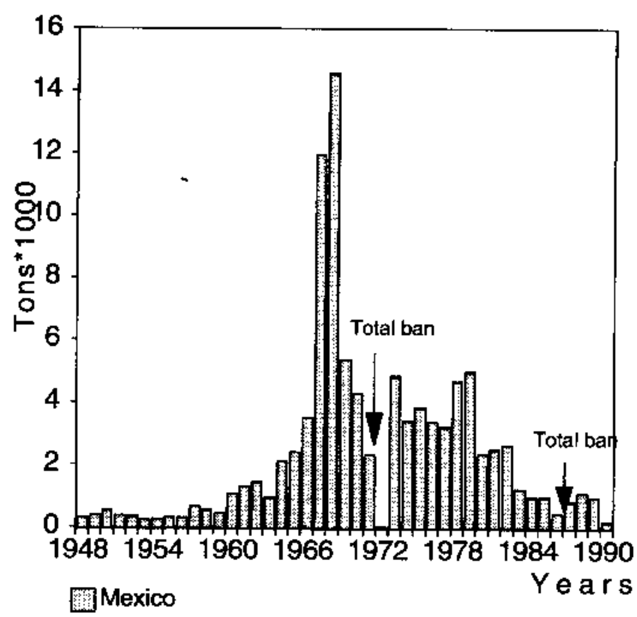

Fig. 2.- Annual capture of sea turtles in México

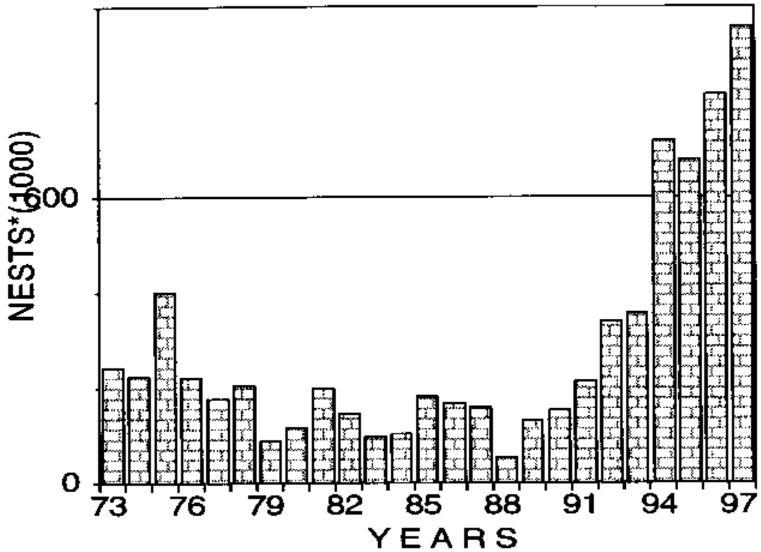

Fig. 3.- Annual number of nests laid in La Escobilla Beach, Oaxaca, México.

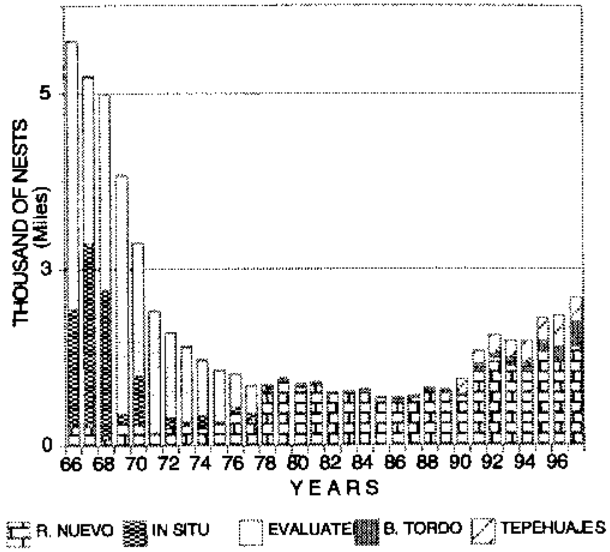

Fig. 4.- Annual number of nests laid in Rancho Nuevo, Tepehuajes and Barra del Tordo, Tamaulipas, México.

STRANDINGS, TRASH AND BEACHES

BEACH GARBAGE: POINT SOURCE INVESTIGATION PADRE ISLAND NATIONAL SEASHORE, TEXAS

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Introduction

Padre Island is a barrier island located on the southeastern coast of Texas. Created by the Congress of the United States in 1962, Padre Island National Seashore (PINS) is the longest undeveloped barrier island beach in the United States and is visited annually by over 1 million people. Although similar in many ways to other National Seashores, PINS is atypical because of the large quantity of marine debris that washes onto its shoreline (Miller et al. 1995). Historically, this was not the case, and Padre Island was known as the Texas Rivera because of its lovely, relatively unlittered, beaches. However, with the increased use of non-degradable plastics by all sectors of society, beach debris has increased proportionally. In 1988, it was estimated that Padre Island National Seashore received about 580 tons of marine debris per year — over 8.5 tons per mile (Cottingham 1988). Fortunately for the park, our marine debris research has indicated that these early estimates were highly exaggerated and, although we do receive a large amount of debris per year, it is nowhere near the early estimates (Miller et al. 1995).

An international treaty known as MARPOL prohibits dumping plastics at sea. The treaty was established in 1973; was ratified by the United States in 1987; and, has been in effect for the United States since December 31, 1988. Annex V of MARPOL specifically prohibits dumping plastics by vessels at sea. As of May 1996, 79 countries had ratified MARPOL Annex V (Sheavly 1996). However, because approximately 90 percent of all shoreline garbage items found at Padre Island National Seashore are made of plastics, we questioned whether the MARPOL Annex V regulations are working.

Sadly, the myriad of problems associated with marine and beach garbage is not restricted to PINS. From 1986-1996, volunteers participating in the Annual Texas Coastal Cleanup removed almost 4,000 tons of garbage from state beaches (S. Besteiro pers. comm.). Additionally, the Center for Marine Conservation estimated that approximately 1.5 million tons of garbage were removed by volunteers during their national shoreline cleanup in 1996 (Sheavly et al. 1997).

Today's beach-goers must not only be fearful of coming into contact with various types of hazardous materials, but they must also tolerate the offensive visual intrusion of a garbage-strewn beach (Faris and Hart 1995). Additionally, thousands of oceanic and terrestrial wildlife creatures are maimed or killed worldwide each year from entanglement or ingestion of marine and shoreline garbage (Cottingham 1988; EPA 1994; Marine Mammal Commission 1994; Faris and Hart 1995; Miller et al. 1995).

Methods and results

From 1988 to 1993, scientists at PINS collected data on types and quantities of garbage that washed onto park beaches. During that time, we employed a variety of methodologies in an attempt to determine the survey frequency and distance needed to provide scientifically valid data. The methods used included: collecting 48 months of quarterly data from six 50 x 100 meter transects; collecting 18 months of 5 days/week data from four, 50 x 100 meter transects; collecting three months of five days/week data from a transect covering eight miles of shoreline. These efforts were a component of a national program monitoring the effectiveness of environmental programs and international treaties in reducing marine debris.

From this initial five-year study, we learned that environmental factors directly influence the amount of daily debris accumulation. Researchers unfamiliar with these daily influences and resulting variability may unknowingly misinterpret data results. PINS research indicates that mathematical extrapolation of data from infrequent surveys are inaccurate. Additionally, PINS research indicates that debris collected from the backshore area of the beach, which has been accumulating over several decades, is not post-MARPOL Annex V garbage. Data collected from the backshore when combined with tidal debris data is inaccurate and does not represent the true accumulation rate.

Based on findings from each of the previous studies, methods were developed to identify and assess the magnitude of marine point source pollution in the Gulf of Mexico. Beginning in 1994, we initiated the PINS Marine Debris Point Source Investigation to identify the amount of garbage washing onto the beach from specific sources. This labor-intensive research project has required daily cataloging and removal of 43 debris items from 16 miles of shoreline within PINS. Quality control procedures were implemented on a frequent basis to ensure data collection and reporting accuracy.

This monitoring effort was initiated to obtain data required to fill many of the gaps existing in scientific knowledge related to developing research methodologies, understanding trends, and identifying point source polluters. We believe that this valuable information can be used for improving the management of marine resources of Texas and the nation.

Upon completion of this year's research season, we have now obtained over 1,000 days of marine debris data, with the vast majority of these days being consecutive. During this effort, we cumulatively surveyed over 16,800 miles of shoreline. The PINS Marine Debris Point Source Investigation represents one of the first long-term, comprehensive, marine debris research projects initiated in the United States.

Because the Padre Island National Seashore data are so extensive, both temporally and spatially, they provide a unique opportunity to investigate fundamental statistical questions related to the collection and general analysis of beach debris data. These questions can be broadly grouped into two categories: 1) survey design, and 2) data analysis. The statistical questions we are trying to answer:

- What is the magnitude of spatial and temporal variation in the PINS data?
- Is temporal variation larger than spatial variation?
- Is the spatial distribution of marine debris along the PINS shoreline homogeneous?
- How frequently should debris data be collected?
- Can factor analysis be used to identify sources of marine debris?
- What is the best variable to use to statistically evaluate temporal changes in the amount of debris washing onto a shoreline?

However, the analyses of these data are complicated by a general lack of good research into statistical models for evaluating marine debris data. Published statistical reports of the analysis of marine debris data use standard techniques of analyses of variance and repeated measures analysis. The validity of these analyses depends strongly upon the statistical model assumed for these data.

Until now, because of an absence of adequate data, it has been impossible to statistically evaluate the assumptions of these analyses. Many marine data are collected at varying sites and times, often on a relatively infrequent basis. Surveys conducted annually or even monthly may be inadequate for evaluating temporal changes. Moreover, such data are likely inadequate for identifying point sources of debris. Events that are associated with point sources of debris are likely to be seasonal, and a monthly or annual survey will not provide adequate statistical identification of this source, at least for many years. The PINS database, however, allows for an evaluation of these assumptions, and for either improvement of these analyses or the development of new methods for modeling marine debris data.

Data analysis has indicated that debris trends can be tracked both temporally and spatially and preliminary statistical analysis suggests that temporal variation is much larger than spatial variation along the PINS shoreline. Preliminary statistical data analysis using four variable correlations indicate that the correlation between sampling locations falls rapidly and seems to plateau at between eight and 10 miles. This suggests that optimum sample spacing would be every eight to 10 miles. It appears that statistical autocorrelations can be used as a key to designing an optimum sampling scheme. These data indicate that the temporal autocorrelation functions die out rapidly and, at eight days, the autocorrelation drops to nearly zero, then it rises slightly and falls again to zero. These data indicate that at 30 days-and-beyond the autocorrelation is essentially zero. This implies that data can not be used to predict debris beyond a month. Moreover, any prediction beyond a week is going to be inaccurate.

Additionally, statistical analysis has allowed us to plot point source debris items over time. We have also been able to develop a regression model indicating that increased commercial Gulf shrimping effort within waters adjacent to our survey area directly correlates with increased numbers of specific types of debris items being washed onto the adjacent shoreline.

Summary

Beginning in 1994, park researchers initiated the PINS Marine Debris Point Source Investigation. This labor intensive research project has required daily cataloging and removal of 43 debris items from 16 miles of shoreline within Padre Island National Seashore. Upon completion of this year's research season, in March 1998, park scientists will have obtained over 1,000 days of marine debris data, with the vast majority of these days being consecutive. During this effort, park researchers cumulatively surveyed over 16,800 miles of shoreline. The PINS Marine Debris Point Source Investigation represents one of the first long-term, comprehensive, marine debris research projects initiated in the United States.

Because the Padre Island National Seashore data are so extensive, they provide a unique opportunity to investigate fundamental statistical questions related to the collection and general analysis of beach debris data. Preliminary data analysis has indicated that debris trends can be tracked both temporally and spatially and preliminary statistical analysis suggests that temporal variation is much larger than spatial variation along the PINS shoreline. It appears that statistical autocorrelations can be used as a key to designing an optimum sampling scheme.

Additionally, statistical analysis has allowed us to plot point

source debris items over time. We have also been able to develop a regression model indicating that increased commercial shrimping effort within waters adjacent to our survey area directly correlates with increased numbers of specific types of debris items being washed onto the adjacent shoreline.

Similar research studies should be conducted in other areas around the United States to identify additional point sources. To solve the marine debris problem, point sources must be identified. Unless they are, actions implemented to reduce the amount of garbage being dumped into our oceans is ineffective. Through education and regulatory enforcement, we can substantially decrease the amount of garbage generated by these point sources, thus resulting in a cleaner Gulf of Mexico.

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SEA TURTLE STRANDINGS IN THE GULF OF MEXICO

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The Gulf of Mexico and adjoining bay systems provide important habitat for five sea turtle species. The Sea Turtle Stranding and Salvage Network (STSSN) was established in 1980 to systematically document strandings of sea turtles on United States beaches along the Gulf of Mexico, Atlantic Ocean, and Caribbean Sea (Teas, 1993). Stranded sea turtles are those found washed ashore or floating, either dead or alive. Stranded turtles are located by network participants in offshore (Gulf of Mexico) and inshore (bay and channel) areas, during systematic surveys or while responding to reports from the public. A standardized form is completed for each stranded turtle. Live stranded turtles are taken to rehabilitation facilities. Many of the dead stranded turtles are salvaged for necropsy. Most stranded turtles are found dead. However, the numbers of dead turtles reported by the STSSN underestimate mortality, since only a portion of dead turtles actually wash ashore and become available for documentation (Murphy and Hopkins-Murphy, 1989).

The STSSN database provides the only long-term, comprehensive database of sea turtle strandings for the Gulf of Mexico. Prior to 1980, some sea turtles were documented stranded on the Gulf of Mexico coast but most early records were gathered opportunistically or in conjunction with other studies. Currently, there is no structured sea turtle stranding network in Mexico. However, records are maintained of stranded turtles that are located on nesting beaches in Mexico during the nesting season.

From 1980-1997, the STSSN documented 9,489 non-headstarted sea turtles found stranded in U.S. states bordering the Gulf of Mexico. About 85 percent of the documented strandings were found in offshore areas. Among the 9,489 were 4,494 loggerhead (*Caretta caretta*), 2,702 Kemp's ridley (*Lepidochelys kempi*), 1,336 green (*Chelonia mydas*), 300 hawksbill (*Eretmochelys imbricata*), 183 leatherback (*Dermochelys coriacea*), and 474 unidentifiable turtles. Of the 9,489 stranded turtles, 4,657 were found in Texas, 907 in Louisiana, 311 in Mississippi, 131 in Alabama, and 3,483 on the Gulf coast of Florida. Differences in the numbers of turtles found stranded in each state reflect differences in shoreline length, stranding network coverage, relative abundance of various species, and vulnerability of those species to stranding there. Most stranded loggerheads were found in Texas and Florida, most Kemp's ridleys in Texas and Louisiana, most green turtles in Texas and Florida, most hawksbills in Texas and Florida, and most leatherbacks in Texas and Florida.

Since the STSSN was established in 1980, the numbers of sea turtles found stranded each year has increased. This increase undoubtedly reflects improvements in STSSN coverage during this time. However, it may also reflect increased mortality due to certain sources and increases in some sea turtle populations. As for all species collectively, strandings of each species individually also increased from 1980-1997.

There are several natural and human-related sources of sea turtle injury and mortality in the Gulf of Mexico and adjoining bay systems (Rabalais and Rabalais, 1980; Hildebrand, 1982, 1983; Caillouet et al., 1991). These sources vary in importance at different locations, for different periods of time, for different species, and for different life stages of various species. The National Research Council concluded that prior to the mandatory use of turtle excluder devices (TEDs) the most important human-associated source of mortality for juveniles, subadults, and breeders in the coastal waters was incidental capture in shrimp trawls, which accounted for more deaths than all other human activities combined (Magnuson et al., 1990). Despite current mandatory use of TEDs and reported high compliance with TED regulations (NMFS, pers. comm.), there continues to be a correlation between shrimping effort in Gulf of Mexico waters off the Texas coast and sea turtle strandings on Texas offshore beaches (Shaver, 1995, 1996a, 1996b, in press a; Weber et al., 1995; Caillouet et al., 1996). Incidental capture in shrimp trawls probably continues to be the most significant human-related source of mortality in Texas offshore waters. During 1997, there was a 90 percent decrease in strandings on Texas offshore beaches during the eight weeks of the Texas Closure (when Gulf of Mexico waters off the Texas coast were closed to shrimping out to 200 nautical miles) as compared to during the eight weeks preceding and following the closure (Shaver, in press b).

Kemp's ridley is the most critically endangered sea turtle species in the world. Most Kemp's ridleys nest on the Gulf of Mexico coast near the village of Rancho Nuevo, Tamaulipas, Mexico. From 1978-1988, a bi-national project was conducted to establish a secondary nesting colony of this native species at Padre Island National Seashore (PAIS), to provide a safeguard for the species (Shaver, in press b). During the last 50 years, more confirmed Kemp's ridley nests have been located at PAIS than at any other location in the U.S. (Shaver, in press b). The 13 Kemp's ridley nests found on the Texas coast in 1998 are: 1) the only confirmed Kemp's ridley nests found in the U.S. so far this year, 2) the most Kemp's ridley nests documented in Texas during a single year, and 3) an increase in the number of Kemp's ridley nests detected in Texas for the fourth consecutive year. In 1996, the first two confirmed returnees from the project to establish a secondary nesting colony at PAIS were located nesting there and during 1998 another three returnees were found.

Unfortunately, more Kemp's ridleys are typically found stranded in Texas than in any other state in the United States. Often nearly as many Kemp's ridleys are found stranded in Texas as in all other U.S. states combined. Additionally, more adult Kemp's ridleys are now typically found stranded in Texas than in any other state in the U.S. or Mexico. From January 1, 1997 through June 11, 1998, 42 adult Kemp's ridleys were found stranded on Texas offshore beaches (including 26 at PAIS). All 42 were found dead at times when Gulf waters off the Texas coast were open to shrimping (Shaver, in press b). Many of these deaths occurred during the breeding and nesting seasons in 1997 and 1998 and this mortality almost certainly reduced Kemp's ridley nesting on the Texas coast and in the U.S. during those years. As a means to protect breeding and nesting Kemp's ridley turtles, nearshore waters off Rancho Nuevo, Mexico are closed to shrimp trawling during the nesting season. After two decades of bi-national restoration efforts, it appears that Kemp's ridley may become a regular nester on U.S. shores. However, this may not occur, and the success of efforts to establish a secondary nesting colony may be threatened, if adult Kemp's ridleys continue to succumb in waters offshore from south Texas nesting beaches.

To address the continuing problem of trawl-related mortality, increased TED enforcement and additional management actions, such as time and area-specific closures, may be needed in some areas where turtles are concentrated and succumbing in large numbers due to incidental capture.

In the future, as the human population increases, it is likely that sea turtle mortality due to human-related factors will also increase. Efforts to monitor strandings, study mortality factors, and develop means to decrease mortality must be continued. Effective conservation of these species requires continued protection at the nesting beaches and in the marine environment.

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POLLUTION AND HYPOXIA

HARMFUL ALGAL BLOOMS IN THE NORTHERN GULF OF MEXICO

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Introduction

The base of the marine food web in the Gulf of Mexico is composed of small single-celled algae collectively known as phytoplankton. These small plants range in size from about 1-500 µm in diameter. A single cubic centimeter of seawater may contain thousands to millions of these small plants. Most marine waters contain a mixture of many different phytoplankton species. When a single species increases in abundance above the levels it is normally found at and comes to dominate a phytoplankton community it is called a phytoplankton bloom. In some cases, a single species may become abundant enough to discolor the water. For example, when a single species of dinoflagellate becomes very abundant, it is sometimes referred to as "red tide" because these abundant cells can accumulate near the surface and discolor the water a reddish-brown color. However, potentially dangerous concentrations of toxic phytoplankton species may be present in the water without any obvious warning signs. Of the thousands of different phytoplankton species that have been described, only about 85 are known to contain toxins. Of these, less than 30 toxic species have been found in the Gulf of Mexico.

Over the past few decades there has been a disturbing trend of increasing frequency of harmful algal blooms throughout the world. The reasons for this increase are still being studied, but possible causes may include nutrient enrichment of coastal waters, transport of exotic species by ship ballast waters and global climate shifts. The Gulf of Mexico has seen an increase in recent years in the frequency of hypoxic events and fish kills associated with red tides, as well as the first appearances of algal species causing amnesic shellfish poisoning and a persistent brown tide that lasted for eight years without interruption. Unfortunately, since we do not understand the factors that favor the formation of these blooms, we still do not have a basis for predicting the likelihood of harmful algal blooms at specific times or locations, nor do we have a basis for predicting their severity or extent once they are observed.

There are two general classes of harmful algal blooms (HAB) that affect the Gulf of Mexico: toxic blooms and high biomass blooms. Toxic blooms can kill marine organisms at various levels in the food web and potentially threaten human health, and are generally of greatest concern to government officials. High biomass blooms can have harmful effects when the phytoplankton settle out of the water column by increasing benthic oxygen demand which leads to hypoxia and or anoxia. High biomass blooms can also increase light attenuation, reducing sea grass primary production in shallow coastal environments, and eventually leading to sea grass habitat loss.

The most common toxic species of phytoplankton in the Gulf of Mexico includes the dinoflagellates *Gymnodinium breve, Alexandrium monilata* and more recently *Gymnodinium mikimotoi.* The "red tides" of recent years that have caused extensive fish kills on the Texas coast and elsewhere in the Gulf of Mexico are caused by *Gymnodinium breve.* A toxic diatom that can potentially cause amnesiatic shellfish poisoning, *Pseudo-nizschia,* has recently been found in the Gulf of Mexico, although no related human health problems have been reported. Persistent blooms of non-toxic phytoplankton, such as *Aureoumbra lagunensis,* the Texas brown tide alga can also cause harm due to indirect effects such as shading out of seagrass beds and altering food web structure in an ecosystem.

Red tides

Red tides caused by the dinoflagellate *Gymnodinium breve* and its associated fish kills are nearly annual features on the Gulf coast of Florida (Tester and Steidinger, 1997). They are less frequent in the western Gulf of Mexico, with major red tides reported on the Texas or Mexican coast in 1935, 1955, 1974, 1986, 1996 and 1997 (Buskey et al., 1996). There appears to be a trend of increasing frequency in the western Gulf, however. Red tide blooms appear to originate offshore; cells may concentrate at frontal boundaries and then be transported inshore. *G. breve* cells and their toxins can accumulate in filter-feeding shellfish such as oysters and clams. Consumption of contaminated shellfish results in Neurological Shellfish Poisoning (NSP); symptoms include dizziness, nausea and tingling sensations in the extremities. No known human fatalities have resulted from NSP. Normal densities of *G. breve* in the Gulf of Mexico are about 10 cells L^{-1}; cell densities above 5,000 cells L^{-1} are considered a red tide and result in closure of shellfish beds. Toxins carried in the air can also cause respiratory irritation in areas close to red tide affected beaches.

The Texas brown tide

The Texas "brown tide" algal bloom is the longest continuous algal bloom ever scientifically documented (January 1990 - October 1997). Although the reasons for its initiation have been well documented (Buskey et al., 1996, 1997) the reasons for its persistence are still under investigation. This dense bloom of the alga *Aureoumbra lagunensis* reduced sunlight availability to seagrasses in the Laguna Madre, which in turn caused severe reductions in their biomass and distribution. Although the extensive El Nino rains of the fall of 1997 appear to have brought this tenacious bloom to an end, the brown tide may be making a comeback in the late spring of 1998.

Hypoxia

Hypoxia refers to waters with low dissolved oxygen concentrations (<2 mg/L). In the northern Gulf of Mexico, hypoxic conditions can occur on the Louisiana continental shelf between April and October, and may at times of greatest areal extent cover 8000 - 9500 km^2 (Rabalais et al., 1991). The hypoxic zone is caused by a combination of thermohaline stratification of the water column in the Mississippi River plume during summer, and the large amounts of organic matter delivered to the benthos during this time which increases benthic and water column respiration rates. The major source of this organic matter is thought to be phytoplankton, stimulated in part by increasing levels of eutrophication in recent years. Fish, shrimp and other organisms' densities are greatly reduced in these hypoxic areas (Renaud, 1986).

Conclusions: Can anything be done to control harmful algal blooms?

What can scientists and public officials do to reduce the negative impacts of harmful algal blooms? Better dissemination of accurate information about harmful algal blooms will help the public avoid risks associated with these phenomena, while also reducing overreactions to these natural occurrences. When the press reports a red tide outbreak, many people will cancel their vacations to the seashore and stop all consumption of seafood.

Red tide blooms are very unpredictable in their occurrence. On the Texas coast outbreaks of red tides have been separated by tens of years in the past. A better understanding of the biology of these organisms and of the current patterns in the Gulf of Mexico may make it possible to better predict the occurrence of red tides in the future.

Agricultural scientists routinely deal with harmful "blooms" of insect pests on crop land by developing chemical and biological control agents to eliminate these pests. Could a similar approach be taken with these toxic phytoplankton species? Possible mechanisms of control harmful algal blooms include direct means such as chemical "pesticides" aimed at these organism, adding flocculants to the water to remove phytoplankton from the water, and biological control mechanisms including adding predators on these organisms or pathogens such as bacteria or viruses. Much research will need to be performed to determine if these types of control measures can be used without harming other organisms.

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INDUSTRIAL ACTIVITIES IN THE NORTHERN GULF OF MEXICO: MARINE SHIPPING AND OFFSHORE OIL AND GAS DEVELOPMENT

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Introduction

This paper will briefly explore the nature and extent of marine shipping and of offshore oil and gas development and production in the Gulf of Mexico, and of environmental concerns related to these industries. We will give special attention to pollutant streams that may lead to significant pollution events or hypoxia.

Marine shipping

Marine shipping is the transport of cargo from one port to another port and is a major economic and industrial endeavor worldwide. Shipping has been important since the dawn of human history. Early exploratory voyages of the Gulf of Mexico involved trade or plunder, and initiated about five centuries of regional history. The shipping industry has evolved in many ways: from sail to steam to fuel oil-powered vessels; from nationalistic to private sector management; from "breakbulk" (loose or palleted cargo) to bulk and containerized cargo; and from harbor facilities to highly sophisticated port complexes. The marine shipping industry is a major economic contributor to the regional economies of Gulf Coast states and port cities. Data compiled by the U.S. Army Corps of Engineers (COE) for 1995 (COE, 1997) and aggregated by heavily trafficked areas, show the major Gulf shipping hubs to be:

Mississippi River area ports*
— 444 million tons

Houston/Galveston area**
— 196 million tons

Corpus Christi area
— 70 million tons

Tampa
— 52 million tons

Mobile area
— 51 million tons

Marine shipping environmental issues

Environmental issues associated with the marine shipping industry are fairly universal for both coastal and marine areas. Similar and related concerns exist for other industries or activities that rely on marine vessels, such as commercial or recreational fishing fleets, oil and gas (O&G) service fleets, or military fleets, but those will not be addressed in this brief paper.

In coastal areas, the primary environmental concerns associated with marine shipping are harbor expansion and maintenance (habitat loss or alterations; nonpoint liquid effluents and air emissions; social or economic displacements, etc.); channel dredging (dredge spoil disposal); and introduction of exotic species, such as zebra mussels. In coastal areas, the environmental effects tend to be localized, contained, and cumulative; significant concerns may be waterway and port water quality, and industrial area air emissions. These sorts of impacts are staggered in time and place: some arise from port development, expansion, or maintenance; others from routine operations; still others from occasional catastrophic accidents.

In the marine environment, the concerns associated with routine operations are discharges of liquid effluents, trash or debris, air emissions, and minor accidental spills from cargo vessels of toxic materials, such as chemicals, crude oil, or refined oil products. In marine areas, the effects are generally local and ephemeral, and there are no significant concerns associated with routine operations. The major public concern, however, is of a catastrophic oil spill, such as the *Exxon Valdez* spill. None of the pollutant streams from these activities or events lead to offshore marine hypoxia.

Government agencies regulate marine shipping, to prevent accidents and to protect the environment. Coastal states, U.S. Environmental Protection Agency (EPA), and the U.S. Coast Guard (USCG) regulate water and solid waste discharges in port and from the coastline to 50 miles offshore, and to protect "special areas." Air emissions are of regulatory concern, however, only while vessels are in port. Disposal of solid trash or debris at sea is regulated by the MarPol Convention. The USCG requirements encourage safe, accident-free operations.

In addition to these generalities, environmental concerns are linked to the areas of heaviest shipping traffic, where routine operations may contribute to cumulative pollution problems, and the nature of cargo being transported (especially crude oil, refined oil products, or other toxic substances). Major Gulf shipping hubs are listed above. Rainey (1991) summarized quantities and pathways of crude oil imports to U.S. Gulf ports. Although this information is dated, the destinations of oil import traffic and the

*Includes Baton Rouge, New Orleans, Mississippi River Gulf Outlet, South Louisiana, and Plaquemines ports.
** Includes Houston, Galveston, and Texas City ports.

magnitudes of crude oil imports remain generally valid:

Houston/Galveston area
— 43 million metric tons

LOOP (Louisiana Offshore Oil Port)
— 39 million metric tons

Mississippi River area ports
— 36 million metric tons

Port Arthur/Lake Charles
— 32 million metric tons

Corpus Christi
— 18 million metric tons

Pascagoula
— 14 million metric tons

Most of this crude oil comes from OPEC countries and enters the Gulf of Mexico via the Yucatan Straits. Smaller amounts come through the Florida Straits and directly from Mexico via the Bay of Campeche.

Marine shipping future trends

Future trends are expected to emphasize container and bulk cargos carried by vessels much larger than the present fleet. These trends will require deeper channels and larger ports and staging areas, well connected to rail and highway transportation routes. Marine shipping concerns for the future reflect those of present and past trends, and tend to be universal port maintenance and growth issues. These include port complex expansion, a trend towards larger cargo vessels, and channel widening and deepening for larger vessels. Regional (Gulf) concerns additionally include a projected increase in oil imports to Gulf ports; an increase in offshore lightering of oil to smaller vessels; introduction of floating production, storage, and offloading (FPSO) technologies for large-volume deepwater O&G production; and establishment of large, sophisticated coastal supply bases to support deepwater O&G activities.

Offshore oil and gas development

In contrast to marine shipping, offshore O&G development is a relatively young industry. Oil exploration in the U.S. began in the late 1800s and "boomed" during the following decades. After World War II, drillers extended coastal operations into marshes and shallow waters using rigs mounted on barges. In 1947, the first well drilled out of sight of land discovered a substantial oil reservoir offshore Louisiana. Over the next five decades, offshore oil and gas production has become a major contributor to U.S. energy needs. Although offshore O&G exploration and production occurs throughout world seas, these activities are especially intense in the United States (state and federal) waters of the central and western Gulf of Mexico.

Representative statistics for Federal waters (also called "Outer Continental Shelf," or OCS waters) of the Gulf of Mexico are:

— 39.5 millions of acres under lease
— 34,904 wells drilled to date
— 3,857 production platforms in place
— 26,646 miles of pipeline installed
— 160 companies operating Federal leases
— 35,800 offshore O and G-related workers
— 3,395 producing oil wells
— 3,401 producing gas wells (Source: MMS, 1998).

During the period 1953 to 1995, the Gulf of Mexico OCS oil and gas program produced substantial energy resources for the Nation and revenues for the U.S. Treasury:

— 9.6 billion barrels of oil produced
— 119.5 billion thousands of cubic feed (MCF) of gas produced
— $43.9 billion bonus bids on leased tracks
— $1.4 billion rentals and "minimum royalties"
— $50.3 billion production royalties (Source: Gachter, 1997).

Offshore oil and gas development environmental issues

Offshore oil and gas activities affect both coastal and marine environments. The "life cycle" of O&G activities on a lease begins with geologic and geophysical (G&G) surveys, then proceeds sequentially: exploration drilling from a mobile rig; installation of a platform and drilling of additional development wells; installation of pipelines; production of oil and/or gas, and transportation of these products ashore via pipelines; and eventual decommissioning of all operations and removal of all structures when the petroleum reserves are depleted. Servicing and support of all of these offshore activities are conducted from coastal shore bases, using both specialized motor vessels and helicopters.

The significant coastal concerns are environmental impacts of pipeline landfalls or oil spills contacting the shoreline; regulatory impacts of air emissions; and environmental, social, or economic impacts of support and supply bases and infrastructure.

The major concerns in the marine environment are physical disturbances to valued ecological or cultural resources on the seafloor caused by emplacement of rigs, platforms, or pipelines; discharges of liquid effluents and air emissions; and accidental oil or chemical spills. None of these impacts or pollutant streams lead to offshore marine hypoxia.

Generally, the environmental effects of these impacts are local and/or ephemeral, and most activities are well regulated. In Federal (OCS) waters, the Minerals Management Service (MMS) closely regulates rig, platform, and pipeline emplacement (and removal), and routine operations, including air emissions; requires industrial standards and practices to minimize the occurrence of accidents or oil spills; and regularly inspects operations to ensure compliance. The EPA regulates liquid effluents (and air emissions in the Eastern Gulf planning area). Coastal impacts are regulated by the COE and State agencies. State agencies also regulate similar O&G activities in State waters.

Key pollution concerns are oil leaks from older, nearshore pipelines (especially in state waters, near the shoreline); and air emissions near coastal areas with air quality regulatory problems. The major public concern, however, is catastrophic oil spills. In spite of the public perception, significant spills from OCS activities are very infrequent. For perspective, during the 21-year period of 1974-1995, there were 11 spills of 1,000 barrels or more of crude oil from facilities and operations on OCS leases, whereas during the same period, there were 587 spills of crude or refined oil products from tankers in worldwide coastal or offshore waters (Gachter, 1977).

Offshore o&g development future trends

Future trends are expected to include reworking of proven fields on the continental shelf of the Gulf of Mexico and a move into the deeper waters of the Gulf of Mexico. Both trends are driven by technological advances. In the next few years, oil and gas production is expected to increase by as much as 40 percent, as production from huge deepwater reserves comes online (Melancon and Roby, 1998).

Conclusions

Within the Gulf of Mexico, both marine shipping and offshore O&G development are thriving industries that provide significant contributions to the region's economy. Marine shipping levels are expected to increase, and major Gulf ports are planning expansions. The offshore O&G industry has recently "boomed," due to new technologies that allow more efficient location of subsalt reservoirs on the shelf, and that allow expansion into very deep water. Production of oil and gas is expected to increase. Both industries have generally good environmental records for routine operations.

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THE HYPOXIA/ANOXIA PHENOMENON IN THE NORTHERN GULF OF MEXICO

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Background

Hypoxia (< 2.0 mg/l dissolved oxygen) and anoxia (0.0 mg/l dissolved oxygen) occur worldwide (see Diaz and Rosenberg [1995] for a review). These events have been occurring in Mobile Bay, eastern Gulf of Mexico, since at least the mid-1800's and have been popularly known as "jubilees." Jubilees were, and are, episodic events in which fish and shellfish move into shallow water next to shore to escape low dissolved oxygen conditions, and are collected by the bucket load by delighted residents.

In the northern Gulf off Louisiana, hypoxic conditions were first noted about 1973 and the data were published in technical reports (Harris, Ragan and Kilgen 1976, Ragan, Harris and Green 1978), although we suspect that shrimp fishermen knew about the phenomenon, long before the scientific community did, as areas where there were no shrimp. The work of Nancy Rabalais and her colleagues since 1985 have shown that hypoxia is a recurrent, almost annual, phenomenon on the Louisiana shelf.

Off Texas, the first reported occurrence of hypoxia occurred off Freeport in June and July 1979 (Harper *et al.* 1981). Hypoxia was thought to be an uncommon event until a seven-year data set was accumulated and it was discovered that hypoxic or near-hypoxic conditions occurred in four of six years in which oxygen data were collected (Harper *et al.* 1991).

Distribution of hypoxia

Between 1985 and 1992 the areal extent of mid-summer hypoxia off Louisiana, as determined by shelf wide cruises, was about 8,000 to 9,000 km^2, and hypoxia was often disjunct, with distinct areas associated with the outflow areas of the Atchafalaya and Mississippi Rivers (Rabalais, *et al.* 1997). In the 1995-96 period, the areal extent of hypoxic water increased to 16,000 to 18,000 km^2 (Rabalais, pers comm). In 1997 the areal extent was slightly less, about 15,800 km^2 (Rabalais, pers. comm.) The hypoxic area, at maximum extent, extends from depths of three to five meters nearshore to 60 m offshore, a straight line distance of between 24 km and 56 km. It is also known that the hypoxic water mass moves; in 1994 part of the hypoxic water mass was shown to be moving westerly, while at the same time normoxic water to the east of the hypoxic water was also moving to the west, suggesting a possible link (unpublished data).

No comparable shelfwide data have been collected off Texas, so the extent, duration and frequency of hypoxia are not known. Those data that do exist were collected during the course of other research projects. In 1979, hypoxic waters were found to extend to at least 50 km offshore from Freeport (Harper *et al.* 1981) and this area was found to have very low abundances of fishes and macroinvertebrates (Pavella, *et al.* 1983). As noted above, the seven-year data set suggests that hypoxia may occur off the upper Texas coast almost annually. Hypoxia in Texas shelf waters is probably imported from Louisiana waters by prevailing westerly currents. A fish and invertebrate kill along the upper Texas coast in June 1984 was attributed to hypoxic conditions in low salinity waters that extended back into the area of Lake Calcasieu in Louisiana (Harper and Guillen, 1989).

Hypoxia is not confined to near-bottom waters. Rabalais *et al.* (1997) found that 10 to 80 percent of the water column could be hypoxic, depending on depth, off Louisiana. Off Texas, during the 1979 event, hypoxic waters extended from about 18 m depth to the bottom along a 50-km transect where depths ranged from five meters to almost 30 m (Harper *et al.* 1981)

Annual cycle of hypoxia

Off Louisiana, hypoxia tends to be present, but patchy, in March - May, and most persistent and severe in June - August. Persistence of hypoxia into the months of September and October is contingent on winds, either tropical storms or the passage of cold fronts (Rabalais *et al.* 1997). Off Freeport, Texas, the 1979 hypoxia was disrupted by the passage of Tropical Storm Claudette in late July 1979 (Harper *et al.* 1981); the other events were less severe and appeared to degrade without the intervention of winds.

Causes of hypoxia

Several factors are associated with the occurrence of hypoxia on the northern Gulf of Mexico shelf. All of these factors are tied to discharge of fresh water from the Mississippi and Atchafalaya Rivers.

River discharge is highest in the spring. Coincident with high freshwater discharge is increased levels of nutrients, especially dissolved inorganic nitrogen. These nutrients support high biological productivity in the form of phytoplankton blooms, especially of diatoms. A large percentage of the bloom-generated organic carbon reaches the bottom via zooplankton fecal pellets or sinking of individual phytoplankton cells. Bacterial decomposition of this organic carbon depletes oxygen concentrations in the near-bottom waters to hypoxic or near-hypoxic levels. In summer, the water column becomes stratified with low salinity, warm water overriding cooler, high salinity water. This prevents mixing and reoxygenation of the bottom water. It also allows much of the suspended particulate material in the water column to settle to the bottom, and often a diver will descend through very turbid water, pass through the pycnocline, and enter very clear water which extends to the bottom.

River discharge volume correlates well with the areal extent of hypoxia. In 1988, a low flow year, hypoxia on the Louisiana shelf was minimal. The "Great Summer Flood" in 1993 was correlated with a two-fold increase in the areal extent of hypoxia relative to the 1985-1992 average coverage (Rabalais *et al.* 1997). Peak primary productivity correlates well with peak river discharge, but lags by about two months.

Changes in nutrient loadings, which drive the phytoplankton blooms, have been reported by Turner and Rabalais (1991, 1994), Justic´ *et al.* (1994, 1995) and Turner *et al* (1997). It has been shown that nutrient loadings have increased during this century, especially since the 1950s - nitrogen and phosphorus have doubled and silicate has decreased by 50 percent.

Biologicial effects of hypoxia and anoxia

Rabalais and Harper (in prep.) have shown that as oxygen concentrations decrease from normoxic to hypoxic to anoxic, the organisms in the affected area display pronounced behavioral responses. In normoxic conditions, divers and ROV operators routinely observe fish, squid and other large mobile invertebrates on or near the bottom. As the oxygen level decreases from 2.0 to about 1.5 mg/l the mobile organisms usually are not seen and it is presumed that they moved to less stressful areas. Those that are seen are usually dead. Further reduction from 1.5 to 1.0 mg/l elicits stress behavior in smaller bottom-dwelling invertebrates; sea stars and crabs climb up on elevations, brittle stars emerge from their burrows and use their arms to raise their disks off the substrate, burrowing shrimps emerge from the bottom, snails move about the bottom with their siphons directed vertically and large worms emerge from the bottom. All these behaviors position the animals' gas exchange organs above the microenvironment at the sediment-water interface where the oxygen concentration may be lowest.

At oxygen concentrations of 1.0 to 0.5 mg/l the sediment develops "cottony" rings of filaments produced by the sulfur oxidizing bacterium *Beggiatoa*. Examination of several of these rings indicates that they expand outward, leaving black sediment in the center of the ring. At this stage, even the most tolerant burrowing organisms, principally polychaetous annelids, emerge from their burrows and lie motionless on the bottom. Often these organisms, when brought to the surface and placed in oxygenated water, revive rather quickly. At these oxygen concentrations the abundances and diversity of smaller benthic invertebrates also decrease.

As the oxygen concentration decreases from 0.5 to 0.0, moribund bottom organisms die. Apparently they do not decompose rapidly, as their bodies continue to lie about the bottom, and they are not eaten, as mobile scavengers are not present. At 0.0 mg/l oxygen the sediment becomes almost uniformly black and there is no sign of life; even the strands of *Beggiatoa* are absent. At this stage, sulfur oxidizing bacteria generate hydrogen sulfide which may diffuse out of the sediment and enter the water column.

Analysis of foraminifera in sediment cores has provided some long-term data on biological effects of hypoxia. These data indicate that species not tolerant to oxygen stress have decreased coincident with increases in species tolerant of low oxygen stress.

The future

Given that the Mississippi River drains 41 percent of the continental United States, it is probable that hypoxia occurred on the continental shelf prior to the advent of humans and their practices. It is also probable that hypoxia has grown in magnitude with the increase in population, and attendant practices, over the past 100+ years. Whether hypoxia remains at its current level or decreases is problematical and is dependent on a general agreement as to the ultimate cause of hypoxia and the willingness to alter activities. Nutrient loadings in the Mississippi River are widely perceived to be the principal problem. Nutrient loadings in the watershed can come from several sources including application of nitrogenous fertilizer to fields, fixation by legumes, atmospheric deposition and sewage input (human and livestock). Of these, fertilizers are widely considered to be the principal source of nutrients, although not everyone agrees. If this is correct, changing agricultural practices may be the best means of reducing nutrient loads.

It can be predicted that if nothing changes, hypoxia will continue to occur on the northern and northwestern Gulf of Mexico. It will wax and wane as the river discharge volume changes, but there will be a trend of increasing intensity and areal coverage as human population in the river watershed increases. It might also be reasonably predicted that increased nutrient loadings will someday result in a *Pfeisteria*-type outbreak in some bay system or in nearshore waters.

Rabalais *et al.* (1996) made several predictions regarding ecosystem response if certain nutrient levels are changed. If nitrogen remains the same and silicon increases, silicon would no longer be limiting and carbon would increase in the sediments, increasing the extent and severity of hypoxia. If both silicon and nitrogen increase, and remain in balance, there would be increased carbon accumulation and an increase in severity and extent of hypoxia. If nitrogen decreases, it becomes the limiting factor, regardless of whether silicon increases, carbon accumulation would be less and hypoxia would decrease. These predictions are based on unchanged river flows. If global warming occurs and if river flow increases, it is likely that the areal extent of hypoxia would increase.

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FISH FOR EVERYONE

A CHANGE IN PERSPECTIVE: A NEW VIEW OF RECREATIONAL FISHING

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Overview

Until recently, recreational fishing was viewed largely as a leisure activity with little importance other than to provide rest and recreational opportunities for its participants. When most people thought about "the fishing industry," they automatically envisioned commercial fishing. That image is now changing because of the realization that recreational fishing is an important industry on which depend hundreds of thousands of jobs and billions of dollars of economic activity. The result has been the emergence of large, grass-roots-based organizations like the Coastal Conservation Association. Such organizations are demanding, and winning, seats at the table when policy decisions regarding fisheries issues are formulated. The more balanced approach to the policy-making process has, in turn, given rise to some tension between the various user groups. The grass-roots conservation groups are here to stay, and this fact will require a heightened level of acceptance and cooperation from those who have heretofore not had to work in cooperation with other user groups.

The Coastal Conservation Association of Louisiana is the Louisiana state chapter of the Coastal Conservation Association, the largest organization of its kind in the United States. CCA is an organization of state chapters comprised of recreational fishermen who have banded together to address conservation issues nationally and within their respective states.

CCA was originally incorporated in 1977 as the Gulf Coast Conservation Association (GCCA). The name was changed to CCA in 1985 to reflect the growth of the organization to states with an interest outside the Gulf of Mexico. The original group was formed in Texas by concerned anglers who were alarmed by declining fish populations. They were made aware of the inherent dangers brought on by dramatically increased commercial fishing pressure and from growing numbers of recreational anglers.

The stated purpose of CCA and its state and local chapters is to advise and educate the public on the conservation of marine, animal and plant life, and other coastal resources, both onshore and offshore. The objective of CCA is to promote, protect and enhance the present and future availability of these coastal resources for the benefit and enjoyment of the general public.

Today, CCA has chapters in 15 states: Alabama, Connecticut, Florida, Georgia, Louisiana, Maine, Maryland, Massachusetts, Mississippi, New Hampshire, New York, North Carolina, South Carolina, Texas and Virginia. The national membership is almost 65,000.

The state chapters, in turn, have local chapters. For example, CCA Louisiana has 12 chapters spread across the entire state. Some of CCA Louisiana's most enthusiastic members belong to chapters located hundreds of miles from the Gulf Coast. CCA Louisiana has 15,000 members and volunteers. Our headquarters are located in Baton Rouge, and we have four full-time employees.

The history of CCA Louisiana serves as an excellent example of the metamorphosis of recreational marine fishing. Recreational fishing is changing from its image of a bunch of "good old boys" drinking beer and casting lines to one of a more sophisticated, serious and well-educated angler who recognizes the need for conservation. Recreational fishing is an important industry as is commercial fishing, shrimping, crawfishing and similar for-profit enterprises.

CCA Louisiana's roots can be traced back to the 1970s to the founding of "Save our Specks," (SOS) a loosely knit group of fishermen whose primary purpose was enactment of legislation restricting use of monofilament gill nets. Even though their numbers were small, SOS won legislative approval of restrictions on gill nets, only to see them sidestepped by a creative loophole.

While CCA Louisiana is involved in a multitude of activities, ensuring that the views of sportsmen-conservationists are presented to regulatory and legislative bodies ranks near the top in importance for the organization's members. Two of CCA Louisiana's major legislative issues were gamefish status for redfish and restrictions on use of entanglement nets, more commonly referred to as gill nets. The Louisiana Legislature granted gamefish status to redfish in 1988 and in 1995 passed the Louisiana Marine Resources Conservation Act, which restricted use of gill nets in state waters.

Both the redfish and gill-net legislative battles were defining moments for CCA Louisiana, increasing its membership as well as the organization's image as a balancing influence in legislative and regulatory matters in the state. Heretofore, Louisiana's regulatory and legislative bodies had been dominated by commercial fishing interests. Few decision-makers thought of recreational fishing as an important segment of the state's economy. (Until 1988, the division of the Louisiana Department of Wildlife and Fisheries that dealt with marine fisheries was named the "Seafood Division.")

During the 1995 legislative session, in which the gill-net issue was debated, the speaker of the House of Representatives, the president of the Senate and the governor were long-time strong allies of commercial fishing interests. The three above-mentioned positions are today held by others. A very strong message was sent in 1996 when newly elected Gov. Mike Foster appointed Jimmy Jenkins, a former CCA Louisiana president, as secretary of the Louisiana Department of Wildlife and Fisheries.

The downside of CCA Louisiana's accomplishments was an increase in tension between recreational fishermen and commercial fishing interests. However, tensions have since subsided. Certain segments of the commercial fishing industry waged aggressive, negative campaigns against recreational fishermen. In its legislative and regulatory efforts, CCA Louisiana has always strived to present issues based on facts and has avoided disparaging any other user group.

CCA has attempted to clarify unfounded statements and dire predictions made by commercial users as to the effects of certain legislation and regulations. For example, representatives of commercial fishing organizations predicted cataclysmic consequences if gill nets were restricted. These predictions ranged from skyrocketing prices for certain species of finfish to loss of tourism in New Orleans. Periodic surveys conducted for CCA Louisiana by an economic research firm have shown no significant change in the price of finfish formerly harvested with gill nets. New Orleans tourism continues strong and the city's many restaurants continue to offer a wide variety of seafood on their menus.

Part of CCA Louisiana's success can be attributed to the group's strong grass-roots support and high level of activity among members. However, the growing influence of recreational fishing as an economic powerhouse cannot be ignored.

A recent study by the Louisiana Department of Wildlife and Fisheries demonstrated the growing popularity of saltwater fishing and its economic impact. According to the report, the number of saltwater fishing licenses issued by LDWF jumped by 45 percent between 1990 and 1996. Saltwater licenses for non-Louisiana residents jumped a whopping 67 percent during the same period. LDWF estimates that 454,000 Louisianians fish in saltwater for recreation.

The LDWF study found that saltwater anglers spend $450 million per year on meals, lodging, travel and equipment. A 1995 study by the Coastal Conservation Association determined that saltwater anglers' investment in recreational-fishing-related durable goods (camps, boats and tackle) exceeds $2.5 billion.

Another recent LDWF study estimates that all recreational fishing in Louisiana (salt and fresh water) generates $790 million in retail sales, has a $1.6 billion total economic effect, sustains 18,400 jobs and generates $38.5 million in sales and income tax revenues. That clearly ranks fishing among the state's larger industries.

The U.S. Fish and Wildlife Service recently released its annual national survey of fishing and hunting activities for 1996, which showed that 17 percent of Louisianians 16 years and older fished that year. Only five states had a higher percentage.

Louisiana's economy is booming as is that of most other states. The difference between Louisiana and other states is that during the mid-to-late-1980s Louisiana suffered through a deep recession—much more severe than that experienced in Texas. The reason for Louisiana's recession was the same as Texas'—trouble in the oil industry. Louisiana's economy has bounced back strong and much of that strength is attributable to renewed strength of the oil industry. Also fueling an ever-increasing level of economic activity along the state's coastal region is saltwater recreational fishing.

One only needs to visit coastal areas that previously were described as "backwater" to see the positive economic effects of recreational fishing. Real estate developments catering exclusively to saltwater recreational fishermen have sprung up across the coast. What makes these different is that they are far removed from the traditional fishing "camps" that were heretofore so popular in Louisiana. These developments feature gated communities with "camps" at prices in the hundreds of thousands of dollars. These developments have provided a solid, diversified tax base for the affected parishes (counties).

Of course, the owners of these camps also become local consumers, necessitating the expansion or construction of new restaurants, retail fuel outlets, boat sale and repair shops, tackle and bait shops and many others.

Today, some in the commercial fishing industry view recreational fishermen as adversaries who want to take away their means of employment. Some recreational fishermen have similar negative attitudes toward commercial fishermen. Even though many of CCA Louisiana's initiatives have been strongly opposed by commercial fishermen's organizations and individual commercial fishermen, CCA's policy has always been to address the issues without engaging in vitriol.

Recreational fishing organizations have made sizeable gains over the past two decades. They have achieved positions on policy-making bodies where their interests were previously unrepresented or under-represented. The likelihood is that the number of Americans involved in recreational fishing will continue to expand, and with that will come growth in the organizations that represent anglers.

American society and the nation's economic structure have always been in a state of constant change. Retail business is very different than what it was 25 years ago, health care is undergoing dramatic changes, and the family farmer is an endangered species. Marine fisheries is not exempt from the changing tides.

Sound policies can be better developed when all sides of an issue share mutual respect for the others' interests and needs. Acrimony between differing user groups will challenge productive management of the nation's marine resources. It is therefore of utmost importance that the various user groups work toward the common goal of preserving the nation's marine resources as national, state and regional policies are made.

FISHERIES REGULATIONS IN THE GULF OF MEXICO OVER THE PAST 50 YEARS

Albert King, Sr.,
Gulf of Mexico Fisheries Management Council

During World War II, fishermen were declared essential to food production for the war effort. Fish and shrimp were not rationed as was red meat, but they were under price control. These war time price controls resulted in the first federal regulation I recall in the shrimp industry. The OPA established the number of shrimp per pound as a uniform measure to define the difference between size and price for shrimp. The first regulations outside of state waters on the shrimp fleet were when the owners volunteered the boats and crews to help the Coast Guard patrol for German submarines. The shrimp fishermen's trade unions helped create many of the state fishing regulations by working with the state fishery agencies and with the cooperation of the fleet owners.

The movement of the shrimp fleet between states was the first contentious issue. Gulf States Marine Fisheries Commission was the result and the solution to this problem. World War II ended and the fishery expanded their operations into Mexico. The Shrimp Association of the Americas (SAOTA) was formed to search for possible solutions to problems between United States and Mexican fisheries. The governments would listen to this organization without being able to give it statutory authority.

The "cold war" and our national security interests helped prod Congress to pass the Magnuson Act in 1976 that extended our territorial sea from 12 to 200 miles and authorized the creation of the eight fishery management councils. In a short time, the other Central and South American countries followed suit by extending their fishery limits. A large fleet of shrimp and red snapper boats who had been fishing foreign waters now had to fish the GOM. The fleets had grown by the assistance of mortgage guarantees from NMFS. These regulatory actions changed fishing practices by area, by number of participants and target specie. "Big Brother" could now control who, what, where, and how fish should be taken. Federal fisheries had been moved from the Dept. of Interior to the Department of Commerce, abolished the Bureau of Commercial Fisheries and created the National Marine Fisheries Service. Some of us soon realized that the mineral resources under the seabed were the true reason for the extension of the territorial sea limit.

The Bureau of Commercial Fisheries was the federal agency responsible for marine fishery. Their research was not so dependent on the grant system of academia as NMFS is today. This bureau helped provide support to commercial fishing as they supplied fish to the non-fishing public. During these years the landing of 10,000 pounds of fish by a commercial gill net fisherman was encouraged and appreciated. It was the sharing of a public resource with 10,000 consumers. The general pubic paid the fisherman by the pound to make sure their share of the public resource was available at the markets and restaurants through out our country. This commercial fishermen's gill net was not portrayed as "walls of death." Bycatch was treated as the recycling of marine organism in the food chain and was not recognized as rape and waste because it fed the sea birds, marine mammals, fish and crustaceans. Nothing is wasted in the sea except where the water is so polluted that animals are not present for natural assimilation to occur. It was recognized that fisheries could not be managed as though it was an aquarium in a controlled environment with a balanced ecology system.

The entry of the Asian population into the Gulf of Mexico fisheries has been important in the shrimp and the longline fisheries. It has been very difficult to quantify or qualify their impact on the fisheries. The language barrier and lack of trust are the main reasons for the problem.

In the late 1970s and early 1980s, the councils started writing their fishery management plans (FMPs) and were required to use the "**best available science**" when making decisions on what species and how these species should be managed. Government agents had collected landing information from seafood dealers for daily market reports. This data was used by NMFS science centers for VPA analysis on the fishery stock conditions in the upper GOM even though it was not collected for that purpose. This was the beginning of a change in fishery science from biology to statistics. Fishery science accepted landings as indices of abundance by allowing statistical mathematical models to create effort while the number of participants was not known. Academia had found a way to substitute statistics for biology and there was less need for fishery independent data from research. Landings from commercial catch could now be used as a foundation for truth and statistical exercises using assumptions and hypotheses as substitutes for anything unknown. Any part that ends up being biologically sound is coincidental. Conservation was once recognized as the "wise utilization of a resource," and the amount of harvest was based on the biology of the animals. At the present, "he who has the gold makes the rule." The state fishery agencies around the GOM have bowed to political pressure of big money and deserted biology for political desire. The examples of this are the gill net bans in the states around the GOM. I hope there is no mistake about who I blame. The governments are to blame because they give priority to political expediency and career goals and use creative science to accomplish both.

During my seven years on the Gulf Council, the stock assessment science has proven to be nothing more than a political tool used for control and re-allocation. All fishermen should be demanding for the objective truth to prevail in science and management. We should not be subjected to this "smoke and mirror science" created by the politically motivated individuals who use unverifiable criteria such as spawn potential ratio's (SPR) to measure stock conditions. This is acceptable because it substitutes sensationalism for truth in the public perception of reality for over-fishing and by-catch. This substitution is politically correct and socially acceptable but it does not change the fact that half-truths are the most horrible type lies because they give the "illusion of truth."

When a biologist does a stock assessment, which does not show the observed condition that exists in a fish stock, the truth would require that he make every attempt to locate the problem. A statistician could and does hide behind a regulatory bureaucratic rule such as the NMFS " Risk Adverse Policy" which mandates, "in the face of uncertainty to err toward conservation." This sounds awesome and inspiring to the general public but they not know that these stock assessments are a "created uncertainty" because:

(1) It assumes what the makeup of an un-fished stock would be.
(2) It assumes that a (VPA) virtual population analysis is correct even though the data used for analysis is flawed, used out of context, or not available.
(3) It assumes to know natural mortality.
(4) It assumes a correct CPUE for historical landings without the availability and environmental conditions and correct effort when stating fishing mortality.
(5) It assumes that the predator and prey relationship is not important by ignoring it or saying it is included in natural mortality.

A true statistician would say that this is what the available data shows — the condition of the **stock might be under perfect conditions.** The truth of a stock assessment is the availability of fish or the lack thereof and is not a subjective term.

When Congress passes a law, the affected agencies write the regulatory authority, which usually contains self-serving political motives of the agency. These regulations are published as a final rule and they become the laws. Congress passed the Magnuson-Stevens Act and one of the mandates was a peer review of the red snapper stock Assessment. Most scientific journals require peer review to be anonymous. This peer review was done under the direction of NMFS. This review was done in a public forum and more than one leading scientist has said the results could have been very different if NMFS have adhered to good anonymous peer review procedures. Flawed data can easily change the results of statistical mathematical models. This has been the case with the red snapper stock assessment and the shrimp trawl by-catch. Extrapolations used to supply missing areas for shrimp effort and assumption of juvenile red snapper spatial distribution are two elements that make the red snapper stock assessment a poor representative of truth. This stock assessment merely creates the illusion of science although the design of the model may be excellent. The results of this flawed data assessment will cost the shrimp industry millions of dollars and have very little effect on red snapper population. As long as NMFS science centers and state fishery agencies use this politico-science for "the best available science" they will continue to allocate by their political desire. The practices described above can also be found in the management of Spanish mackerel, king mackerel and red drum. NMFS, and the state agencies around the GOM, encourage moratoriums on commercial entry, ban use of gear types, and promote area closures, while encouraging recreational expansion. You see the commercial fishery close when its allocation is reached while allowing the recreational harvest to continue. Is this the agency example of **"fish for everyone?"**

The industrial waste from the petro-chemical and paper industries will continue to pollute our rivers, estuaries and oceans. The large tax-exempt foundations and big polluting industries will continue to fund the environmental movement and fishery conservation groups. The advertising media will continue to help them direct the attention away from industrial waste and toward farm run- off and municipal pollution, endangered species, bycatch and overfishing by commercials. The government grants from taxpayer dollars will continue to fund the education system of universities whose research will give credability to creative science and the political agenda of big money because big money controls all government. The advertising industry will continue to control the public perception of reality for their clients.

I offer the following as solutions to some of the problems I perceive in fishery management.

(1) Require that fishery science return to biology.
(2) Require the stock assessment scientists to state how they validated the data they used in their work and what data they specifically need for better results.
(3) Recognize empirical information as part of science by having professional fishermen serve on SSC to help correct errors and assumptions before actions are taken.
(4) Do not allow state fishery officials to vote on fishery management council issues.
(5) Take a strong stand on industrial water pollution.
(6) Promote the fact that commercial fishing offers the only equal opportunity for the non-fishing general public to share in a public resource.
(7) Recognize the fact that the oceans are not closed- system aquariums and cannot be predicted by a mathematical model because nature in itsself is chaotic and unpredictable.
(8) Don't forget that preemption of state laws is available as a management tool.

Let me close by saying that I come from a work ethic culture taught by apprenticeship and actual experience.

My experience of more than 60 years has taught me that truth should not be subjected to need. Truth will stand and endure without support or explanation. Our actions should always be questioned because there are two forces, which cause and motivate all of our actions. One is fear, and the other is character. We are all given the choice of what type of character we build to keep fear from controlling us, as it did while we were children. Good character promotes truth, and it is free from fear. Fear will always control the character of those who hide from truth.

PROBLEMS, SOLUTIONS, AND COMPROMISES: MANAGING TEXAS MARINE RESOURCES

Hal Osburn and Larry D. McKinney
Texas Parks and Wildlife Department

Habitat and fisheries

Texas is blessed with a wide diversity of marine ecosystems including eight major estuarine complexes, from the freshwater dominated sabine lake to the hypersaline laguna madre. There are 2,400 miles of coastal shoreline habitat as well as 4 million acres of saltwater, including the Texas territorial sea out to nine nautical miles.

This diverse marine environment supports significant commercial fisheries with thousands of jobs in direct and indirect employment. Extensive infrastructure has developed throughout the coast to service thousands of commercial vessels and hundreds of seafood dealers. Shrimp is the largest commercial fishery with 69 million pounds landed annually on average, followed by finfish (7 million pounds), crabs (6 million pounds), and oysters (5 million pounds). The expanded economic impact to the state from these fisheries is $550 million.

Major recreational fisheries have also developed in the bays and gulf. These include private, charter, headboats and shorebased anglers supported by a host of fishing and tourist based industries. Boat anglers alone annually expend 6 million man-hours fishing and land 3 million fish. Saltwater angling's economic impact in Texas is $2 billion. The coastal zone also provides extensive non-consumptive recreational opportunities like scuba diving and birdwatching.

Problems

However, along with the many benefits, human habitation and use of the coastal zone has also caused widespread habitat degradation. The resulting stresses on coastal habitat have reduced the productivity and sustainability of the marine resources that are the source of these benefits. Seafood market demands, both domestic and foreign, puts additional pressure from harvesting on these resources. Indeed, the current population of 18 million Texans is expected to double by at least 2050. People want to live by the sea but the greater demands on the habitat and the resources resulting from these population increases need to be anticipated by managers.

Resource managers are, even now, challenged by the loss of critical habitat such as seagrasses and wetlands which, when healthy, represent some of the most productive habitats and nursery areas on earth. Biodiversity and productivity of these ecosystems are now being disrupted by the lack of freshwater inflow from Texas rivers which provide nutrients, sediments and lower salinity critical to estuarine organisms. Historic hydrological regimes and salinity gradients have also been altered by channelization. Industry, agriculture, and urbanization all contribute tons of point and non-point source toxins and other pollutents into the bays. Numerous areas have been closed to fishing and seafood consumption.

Historically abundant resources along the coast have attracted more and more harvesters. These open-access fisheries have resulted in overcapitalized shore-based infrastructure and commercial fleets that must now fish harder and harder to sustain themselves. Heavy fishing pressure also results in excessive bycatch on non-target species which often make up an important part of the food chain. Traditional methods of controlling harvest such as bag limits and closed areas have limited use when there is no cap on the number of fishermen.

Solutions

While these problems are daunting, they are not insurmountable. However, effective long-range planning and timely action will be needed to find and apply appropriate solutions. Managers must begin by collecting better information on the resource and the users. Texas has the most extensive long-term coastal monitoring program in the nation with nearly 24 years of continuous data collection. Sustaining and expanding this program is critical to deciphering long-term solutions. Funds must also be invested in special research projects to fill in numerous data gaps. Those projects must target not just traditional biological questions but also social and economic needs to allow managers to better define optimum yield from our public resources.

Solutions will also require better tools for managers. For example, Senate Bill 1 from the 1997 Texas legislative session provides an opportunity to develop a better plan for assuring adequate freshwater inflows to the bays and estuaries. Expanded limited entry and license buyback programs are other important tools needed to deal with the "tragedy of the commons" occurring in many of our open-access fisheries.

Management regulations are meaningless without good law enforcement. New, high tech products like satellite tracking of illegal pollutant discharges or fishing vessels in closed areas offer the promise of inexpensive and efficient protection for habitat and resources.

It must be recognized that government managers cannot solve the problems alone. A better process for involving coastal constituents must be created and nurtured. Problem solving begins with education of the public to assure understanding and support for the hard decisions that must be made. Bringing all the stakeholders together in a process of co-management will provide maximum input into the decision making. Building partnerships with industry, conservation groups, universities and others has already proven to be a successful way to achieve significant results. This Sea Grant program conference represents an excellent example of creating better information and a better process for managing our coastal resources.

Compromises

Long-term solutions will, undoubtedly, require compromises. The department's recent shrimp and crab fishery limited entry programs were compromises to achieve needed reductions in fishing effort without imposing more restrictive regulations. The commercial fishers can now choose to sell their license back to the department, thus reducing effort over time without creating social and economic chaos for local fishing communities. Compromises are also necessary in protecting habitat. For example, the agreement reached with the city of Corpus Christi to provide minimum releases of freshwater into the nueces estuary from the choke canyon reservoir represents a model for the future. Human needs can be balanced with resource needs when decision makers seek these kinds of long-term solutions.

Developing solutions before problems become intractable is the key to proactive management. Because of past successes with a proactive approach, we can be optimistic that degraded habitats can be restored and declining resource trends can be reversed. Recent examples include the marsh restoration projects in Galveston Bay for both submergent and emergent vegetation. In addition, critically low red drum populations 20 years ago now support a premier sport fishery thanks to more restrictive fishing regulations and stocking efforts. Black drum populations have responded as well to conservation measures and now represent the number one commercial finfish harvested in Texas bays.

Summary

In summary, assuring fish for everyone in the future is a realistic goal. But it will take patience and it will require abandoning our historical perspective that the harvest from the seas is boundless. Crafting compromises to achieve sustainability demands that we gather the right information, apply the right tools, and include the right people in the decision making. By developing environmentally responsible fisheries and ecosystem based management approaches, we can hope to enjoy our coastal resources for generations to come.

DEPENDS ON WHAT YOU MEAN BY EVERYONE

Larry B. Simpson, executive director
Gulf States Marine Fisheries Commission

Let me begin by saying that my comments here today are mine alone and do not represent the official position of the Gulf States Marine Fisheries Commission. As I contemplated this panel's assigned topic, *Fish for Everyone*, it begged several questions. First, do we want fish for everyone? Second, should we attempt to provide fish for everyone?

My contribution to this provocative question (and I realize that was its purpose) is to back up and begin with a basic foundation. In my mind, we as Americans all have the same rights to the marine resources of this Nation. Those rights must be tempered with what is best for the fish and what is best for society. For example, it would be like whales belonging to all of us; however, killing whales to eat or for oil is not in the best interest of the animal or society. Therefore, I must suppress my personal desire for whale products for the greater good. Having said that, I can even further subjugate my rights in favor of a group of Aleuts whose culture has historically had a reasonable take of this resource. It may be that a spiritual or cultural explanation has been reasoned to my satisfaction. Some may say that this is too much waffling. Not in my mind it is not.

The difficulty is working all of our personal desires and subjugations into a workable management scheme. Each specific fishery contains a common thread of rights that are subjugated for the greater good. Let us take king mackerel, for example. In the spring, king mackerel migrate from southern Florida up to the northern gulf at least to the mouth of the Mississippi River. An important fishery has developed and still exists for this fish in Florida. Management determined that the fishery must limit take, known as Total Allowable Catch (TAC), and included in those limitations an allowable fish size as well. On at least one occasion in the past, the Florida fishery landed the entire allowable harvest. This left the northern states without the opportunity to harvest their historical portion. This certainly is neither reasonable nor proper under any standard. The situation has been rectified by the establishment of zones, take quotas, and fishing years that start based on life history within those areas. That way, the entire Gulf of Mexico fishing and consuming public share in the resource.

This is just one example to demonstrate that we must give up some of our individual rights and desires for the greater good. We must defer our ability to capture fish to the management regime in order for others to capture fish. Obviously, that management regime must be well thought out, examined carefully, and should include input from all sectors affected. Also, the data used for decision-making must be the best possible.

Problems occur with people and management of fish when we buy into a management regime with our hearts and not our heads. Management of this nation's natural marine resources is far too important to play games with. Some of the stewards bestowed with management responsibility have consciously and unconsciously played a game with fisheries management. Some users of this nation's natural marine resources have been less than honest about reporting what, when, where, and how much they have caught. Some users have even given false testimony to management bodies that have caused inappropriate actions to be taken against others sharing in the resource. It is a matter of commitment to a management scheme and good information for that system to use in its deliberations.

One other thought here — if we commit and the outcome is not what we want or the direction is different from what one individual or group of individuals would like — we should still stick with the system. That is the hard part. All is fine until your own ox is gored. If the group or individual always got its way, there would be no need for a system. Management by its very definition is limiting. We buy in for better or worse. It is like breakfast, the chicken is involved, but the hog is committed.

The decision point in sharing, allocating, and managing marine resources is when we agree to the system. In the case of the federal fishery management councils, the Congress of the United States (through elective delegation of powers from us to them) are the decision makers with regard to what kind of management scheme we operate under.

Now that I have established this foundation, I will move onto the panel question — *Fish for Everyone?* Twenty years ago, I would have said yes. Now, I say no. What changed? The finite nature of the resource, an ever increasing human population, limited species that are being targeted, better technology, and more habitat loss and degradation. These are just some of the reasons my position has changed.

I used to love to bass fish. Still do really, but the traffic in my area of the world became too distracting for my personal goals of success to be satisfactorily met. Before jet skis, there were the water skiers. Before water skiers, there were those other bass fishermen who invaded my personal space when I was fishing. I have given directions out of the myriad of bayous and swamps that took me a lifetime of youthful days to learn and explore. This, along with the good-hearted boy scouts of the area who put signs up naming the various watery veins coupled with maps at every fish camp helped some of the hapless fools but not completely. I have towed the, heaven forbid, "California Yankees" back to civilization when their unmaintained boats broke down in my domain. Yes, I have broken down too, but that does not count. It just got harder and harder to catch big bass from public waters, so I went to an ultralight gear to simulate the action I wanted on smaller fish.

My favorite species to catch are flounder, bass, spotted seatrout, and red drum. I really do not care about much else. I love to eat a variety of other species, but many of them I could care less about catching because of my own personal views of what is fun. So I depend on others to supply my share of those resources to me. If others were as closed minded as I am, and I have no doubt they are, you see where the problems are concentrated. What is the answer? *Fish for Everyone?* Someone's ox is fixin' to get gored. Have you ever seen someone just learning to play tennis or golf? You painfully watch for a few minutes then you say to yourself, "that can't be fun." That's the way I feel about the current state of public domain fishing. I now have to go to Cocodrie, Louisiana, and then forever from there to get what I consider good fishing on a regular basis. Float trips by canoe well beyond the boat ramp-reaches of power or trips to a private lake are now required to get the kind of bass fishing I like. I floated a cold water, sandy bottom creek in south Mississippi for 13 consecutive years with like-minded buddies. Put in on Thursday afternoon and came out sometime Sunday, sunburned but with a smile on our faces.

I have bought into the state establishing the management regime and will live by the law, but if I had my way, I would limit the participation of others on the species and places I want to fish back to the way it was twenty years ago. Limit the sale of new boats, limit access to certain areas, and make catch and release mandatory for bass. Well, now that I have made a point, you see what I am getting at. We all have our own way we would do things. I do not really feel that way about my ideal management scheme, well not completely anyway.

Back to the panel question - *Fish for Everyone?* It depends on what you mean by everyone. Is the real question, will you submit to everyone having an equal chance at our Nation's fishery resources? My answer is yes. I have some fixed opinions about how we should manage certain fish as well as some firm thoughts about how we should manage the people who target them. Even given all of that, I still will submit to the management authority placed over this responsibly. I only wish everyone thought like me. Maybe you all would too if you had my same desires and background. Until then, I guess we just have to put our faith in a system established by rule of law and the professionals and others who are in the position to establish management measures. This will just have to do until I am king of the world, that is.

MARINE EDUCATION: WHAT WORKS?

WORKING WITH THE MASS MEDIA: IF YOU LIKE THE GULF'S DEAD ZONE, YOU'LL LOVE THE MEDIA'S

Peter Dykstra, Senior Producer
Environmental Unit, CNN/Turner Broadcasting

January is a tough enough time for New England lobstermen, but when a tugboat and a bunker-oil barge ran aground off Point Judith, Rhode Island two years ago, things got a whole lot worse. A comparatively minor spill managed to make some history: It was arguably the first time that news coverage of a spill did more harm than the oil did.

The barge snagged a sandbar in the midst of a locally treasured lobstering ground. By the next morning, the remarkable scene of hundreds of oil-soaked lobsters, hauled out onto the beach to die, dominated local newscasts in Boston and Providence. For field producers, reporters, and cameramen, it was The Shot That Told the Whole Story: Dead, messy lobsters against a backdrop of breaking waves, whirring helicopters, gooey oil, and the stricken barge, swarming with Coast Guardsmen effecting a rescue.

The Point Judith fishermen were shut down. But in Portland, Maine and other ports hundreds of miles from the nearest drop of spilled oil, a slow season for lobstermen became a much slower one. From Halifax to Harlingen, lobsters didn't exactly get the benefit of the doubt in the Krogers, Safeways, and Red Lobsters of the world. Fishermen suffered, even in areas that were hundreds of miles from the nearest drop of bunker oil.

And the national newscasts? Most didn't consider the story of great national significance; 20 seconds of pictures and a few sentences of words would suffice. The oily corpses of beached lobsters were pretty much the only image that the national audience saw. A business already marginal had suffered a disastrous blow.

Fast Forward to Chesapeake Bay, August 1997: Maryland Governor Parris Glendening stages a deluxe media event, dining on Bay seafood to prove that he's not scared of *Pfiesteria piscicida*. Sore-covered fish and bedridden fishermen had become a recent staple on newscasts. But even if it was confined to a few estuaries, something was very, very wrong. Who would you trust more: Alarming pictures of stricken fish, or a politician who orchestrated a televised feast on blue crab, oysters, and rockfish in order to tell you that everything was fine? From Eastern Shore crab packing plants to Washington DC's waterfront fish markets, seafood sales crashed.

The moral of these stories is that even the straightforward, easy-to-explain stories are vulnerable to misinterpretation. The media can work well for you, or it can be the bane of your existence. Rather than offer solutions for these problems, and the many ways they can affect environmental educators, marine biologists, and others who work on the Gulf, I thought I'd take my time to get you a little more worried about the challenge that we'll face in the next few years. I don't for a moment think we do more harm than good; I think TV news is an invaluable tool for basic education. I don't necessarily recommend it as a place for marine biologists to learn a great deal more about marine biology. But if you're a marine biologist, it's a great way for your neighbors to learn two minutes' more about your line of work than they knew before. But beyond that, sometimes it ain't pretty.

Channel zappers

The profusion of cable TV, not to mention the Internet and other new information sources, gives consumers a wealth of choices. That also means a dearth of attention span. TV news organizations have whittled away at story length in recent years. TV, picture-rich but information-poor, isn't well served by this. Already, a half-hour TV newscast contains roughly the same number of words as two-thirds of a single newspaper page. Now, the fear that two and a half minutes on a single topic will chase viewers away has whittled down the average story length on TV to under two minutes. Put yourself in my place for a minute: Your assignment is to adequately explain an important scientific subject say, endocrine disrupting chemicals, in two minutes. In its simplest terms, this allows me to condense the life's work of scientists like Theo Colborn, who has taken a strong stance that the environmental presence of some persistent organic chemicals is a direct threat to human reproduction, into a single sentence. Her scientific antagonist is Dr. Stephen Safe, who's based right here at Texas A&M. He says the links between certain chemicals and human hormones is unproven at best, and seriously over-hyped at worst.

See, it just took me all these words to explain these two to a group of credentialed scientists and educators. Remind me not to leave out the potential conflict-of-interest parts: Dr. Colborn draws her paycheck from the World Wildlife Fund; Dr. Safe consults for chemical manufacturers.

The big hook

Given the shortness of late 20th-Century attention spans, editors who place stories in newspapers, and news directors or executive producers responsible for setting up TV news broadcasts, are looking for the big hook for a big story. For TV, spectacular video helps. Coral reef stories get a lot of attention, provided they have good underwater video. Weird stories work well; if you don't believe me, check out the enormous attention that's been given to the handful of Manly Men in the Gulf Coast states who catch flathead catfish with their bare hands. Granted, it's an activity that's legal in all but forty-three states. But the seven where it's legal are all within walking distance of the Gulf of Mexico.

A word about OJ

Blame half of it on the media, no more, no less: My employers at CNN take great pride in their skill at bringing a truly global approach to news. CNN's 6pm newscast, WorldView, focuses on international news: A bit less Monica Lewinsky, a bit more Bosnia and Pakistan. It is routinely the lowest-viewership program on CNN's daily schedule. Contrast that with the OJ Simpson case, which my bosses don't brag about as often. It was on CNN 10 hours per day for a year and a half. It averaged three to six times the audience CNN draws when it's merely offering the news of the world. Shame on CNN for pandering to a high-ratings celebrity murder case. But save 50 percent of your shame for the audience who turned out in record number for the spectacle. Does this help explain why the decline of the grouper hasn't yet hit the national press?

What really decides what gets on TV

1) Cost: For a newspaper reporter to visit the Flower Gardens, it would cost a few days time and expenses at worst, kick in the cost of a photographer. For TV, we'd be sending minimum of three people -- maybe more. Already, it costs us at least 50 percent more to cover the same story as the newspaper. The camera costs over $100,000; I bet the print reporter's laptop was at least $99,000 cheaper. The TV reporter and camera crew are under demands to cover several different stories; staying several days is probably not an option. What might cost a newspaper $1,500 in airfare and other costs would cost me three or four times as much.
2) Pictures: Depicting overfishing on TV is difficult; seeing a turtle carcass in a shrimp net doesn't need elaborate explanation. Sometimes, as with the lobsters in Rhode Island, the simple picture tells a simple story. It's just not always the correct one.

Selling a story

Sea Grant communicators, teachers, and marine scientists have to sell a story to someone like me if they think it's important. I'm paid to have at least a good layperson's knowledge of issues ranging from timber harvests to airborne particulates to endangered species to overfishing. Once I'm persuaded that a story's worth airing, we're halfway home. I have to make a sales pitch to my bosses that the story I want to produce is worth putting on the air. Sometimes it's a straightforward sales pitch; sometimes it's not. Here's an example that will curl your teeth and wrinkle your clothes: For about two years, I'd tried unsuccessfully to persuade CNN's national editors that people who lived in off-the-grid homes -- electrically self-sufficient folks who weren't hooked up to anyone's power lines -- were a worthwhile story topic. To spice up the package financially, my story subject was in the Florida Panhandle, less than half a day's drive from Atlanta. No dice; they felt that the idea of off-the-grid homes didn't have any widespread appeal to CNN's audience. Then, along came Hurricane Opal, tearing a swath through the Florida Panhandle, Alabama, and Georgia. We re-submitted the story, this time emphasizing not that this was an off-the-grid home, but that we'd found the only man in the Florida panhandle who had electricity that day. Bingo.

History

TV is context-poor, picture rich. Is that totally bad? No. Science and environment stories tend to leave a lot of room for hype and bombastic predictions. Environmentalists told us that regular flights of the SST would result in massive bird kills near airports. Not. Industrialists told us that failure to build more nuclear plants would have us freezing to death in the dark before the end of the 20th Century. Alrighty. NASA's Steven Schneider told us in the '70s that the greenhouse effect would bump up sea level rise by 20 feet or more. Never Mind. The American Petroleum Institute told us in 1988, amidst a debate about opening up the Arctic National Wildlife Refuge to oil drilling, that there would never ever, ever be a serious oil spill in Alaska. Well & ...

TV is at its best in some cases because it's a great medium for accountability. When people lie, or hype, or make honestly wrong statements, their lips move. And it's in our library. And I love putting it on the air five years later to set the record straight. And when someone's caught in a Big Lie in front of an audience of millions, I don't mind if their Mama's watching.

And much much more

TV specifically, and the mass media in general, can make your work much easier. Or harder. At this conference, I look forward to hearing your feedback and working toward a greater understanding of catching the good parts of interaction between marine educators and the media. We'll throw back the bad ones, okay?

MARINE EDUCATION: NOT JUST FOR STUDENTS ANYMORE WHAT'S WORKING FOR THE FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARY?

Shelly Du Puy, education coordinator
Flower Garden Banks National Marine Sanctuary

Introduction to the Flower Garden Banks National Marine Sanctuary

The Flower Garden Banks National Marine Sanctuary is part of a national system of marine protected areas in the United States and its territories that are administered by the Department of Commerce's National Oceanic and Atmospheric Administration. The National Marine Sanctuary system currently has 12 designated sanctuaries and one proposed sanctuary. The mission of the Marine Sanctuaries Division is to "Serve as the trustee for the nation's system of marine protected areas to conserve, protect, and enhance the bio-diversity, ecological integrity, and cultural legacy of these ecosystems."

The Flower Garden Banks National Marine Sanctuary (sanctuary) consists of three separate banks: East Flower Garden, West Flower Garden and Stetson. Each of the banks is an "underwater mountain," surface expressions of salt diapirs pushing upward on the overlaying sediment layers. Located approximately 115 miles directly south of the Texas/Louisiana border, the two Flower Garden Banks support the northernmost hard (i.e. reef building) coral reefs in the United States. Stetson Bank, located about thirty miles northwest of the Flower Gardens, supports a coral/sponge community on silt stone bedrock, but does not support reef building corals. The three banks serve as biological reservoirs for Caribbean species in the northern Gulf of Mexico.

Education in the Flower Garden Banks National Marine Sanctuary

Education plays a significant role in achieving the sanctuary's natural resource protection goals. Like many organizations involved in environmental education today, the Flower Garden Banks National Marine Sanctuary (sanctuary) has adopted a broad definition of "education" in our efforts to protect the natural resources for which we are responsible. Rather than restricting education efforts to students in the classroom, the sanctuary has specific education programs targeting several different audiences, selected based on their current and future potential to directly impact sanctuary resources. Target audiences include recreational SCUBA divers and associated businesses, oil and gas industry, commercial and recreational fishers, educators and students. While the approach for each target audience is different, the goal is the same. We want to convince each audience of the important role played by the Flower Gardens in the Gulf of Mexico ecology and help them make the mental links between their daily actions and the effect they have on offshore areas, such as the sanctuary. All of the programs require one or more cooperative partnerships to be successful.

Recreational SCUBA diving community

Recreational divers are the primary user group in the sanctuary. While the 3,000 annual diver visits to the Sanctuary may seem minimal compared to the millions visiting the Florida Keys each year, they represent a significant increase from the less than 1,000 annual diver visits to the Sanctuary when it was designated in 1992. To be proactive in preventing potential damage to the reefs caused by diving activities, sanctuary education efforts focus on teaching divers about the natural resources and how they can preserve the resources for future divers. Divers, dive shops and charter operators are targeted through organized functions such as trade expositions and dive clubs where sanctuary staff routinely make presentations and interact one-on-one with divers and industry representatives. Additionally, several specialty programs targeting divers are conducted.

One of our most successful efforts has been a cooperative project with the Reef Environmental Education Foundation (REEF), a non-profit organization committed to involving divers in marine conservation. Each year, REEF sponsors a recreational trip to the sanctuary. Divers participate in a pre-trip fish identification course and then practice their skills by completing fish census forms during each dive. The data are included in a national data base accessible on the internet. The divers learn about the fish and habitats in the sanctuary while providing valuable baseline data that can be used by managers to determine where research and protection efforts should be focused.

Interested divers are also recruited to help hoped, primarily because it depends on being administered by volunteer dive masters on the charter vessel. These volunteers are already kept busy with their primary duties and have little time to present lectures and administer tests. There is no incentive, other than an altruistic endeavor, to motivate them to add to their list of duties. We are considering other methods of delivery, such as purchasing space on the charter vessel during the peak dive season and recruiting volunteers to do nothing but this course. This, however, is an expensive option, so outside funding will be necessary.

Oil and gas industry

The Flower Garden Banks National Marine Sanctuary is surrounded by oil and gas exploration and production. The banks have long been protected from direct impacts of oil and gas operations by no-activity zones, established by the Minerals Management Service (MMS). They are further protected by MMS's four-mile zone in which oil and gas operations are required to follow more conservative procedures. Monitoring, to date, has indicated no discernible impacts to the reefs from oil and gas operations in the area. This success has been largely dependent upon the industry adhering to the regulations without excessive enforcement being required. To encourage individual industry representatives to voluntarily comply with these safeguards, we target them with several programs.

Oil and gas representatives routinely attend training sessions to keep them abreast of current regulations, technologies and industry standards. Sanctuary staff participate in many of these sessions by presenting programs that show industry representatives the resources that are being protected when they adhere to the regulations. Presentations also include refresher topics on the regulations and proper communications with the sanctuary in the event of a spill or other emergency. In addition to gaining knowledge, these presentations allow industry representatives to personalize the sanctuary and its resources by meeting sanctuary staff and developing individual rapport with them.

Oil and gas operators are also required by MMS to conduct periodic oil spill drills in which they role play what should happen in the event of a spill. The sanctuary is frequently part of the scenario, especially for those companies with operations in the vicinity of the Flower Gardens and/or Stetson Bank. This offers an opportunity for the individuals who would be involved in addressing a spill to refresh their knowledge of sanctuary regulations and to speak with the appropriate sanctuary staff.

When the sanctuary was designated, oversight of oil and gas activities remained with the MMS to avoid duplicative regulatory efforts. To insure that sanctuary resources are fully protected and that sanctuary staff remain abreast of on-going activities, MMS requires that all proposed activities inside the four-mile zone are reviewed by sanctuary staff. MMS also coordinates with the sanctuary in cases where activities outside the four-mile zone are likely to affect sanctuary resources. Additionally, MMS and the sanctuary split the annual cost of monitoring at the Flower Gardens and cooperatively determine how it will be conducted to insure that any long-term, chronic effects of oil and gas activities will be detected. Such routine coordination educates MMS staff about current sanctuary policies and activities.

Fishers

While most types of fishing are not allowed (spear fishing, bottom long-lining, trawls, traps), traditional hook and line fishing is allowed inside the sanctuary. This definition specifically allows electric reels, which can include both recreational and commercial operations, provided they are not trawling along the bottom. No accurate data exists on how much fishing activity takes place in the sanctuary. Recent anecdotal information, however, suggests that there may be enough to adversely affect sanctuary resources, especially from commercial snapper/grouper operations. To gain a better understanding of fishing frequency, the sanctuary has recently begun coordinating closely with the U.S. Coast Guard to obtain the information during routine over flights of the Flower Gardens and Stetson Bank. Once the appropriate data are gathered, the sanctuary can more effectively target education efforts.

In the meantime, fliers have been developed to target commercial snapper/grouper fishers. Regulations regarding fishing in the sanctuary have been summarized for quick reading to let commercial fishers know what types of fishing are not allowed. The information was distributed to fishers through cooperation with Fishery Reporting Specialists of the National Marine Fisheries Service.

Educators and students

Today's students are tomorrow's sanctuary users and supporters. By instilling love, respect and understanding of the marine world in students, we are cultivating a well informed sanctuary constituency for the future. By focusing on the educators, including classroom teachers, youth organization leaders, nature parks, zoos, museums and aquariums, we can use the multiplier effect of one educator reaching many students to reach a far greater number of individual students than if we concentrated on students alone.

The most effective educator program to date is the annual *Down Under, Out Yonder* Education Workshop and Field Excursion. Sponsored by the Gulf of Mexico Foundation's Flower Gardens Fund and organized by sanctuary staff, the annual workshop takes a small group of teachers (about 20) each year through a four day workshop. Participants start off with a full day of classroom lectures on land, covering topics such as coral reef biology, overview of sanctuary resources, human and natural impacts on those resources, overview of sanctuary activities, and training in coral reef fish identification and censusing. Following the classroom lectures, participants spend three days diving in the sanctuary, participating in the fish census and interacting with sanctuary researchers. Although the number of teachers reached with this workshop is comparatively small, those who participate come away with a more in-depth understanding of the sanctuary ecosystems than do the larger numbers of educators reached through strictly land-based workshops. The greater understanding and first hand experiences foster intense enthusiasm and more effective instruction of students.

While we would prefer to take all educators through the field excursion, that is not possible. To reach those educators unable to take the field excursion, sanctuary staff make presentations in a variety of venues for educators, especially educator conferences and workshops sponsored by other organizations. To facilitate bringing the marine world into the classroom, the sanctuary has developed *Corals to Classrooms,* a traveling trunk with coral skeleton samples and teaching aids such as video, slides and learning activities. The trunks are available for loan to educators, who are responsible for return shipping.

While educators are the greater focus, we also try to provide first hand exposure to sanctuary staff for students by offering classroom presentations, attending local environmental festivals, participating in career workshops and answering student requests for information about the sanctuary.

Is it working?

Are the sanctuary education efforts working? We have conducted no statistically valid evaluations of the effectiveness of these programs. Those familiar with social research know well the difficulties of measuring existing human attitudes, much less the change in human attitudes resulting from specific education efforts. We have, however, attempted to evaluate our efforts with less exacting methods such as pre- and post-tests for knowledge gained, evaluation questionnaires completed by program participants, anecdotal feedback from constituents and changes in the volume and type of requests for information.

Pre- and post-tests indicate there is an increase in knowledge about the sanctuary and its resources among workshop participants. We can only hope that the new knowledge enhances attitude and behavior changes. We have also noted a decrease in misunderstandings about what is allowed in the sanctuary, especially regarding fishing, among sanctuary users. Also noted, are increases in the number of people calling to say "I hear the Flower Gardens are protected now; what do I need to know before I visit?" or simply "What can you tell me about the Flower Gardens?" There has also been an increase in the complexity of the questions being asked, indicating that people are truly looking to understand how best to protect the resources.

Summary

Education in the Flower Garden Banks National Marine Sanctuary is designed to meet the sanctuary's management objectives of protecting the natural resources. Education is broadly defined to include all user groups and constituents. Specific programs have been developed to target specific audiences deemed by the sanctuary to have the greatest potential for affecting sanctuary resources. General evaluation indicates that the combined education efforts have a positive effect in increasing awareness of the sanctuary and its resources and in prompting users to find out how they can help protect those resources.

For more information about how to participate in any of the Flower Garden Banks National Marine Sanctuary education efforts, please contact Shelley Du Puy, Education Coordinator, at 409-779-2705 or sdupuy@ocean.nos.noaa.gov.

CURRENTS IN THE GULF: CHANGE, CHALLENGE, AND CHOICE

Mary Jane Naquin, President
Informed Futures

The inside cover of the Conference brochure has a quote by Richard Wilbur. It reads

"All that we do is touched with ocean, yet we remain on the shore of what we know."

This conference is about knowing, but it is also about leaving that safe and comfortable shore of certainty, and swimming in waters that are unfamiliar and may have many under currents and tows.

We know more than ever before about the world we live in. We call this the *Information Age*, a period of time in which information doubles every 12 to 18 months. And, though we know more, we recognize that the information we deal with is always changing and that the shore we stand on today will be different tomorrow, and different next year.

Knowing more in the present compels us to think about the future and anticipate how today will unfold into tomorrow. This is not easy to do. It requires us to question our assumptions about our worldview and our sense of what is, and to express what we hope for and what we fear. Looking at the future raises questions about how to manage resources, how to identify risk and opportunity, how to balance needs, and where and how to exercise our responsibility. When a group such as this, representing may entities, all having unique views, hopes, needs and fears, contemplates its common future it's necessary to do so in a safe environment, one that provides for open, honest comment. It is important to have time to establish relationships and to create processes for communicating and working together. This task alone can be challenging before it addresses the future.

Thinking about the future occurs only if you believe you have choice and can influence how things will unfold. NO one would be here now if this conference were about the past, or if it did not hold some promise of improvement for each attendee's or group's future. You are here because, in some way, you expect change, and want to learn about it, to influence it, and to make it work for you. If you believed you had no choice about the future, and that planning for the next generation was not important, you would find other ways to use your time and energy.

However, the starting place is the present — the present as you understand it, and as you define it within the whole group. Without your view of how things are and your needs are being articulated, the future we work toward will not reflect all of the possibilities that it encompasses. Over the past two days you heard reports about what we currently know and understand about the Gulf. Status reports, current perspectives, identification of existing needs, acknowledgment of concerns, resource assessments — all have been reported and heard by you. The next step is to begin shaping a vision for the future and to identify ways to collaborate on common interest and ways to share the gulf's resources.

This body of water exists in a larger context too, and understanding some of the most important forces of change that will impact, it provides a setting in which to think about its future. Here are several inter-related change-drivers that will define the future and the Gulf of Mexico. Although there are others, and counter-trends as well, these factors will give you a picture of possible futures.

Globalization

The Gulf is part of a growing world marketplace and subject to the economic and political conditions of the states and nations that surround it, as well as those of the global citizens that enter and leave its waters. International economics, trade policies, industry regulation, workforce management, and environmental policies — all of these will be at play in the Gulf. Where there have been competing and conflicting interests in the past, be assured that there will be others and more in the next decades.

The geographical location of this body of water makes it a main artery of economic and political power, a transportation pathway for many products, people and problems, and a vulnerable target for those who want to harm or influence its stakeholders — politically, economically or environmentally.

Economic systems

The Gulf will continue to be a center of energy, a source of food, and the playground for a population that has more money, time and interest in leisure activities. It will become a launch pad for new ventures, and the site of new scientific interest, and technical work arena for those wanting to explore it and harvest its deepest resources. Whereas in the past we have seen economies move in an east to west pattern, in the future we may find economic powers that are centered in regions, and whose primary dynamic flow is north and south. This makes the Gulf of Mexico one of the most strategic economic centers in the future. A threat to a strong economic future is the existing gap between the "haves" and the "have nots," not only around the Gulf, but throughout the world.

Demographic patterns

We know there will be more people in the future, and more of them will live near and use the Gulf. Changing fertility rates and immigration drive continued growth and expansion of the United States' population (especially in the Sun Belt region). Hispanics in the southwest will shape the culture, the politics, and how business is done. Diversity will be observed in lifestyle, religious expression, and family structures. Spanish will be the second language in the United States and will be used across the Gulf. Water has no boundaries that are solid, and neither will the societies that are located on the Gulf shores. A common culture could evolve in which the unique features of ethnic groups are maintained and an overlaying system of values, customs and norms evolve. The warm climate could promote a blending of many activities into a lifestyle that is integrated, rich in texture and hospitable to the diversity that composes it.

We also are aging worldwide, and an aging population creates a shift in the balance of power. The older generation will have more money for recreation, more political influence because they exercise it, and will reach the developmental stage of "generativity" during which they seek to leave their mark on the world, and to contribute something of value to the future. They will be healthier, more active, and more educated. An older population has learned to appreciate the world, and many will focus their interests on a sustainable environment.

Values

The environment could become a prominent feature of people's concerns in the future. It may become the unifying theme around which community forms and activates, and a shared space where differences seek agreement. Sustainability, a concept we are developing, could become a principle in the ethic of the future. Environmental values will be supported by economies as business realizes it is profitable to be resource-wise.

Companies are increasingly expected to be good environmental citizens. Science will develop technologies that improve performance and productivity, and the public will be better informed about what business does, and how. Public opinion will affect business as better informed citizens pressure industry to do the "right thing. The environment will be a focus of protection, restoration, and enhancement by business, industry, the government, and the public.

"I'll Do It My Way" will be the theme song of regulatory compliance as we move from governmental prescription to flexible innovation in meeting standards and compliance levels. The "throwaway" mindset of the past will shift toward recycling, reclamation and re-manufacturing as one group's waste becomes another group's want, and the notion of "cradle to grave" responsibility will infiltrate manufacturing. And as we learn more about the world ecology we will be called to act even more responsibly.

These are only a few of the changing currents to consider when thinking of the future of the Gulf of Mexico. These changes will present us with challenges of governance, resource utilization, and of access to timely and accurate information — more commonly called communication. We will be challenged to create new structures to manage the diversity of stakeholders and the constituents of the Gulf of Mexico.

In managing multiple perspectives and needs in an arena that is as complex as the Gulf it is difficult but necessary to find unifying elements. Users are faced with speaking to multiple jurisdictions, negotiating different and competing agendas, and managing pressures of time, the varying magnitudes of need, and deficits of authority. These conditions impinge on developing a shared agenda for the future and threaten our ability to blend the diverse interests using the Gulf.

There are obstacles that must be broached and **challenges** that will be met to be successful in creating a shared agenda for the future of the Gulf. They fall into six broad interrelated categories — ignorance, neglect, parochialism, fit, timing and scarcity.

Ignorance

Too few people see the big picture and the complexities that exist in the Gulf. Our present educational systems do not address problems at the "meta" level. School systems themselves don't fully comprehend problems such as these, and don't teach the creative thinking, analysis, or synthesis which complex problems require. There is no program for group reflection, and no system of negotiation with the sophistication needed to be practical. Most students leave school with very rudimentary methods for dealing with situations involving local to international players, scientific and environmental issues, with economic and cultural components. Most scholars do not address the masses but focus on narrow subjects for specific audiences, and journalists deal with day to day events that sell the news. There are no comprehensive educational systems to teach these lessons or to help students understand multiple agendas. These Gulf of Mexico complexities require critical analysis by interdisciplinary groups rather than hit or miss sound bytes that focus on quick fixes. In addition, much of the public is too preoccupied with basic life needs to have time to reflect on larger issues and often unable to absorb peripheral fragments of information that is embedded in other contexts. Moreover, to grasp the challenges of the Gulf's status, one must first understand their own biases and socio/political filters in order to set them aside and let more global learning occur.

Neglect

Indifference to the realities found by educating oneself about the Gulf of Mexico is the next level of challenge. Denial is a psychological defense mechanism we use in order not to deal with difficult problems. Pushing bad news out of mind prevents our accepting its reality. We subconsciously wish the idea of something amiss would just go away, that something else will intervene, and things will take care of themselves. This is the human condition at work. Some problems seem too big to imagine, and helplessness sets in. Moreover, if a problem does not affect us directly it is easy to neglect because we tend to disown it. In addition, those things that are potential burdens in the future are easily set aside as we more readily react to other risks that are more imminent in time.

Awareness goes before concern, and concern must be experienced at the feeling level before it is acted upon. Fear is a motivator, just as is anger, but we suppress and displace them instead of directing them in useful ways. Responses come out of an informed mind and stimulate action. Ignorance leads to apathy (from "a" without, and "pathos" arousal or feeling) and apathy leads to neglect. Consequently, good solutions and available tools are wasted, and in time become useless because problems change and take on different, often more serious, dimensions.

Parochialism

There is a tendency in all of us toward self-interest and socially ingrained move to preserving positions; this prevents cooperation and collaboration. We live and thrive in a society that values winning. Commitment to winning (with its implied *losing* to the other side) keeps conflicting goals in place and stymies finding common ground (water). Belief in the "one, right way" means closing off alternatives, innovations, and stalls action. Worse, it prevents the formation of new communities that share an interest in a common future. It stops the process of listening, learning and growing because it focuses energy on preserving a position, an ideology, a view. This is a narrow but safe space for those who resist accepting difference, and abhor leaving their comfort zone.

Fit

Some solutions are not the right size for the problem. If the issue is one of power, the solution used should be at the level of the issue. For example, a political solution imposed to create an orderly system can have consequences that do just the opposite and yield more chaos. Or an economic tool inappropriately applied can cause unintended damage to another part of the system. The most obvious solutions are often the most visible and immediate, (such as regulatory or economic measures) whereas the most appropriate tools, like dialogue and reflection, are subtle and require time to implement properly. Moreover, change with these approaches is often hard to identify and track because it takes place at the level of consciousness and has a subtle path of movement. In addition, we think of ourselves as "decision makers" which implies visible action that is supported by resources. Reconciling interests and competing factions produces justice, satisfaction and voluntary change that is not measurable, can't be tracked, and lacks authoritative implementation.

Timing

Some of the solutions we bring in are "too little, too late", therefore they fail. Others are too much too quickly, and these don't work either. Looking at the root of the problem rather than the symptom is the first step in timing the response. Understanding the system of interest, its goals, rewards and relationships takes time, but is essential to smooth functioning. Problem prevention is preferable to over or under applied means. Looking ahead for trouble spots and strife and being willing to manage from multiple views keeps prevention on track and bad timing out of the system.

Scarcity

Resources can be insufficient, or can be perceived to be insufficient, for the needs of the whole system, which leads to fear and competition for their use. Real or perceived scarcity has the same outcome — it stops cooperation, creates defenses, and leads to conflict. Natural, economic and human resources are essential for survival, and must be protected and invested for the future. But by concentrating on one aspect of scarcity and acting to protect it out of fear, it diminishes the others. While natural and economic resources may be limited, the human resources of intellect, imagination, judgment and vision are not limited and are actually more critical. We have at hand the technical means to solve many problems, but lack the human will or judgment to do so. By emphasizing our human resources and utilizing them we can compensate for our scarcities, perhaps finding even greater resources available than we had imagined.

This brings us to the greatest of the challenges for the future of the Gulf — that of **choice**.

We find ourselves on Richard Wilbur's shore of our knowing and in the Gulf are our choices. Tomorrow you will come back for the final session having heard many views from multiple speakers over a two-day period. You will be invited to look at what you've learned, and to find its overlapping interests, its common themes, its parallel agendas, and to formulate a system that can meet the changes in the future and resolve the challenges I've just outlined for you.

You have heard current assessments of resources and about pending issues from industry, from academics, from fishery from environmentalists. You are more familiar than before with the array of the Gulf's resources and the ways we use them. Most importantly, you have engaged in dialogue with others and have knowledge of others' interests and needs. The future rests on relationships and the mutual needs and rewards they represent in the larger scheme of things.

Tomorrow you will make an initial **choice.** You will decide whether to view the future of the Gulf of Mexico from the perspective of vulnerable position or from the perspective of common interests.

If you chose to interact from a position perspective, it derives from a belief system that says

the pie is limited

a win for me is a loss for you

we are opponents

there is one right solution — mine

I must stay on the offensive and be guarded

to concede something is a sign of weakness

If you communicate from the perspective of interests, the system of beliefs includes

an unlimited pie, or one of unknown limits

a commitment to win/win agreements

listening and hearing all needs

collaborating to solve problems

building and keeping relationships

creating many alternative solutions

If you chose to dialogue on interest, your interaction in the session will have a different character than if you choose to engage from a position orientation. The choice is each individual's, realizing that each choice about sharing the Gulf of Mexico shapes its future.

I began this material with a quotation about the water and the shore that I noticed in the Conference brochure. I want to leave you with another story about water and the shore that a long-time friend of mine sent me. It is called "The Enlightenment" and speaks about change, the uncertainty of what we think we know, and what is really important.

We are in the great torrent of historical time. Native American storyteller, Choquosh says:

"The elders have sent me here to tell you the NOW is like a rushing river, and this will be experienced in many different ways.

There are those who would hold on the shore . . .there is no shore.

The shore is crumbling . . .

Push off into the middle of the river.

Keep your head above water, see who else is in the river with you, and celebrate."

SEA GRANT STUDENT AWARD RECIPIENTS

ANEMIC OCEANS

Nicklaus Simpson
Stone High School
Wiggins, MS

The purpose of this project was to determine if life could be restored to barren waters by adding certain supplements. It was hypothesized that additives would increase the growth of algae. I visited the J.L Scott Marine Education Center in Ocean Springs, Mississippi for information on algae and salt water. Porphyridium algae were ordered from the Carolina Biological Supply Company. I obtained salt water that had been collected from the Mississippi River sound and autoclaved at the J.L. Scott Marine Education Center.

The flasks for my experiment were sterilized by boiling them in water for 15 minutes. The prepared salt water and 2 mL of algae medium with Porphyridium were added to the flasks. Each flask was labeled and one drop of fertilizer was added to flasks d, e and f. One-half gram of iron filings was added to flasks g, h and i. Flasks a, b and c served as controls. The flasks were checked weekly for alga growth, and an algae count was made. The results of this project were that the control flasks contained an average beginning count of 18 and an average ending count of 35. The fertilizer flasks had an average beginning count of 19 and an average ending count of 52. The iron filings flasks had an average beginning count of 19 and an average ending count of 82. The hypothesis was proven correct.

The idea for this project was found in "E Magazine." It appealed to me because I felt it would be beneficial to our world to be able to eliminate the dead zones in our oceans. I was able to contact the author of the article by e-mail after the project was completed.

THE ACCELERATION OF EUTROPHICATION IN DIHYDROGEN MONOXIDE CAUSED BY NUTRIENT-ENRICHED AGRICULTURAL RUN-OFF

Amy Waguespack
Lutcher High School
Lutcher, Louisiana

The purpose of this project is to determine the effect of agricultural run-off, enriched with phosphate and nitrate, on the eutrophication of water. Also this project will determine if the acceleration of eutrophication affects the oxygen levels in water.

Phosphate and nitrate were introduced as pollutants into water samples from Blind River. All of the samples were observed for an increase of algal bloom. Tests were conducted to determine pH, dissolved oxygen, total organic carbon, inorganic carbon, total carbon and turbidity.

In another experiment, phosphate and nitrate were placed in samples containing an algae culture of chlorella, closterium or clamydomonas. The acceleration of algal bloom and pH were noted in each sample.

In the last experiment, detergents – Cascade and Arrow – and the fertilizer Miracle Gro were introduced into water samples from Blind River. In each sample, the increase in algal bloom and pH were noted.

The conclusion of this project is that agricultural run-off enriched with phosphate and nitrate does accelerate the eutrophication in water. It was also concluded that the acceleration of eutrophication does affect the oxygen levels in water.

EROSION AND JETTIES

Elisa Moreno
Gladys Porter High School
Brownsville, Texas

The original idea for this project came to me while reading a magazine at the library. As I read, I learned about people who lost their homes and property to erosion. I also read about different barriers that slow erosion to an extent but do not stop it. I decided to try another method of prevention in regards to erosion. Before doing this, I researched the topic of the American shoreline and the loss of it. Them, I proceeded to do the project.

The purpose of this experiment was to determine the amount of erosion waves would produce using a constant flow rate. The materials used were the following: sand, a large rectangular container, a wooden board, a six-inch long tube, a motor and a metal frame. The critical steps in this experiment involved generating waves, maintaining a constant flow rate and measuring the amount of eroded sand. The erosion was dependent on the way the jetties were constructed. Different points on the beach indicated how much shoreline eroded in centimeters.

I found that a certain type of jetty design consistently prevented more erosion. After conducting this experiment, I realized I had gained a lot of knowledge about the beach and how to protect our shoreline.

THE LEVELS OF MERCURY IN CULTIVATED AND UNCULTIVATED FISH

Rushi Patel
Lecanto High School
Hernando, Florida

This project involves the findings of mercury in predatory animals. I measured muscle and retinal tissue for mercury levels and hypothesized that the farm-raised catfish would have the least amount of mercury in their tissues.

This method details the digestion of tissue samples of the muscles and the retina of four different types of fish for the total mercury content. First, add 25 grams of permanganate crystals to a 500-mL Nalgene bottle that is half full of de-ionized water. Also, add 12.5 grams of potassium persulfate to a 250-mL Nalgene bottle and dilute it to a volume of 500 mL with de-ionized water. Mix well. Take a sample of each different fillet in a fish, homogenize it and mix all the samples together from that particular fish. The tissue for the muscle and the retina should now weigh between 0.245-0.248 g.

Next, spike all of the vessels with sulfuric acid and nitric acid. To help speed the process up, put these containers in a hot-water bath. After allowing the vessels to cool, take the vessels out of the bath and add 40 mL of de-ionized water to each. Now, add the potassium permanganate and the potassium persulfate to the vessels. Allow 12 hours before starting analysis.

This method measures the mercury content in the tissue using cold vapor-absorption spectroscopy. Samples are treated with hydroxlamin hydrochloride. Next, antifoam is added to all of the vessels. To allow excess gases escape, sonication is required. Stannous chloride makes the mercury readable from Hg^{2+} to Hg°. Each sample takes three minutes to read.

My hypothesis supported the data, but the pH levels that are acidic to this environment are normal. Acidic environments should contain higher mercury concentrations. In conclusion, aquacultural products, however, should be able to change the acidic levels with filtration methods and buffer solutions.

POSTER SESSION

MODELING OPTIMUM INFLOWS IN BAYS AND ESTUARIES

Gary L. Powell* and Junji Matsumoto
Texas Water Development Board
Austin, Texas.

The Texas Water Development Board (TWDB) and the Texas Parks & Wildlife Department (TPWD) have jointly established and maintained a data collection and analytical study program, under legislative mandate, focused on determining the effects and needs for freshwater inflows to the state's bays and estuaries. Freshwater inflows to the estuaries are compiled from gauged streamflow records and TxRR rainfall-runoff modeling of ungauged drainage areas, with corrections for permitted diversions and return flows from water users. The biological data are compiled from TPWD's commercial harvest records and coastal fisheries monitoring data. For the purpose of determining inflow needs, statistical regression models and other numerical analyses are developed to provide quantitative relationships among freshwater inflows, estuarine salinities, and coastal fisheries species. A compartment model (STELLA) is used to account for nutrient loading and biogeochemical cycling, and develop estuary nutrient budgets. Constraints on estuary sedimentation, if any, are analyzed using SED5 accretion model. Results from these models are placed into the TxEMP model, along with information salinity viability limits for survival, growth, and reproduction of estuarine plants and animals, and solved mathematically to meet state management objectives for maintenance of biological productivity and overall ecological health. TxEMP is a non-linear, stochastic, multi-objective, mathematical programming (optimization) model that was specifically developed as a tool for decision-making on the freshwater inflow needs of Texas bays and estuaries. Feasible solutions from the TxEMP model are verified TWDB's TxBLEND modeling of resulting circulation and salinity patterns, as well as TPWD's analyses of species abundance and distribution patterns.

BIOLOGICAL EFFECTS OF MECHANICAL BEACH RAKING IN THE UPPER INTERTIDAL ZONE ON PADRE ISLAND NATIONAL SEASHORE, TEXAS

Tannika Engelhard and Kim Withers
Center for Coastal Studies
Texas A&M University - Corpus Christi, Texas

Padre Island National Seashore (PINS) employs mechanical raking as a public-use management practice for removal of beach wrack to improve the aesthetic quality of the beach for visitors. This study was undertaken to determine effects of mechanical raking and to offer management recommendations. Four sites along Malaquite Beach were sampled May through September 1997. Two treatments were applied, weekly and bi-weekly raking. Samples were collected on days 3, 7, 10 and 14 following raking. Avian abundance, macrofaunal abundance and biomass and sediment parameters (Chlorophyll (alpha sign %TOC and % water) were determined for raked and unraked areas and analyzed using a two factor ANOVA. Results indicated that the dominant invertebrate macrofauna could be grouped into benthic organisms and organisms associated with wrack material. Both groups were affected to some extent. The greatest differences between raked and unraked sites occurred within three days following raking with mean density and biomass significantly higher in unraked areas for all macrofauna. No significant differences existed between raked and unraked areas by Day 14. Sediment parameters exhibited no significant differences between sites for any days. As a result, it was concluded that macrofaunal density and biomass decreased due to raking either by direct removal or as a result of vertical migration into the sand column in response to disturbance caused by raking. Bird abundance was not significantly different between raked and unraked sites during the study. Management recommendations were made based on the effects of raking macrofaunal abundance, avian use and public visitation trends.

SEA WORLD OF TEXAS EDUCATION AND RESEARCH PROGRAMS

Paige W. Newman

Sea World of Texas opened in May 1988 in San Antonio, Texas, approximately 150 miles from the Gulf of Mexico. Education, research, and public awareness of marine life are our fundamental corporate mission. Sea World's primary education tools are the entertainment-orientated shows, animal exhibits, and educational programs. These programs offer more in-depth curriculum, such as tours, workshops, camps, field trips, and outreach programs for all ages. We have had more than one million participants in these programs.

Sea World promotes and provides facilities and excellent care for the rehabilitation of marine mammals. A Florida manatee (*Trichechus manatus*), a hawksbill sea turtle (*Ertmochelys imbricata*), and bottlenose dolphins (*Tursiops truncatus*) have all successfully been rehabilitated at Sea World of Texas. This rehabilitation process allows our staff an excellent opportunity to study these animals.

Sea World participants in many research programs. Specific to the Gulf of Mexico, Sea World, in conjunction with Texas A&M University, U.S. Fish and Wildlife Service, and the National Marine Fisheries Service, has participated in various Kemp's ridley sea turtle (*Lepidochelys kempii*) research projects, tracking studies, and hormonal studies.

Sea World also has a wonderful base of volunteer employees who form the Sea World Environmental Action Team (SWEAT). SWEAT participates in beach cleanups and other environmental friendly events.

The Gulf of Mexico is an invaluable resource. As a resource, the Gulf should be both used and preserved. At Sea World, we strive to protect this resource, and other, by conservation through education.

DISTRIBUTION OF SPERM WHALES IN THE CENTRAL AND NORTHWESTERN GULF OF MEXICO AS DETERMINED FROM AN ACOUSTIC SURVEY: IMPLICATIONS FOR HABITAT CHARACTERIZATION.

Troy D. Sparks, Jeffery C. Norris, and William E. Evans
Marine Acoustics lab, Center for Bioacoustics
Texas A&M University - Galveston

Recordings of sperm whales (*Physeter macrocephalus*) were collected via a towed passive hydrophone array. The study area ranged from 100-2,000 m isobaths from the Florida-Alabama to the Texas-Mexico borders in the northwestern Gulf of Mexico. The study area was divided into 14 north/south transects at 74 km intervals. Seven cruises were conducted on a seasonal basis from 1992-1994. Sperm whale vocalizations were identified. There were a total of 67 on-effort acoustic sperm whale contacts (a contact is defined as an encounter with a vocal whale or whale group) during 11,997 km of acoustic recording. x2 analysis of depth categories indicated that more sperm whales were observed than expected at a depth range of 711-1,190 m along the continental slope. A x2 analysis of seasons indicated no significant difference in the number of sperm whale contacts across seasons. A x2 analysis of the ocean surface via TOPEX/ERS satellite altimetry data indicated that more sperm whales were observed than expected at a low dynamic height range of -30 to -10 cm. There were sperm whale concentrations in the Mississippi River Canyon and Northwestern Gulf that may be associated with the Loop Current, and eddy formations and decay. These concentrations seemed to be characterized by areas of increased primary and secondary productivity associated with low dynamic height of cold-core eddies and the interactions between warm-core eddies and Mississippi River outflow.

SHARING OUR GULF - A CHALLENGE FOR US ALL

CONFERENCE AGENDA

Wednesday, June 10

7:30-8:30 a.m. **Registration/Continental Breakfast** Lobby

7:45 a.m. **Facilitator Meeting** Theater

8:30-9:15 a.m. **Welcome and Introductory Remarks**
***David Owens**, conference director*
***Robert Stickney**, director, Texas Sea Grant College Program*
***Ronald Douglas**, executive vice president and provost, Texas A&M University*
***Mary Jane Naquin**, president, Informed Futures*
***Ron Baird**, director, National Sea Grant College Program*

9:15-10:15 a.m. **Keynote Address** Theater
***Donna Turgeon**, science program manager, Center for Coastal Monitoring and Assessments*

10:15-10:30 a.m. Morning Break

10:30-11:00 a.m. Small Group Session Theater

11:00-1:00 p.m. Status Reports: How We Use theGulf Meeting Room
***Benny Gallaway**, president, LGL Ecological Research Associates*
***Jim Kachtick**, environmental manager, Southern Region, Occidental Chemical Corporation*
***André Landry**, professor and chairman of Department of Marine Biology, Texas A&M University at Galveston*
***Kenneth Roberts**, marine economics specialist, Louisiana Cooperative Extension Service*
*Moderator - **Robert Stickney**, director, Texas Sea Grant College Program*

`1:00-2:00 p.m. **Lunch and Keynote Address** Meeting Room
***Honorable A.R. "Babe" Schwartz**, attorney and retired Texas senator*

2:00-5:00 p.m. **TEDs, BRDs, and the Fisheries** Meeting Room
***Pete Aparicio**, former president of the Texas Shrimp Association and current member of the Gulf of Mexico Fisheries Management Council*
***Kim Davis**, regional fisheries project manager, Center for Marine Conservation*
***Gary Graham**, marine fisheries specialist, Texas Sea Grant College Program*
***Wade Griffin**, professor of agricultural economics, Texas A&M University*
***Andrew Kemmerer**, southeast regional administrator, National Marine Fisheries Service*
*Moderator- **Steve Branstetter**, program director, Gulf and South Atlantic Fisheries Development Foundation*

3:45-4:00 p.m. **Afternoon Break**

6:00-8:00 p.m. **Reception/Poster Session**

Thursday, June 11

7:30-8:15 a.m. **Registration/Breakfast** Lobby

8:15-8:30 a.m. **Introductory Remarks** Theater
***David Owens**, conference director*
***Robert Ditton**, professor, Department of Wildlife and Fisheries Sciences, Texas A&M University*

8:30-9:30 a.m. **Mexico's Ban on the Turtle Fisheries** Theater
***Representative** from the Instituto Nacional de la Pesca*
***Jack Frazier**, professor, Centro de Investigacion y de Estudios Avanzado*

*Moderator - **René Márquez**, national coordinator, Mexican Sea Turtle Research Program, National Fisheries Institute of Environment, Natural Resources and Fisheries*

9:30-10:30 a.m. **Strandings, Trash and Beaches** Theater

__John Miller__, chief of the Division of Science, Resources Management and Interpretation, Padre Island National Seashore
__Donna Shaver__, research biologist, Biological Resources Division, U.S. Geological Survey
__Graham Worthy__, director, Physiological Ecology and Bioenergetics Laboratory, Department of Marine Biology, Texas A&M University at Galveston
Moderator - __Villere Reggio__, outdoor recreation planner, Gulf of Mexico OCS Region, Minerals Management Service

10:30-10:45 a.m. **Morning Break**

10:45-12:30 p.m. **Pollution and Hypoxia** Theater

__John Barrett__, agricultural row crop producer, San Patricio, Texas
__Edward Buskey__, associate professor, The University of Texas Marine Science Institute
__Greg Boland__, Minerals Management Service
__Donald Harper__, professor of marine biology, Texas A&M University at Galveston
__James Ray__, manager, Environmental Studies, Shell Oil
Moderator - __Sharron Stewart__, Texas Environmental Coalition

12:30-1:30 p.m. **Lunch** Meeting Room

1:30-3:30 p.m. **Fish For Everyone?** Theater

__Jeff Angers__, executive director and CEO, Coastal Conservation Association of Louisiana
__Albert King__, Gulf of Mexico Fisheries Management Council
__Larry McKinney__, senior director for Aquatic Resources, Texas Parks and Wildlife Department
__Larry Simpson__, executive director, Gulf States Marine Fisheries Commission
Moderator - __Robert Ditton__, professor, Department of Wildlife and Fisheries Sciences, Texas A&M University

3:30-3:45 p.m. **Afternoon Break**

3:45-5:00 p.m. **Marine Education: What Works?** Meeting Room

__Peter Dykstra__, senior producer, Environmental Unit, CNN/Turner Broadcasting
__Shelly Du Puy__, education coordinator, Flower Garden Banks National Marine Sanctuary
__George Jessup__, director, Research and Computer Support, College of Education, Texas A&M University
Moderator - __William Younger__, Marine Education Specialist, Texas Sea Grant College Program

6:00-8:00 p.m. **Texas Barbecue** Meeting Room

"Currents in the Gulf: Change, Challenge, and Choice"
__Mary Jane Naquin__, president, Informed Futures

Friday, June 12

7:30-8:15 a.m. **Breakfast**

8:15-8:30 a.m. **Introductory Remarks**

8:30-11:30 a.m. **Small Group Session** Meeting Room

"Paving the Way for Communication and Collaboration"
Mary Jane Naquin, president, Informed Futures

12:00-2:00 p.m. **Lunch/Closing Address**

David Owens, conference director

SHARING OUR GULF REGISTRANTS

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