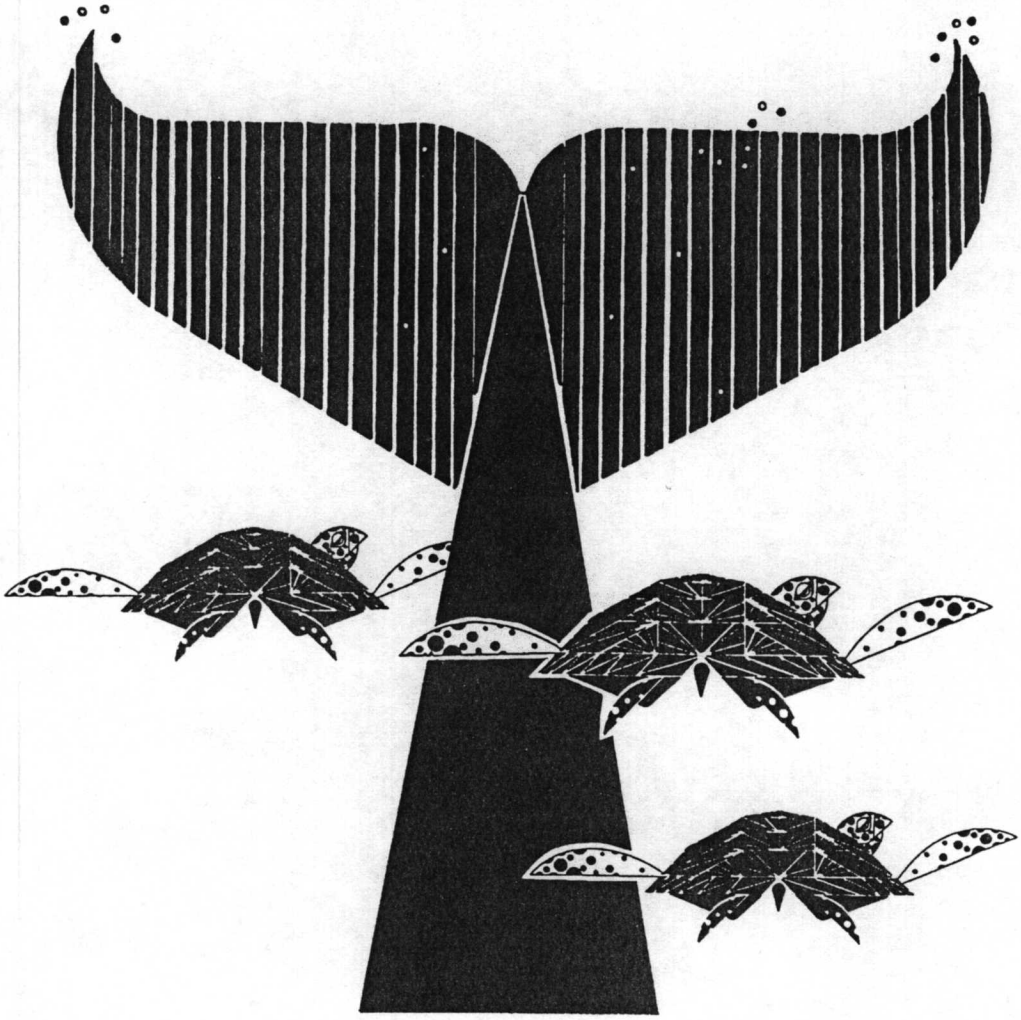
OCS Study
MMS 90-0009

Sea Turtles and Marine Mammals of the Gulf of Mexico

Proceedings of a Workshop Held in New Orleans

August 1-3, 1989



MMS U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

OCS Study
MMS 90-0009

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Prepared by

Tucker & Associates, Inc.

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ABOUT THE COVER

This artwork is part of an original design created by Mr. Charles Harper for the National Park Service. Mr. Harper has granted special permission to the MMS to use elements from his design for publication associated with this Workshop.

FOREWORD

The Minerals Management Service (MMS) has conducted a number of studies to gather information that might be useful for the protection of marine mammals and sea turtles from any adverse impacts due to offshore oil and gas development in the Gulf of Mexico. The MMS planned and conducted a workshop of eminent experts and cognizant agency representatives to evaluate the need for further studies that would address the following issues:

- assessment of available data
- identification of information needs
- consideration of study approaches

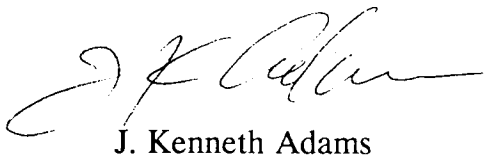
The scope of the workshop was specifically confined to marine mammals and sea turtles that occur in the northern Gulf of Mexico.

This proceedings volume contains summaries of the presentations and discussions of that workshop-- the Gulf of Mexico Sea Turtles and Marine Mammals Workshop, held at the Doubletree Hotel in New Orleans, Louisiana, August 1-3, 1989. The MMS, Gulf of Mexico OCS Regional Office was sponsor and over 150 participants represented Federal and State agencies, universities, and the private sector.

This workshop successfully met MMS goals by providing a reliable foundation for continuing discussions on study needs and approaches. The MMS plans to fund several studies in the coming years and appreciates the efforts and expertise of the workshop participants in contributing to the planning base for these studies.

The MMS wishes to thank Tucker and Associates, Inc., for providing excellent logistical support for the workshop. Special thanks are extended to the project manager,

Ms. Debra Vanderhorst, who planned and monitored workshop activities, ensuring that the workshop ran smoothly and as planned. Her relentless efforts to gather and polish author's manuscripts, figures, and tables have resulted in a quality proceedings volume. Our sincerest appreciation is extended to Debra for her effective management of this project.



J. Kenneth Adams
Regional Supervisor
Leasing and Environment
Gulf of Mexico OCS Region

ABSTRACT

As part of its environmental studies program, the Minerals Management Service Gulf of Mexico Region convened a workshop of scientists, government officials, and oil and gas company executives in summer 1989 to plan future studies regarding sea turtles and marine mammals in the northern Gulf of Mexico. Speakers discussed key relevant provisions of the Marine Mammal Protection and Endangered Species Acts and the status and conservation of these species. Participants emphasized the need to develop an adequate information base that would lead to creation of predictive models. Sea turtle specialists recommended priority be given to the Kemp's ridley sea turtle. Particular goals were listed: compilation and synthesis of existing information; study of pelagic, benthic, and nesting beach habitats; development of standardized marking and biotelemetry techniques and long-term ecological, behavioral, and demographic studies; definition of physiological limits to distribution; determination of toxicological effects; establishment of a biological task force to respond to environmental crises; and development of reliable techniques to identify age, stock, and natural sex ratios. The marine mammal group recommended studies to assess and monitor human activities affecting or potentially affecting marine mammals, including coastal development, commercial fisheries, lost gear and debris, pollution, and platform removals by explosives. Goals were established to determine and monitor levels of pollutants and natural biotoxins in representative northern Gulf mammals; to determine the number and species caught and killed incidentally during commercial fisheries operations; to improve the determination and monitoring of the demography and dynamics of the bottlenose dolphin populations, including stock discreetness studies; to evaluate and improve the Gulf Marine Mammal Stranding Network; and to characterize and monitor key components of important marine mammal habitats in the Gulf.

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*Speaker

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ACKNOWLEDGMENTS

Many individuals contributed to the success of the Gulf of Mexico Sea Turtles and Marine Mammals Workshop. Tucker and Associates, Inc. (TAI) wishes to extend a very special thanks to the speakers whose timely presentations stimulated discussions and an exchange of technical information, and to the discussion group chairs and cochairs for channeling the energies of the working groups to the tasks at hand. Special thanks are extended to the workshop participants for their contributions to this proceedings volume through their informed and lively discussions of ideas and issues. Thanks are also extended to the National Marine Fisheries Service and the U.S. Fish and Wildlife Service for their encouragement and participation in support of the workshop. The staff of the Doubletree Hotel provided excellent logistical support for the workshop. As a result, the workshop ran smoothly without any major problems. Ms. Dionne Powe, whose patience and understanding throughout this project were greatly appreciated, provided excellent technical computer services support.

And finally, special thanks are extended to the Minerals Management Service (MMS) staff responsible for planning and conducting the workshop. In particular, thanks are extended to MMS Headquarters staff members Dr. Bill Lang, Ms. Carol Fairfield, and Dr. Bob Middleton, who were avid supporters for the workshop and without whose conceptual support, this workshop would not have been possible. Tucker and Associates, Inc. is especially grateful to MMS Gulf of Mexico OCS Region staff members Ms. Janice Blake, Program Specialist, who served as coordinator for this contract; Mr. Pat Mangan, Biologist, who served as Workshop Coordinator; and Mr. Mike Dorner, Region Writer-Editor, for improving this document with his editorial skills.

SECTION I
INTRODUCTION

INTRODUCTION

Patrick G. Mangan
Gulf of Mexico OCS Region
Minerals Management Service
New Orleans

The Minerals Management Service (MMS) is responsible for administering portions of the Outer Continental Lands Act amendments pertaining to the exploration, development, and production of oil and gas in the United States Outer Continental Shelf (OCS). This mandate includes the assessment and mitigation of potential environmental risks associated with the oil and gas industry. Impacts to sea turtles and marine mammals are of specific concern because of their protection by the Endangered Species and Marine Mammals Protection Acts.

The MMS sponsored a workshop in New Orleans, Louisiana, on August 1-3, 1989, to review the impacts of human activities on sea turtles and marine mammals, and to rank data to be collected for these species. The meeting convened experts from throughout the United States, Mexico, and Canada to discuss the following goals:

- Review the existing state of knowledge for Gulf of Mexico protected species;

- Review ways in which marine mammals and sea turtles have been or could be affected, either directly or indirectly, by activities and events associated with various Gulf of Mexico industrial activities;

- Identify the types and specificity of data needed to support endangered species consultations or management decisions;

- Discuss and reach consensus on the most immediate data still needed for endangered species consultations; and

- Identify and discuss the advantages and disadvantages of various methods that might be used to obtain needed data.

The workshop was divided into invited presentations, discussion groups, discussion summations, and the development of priorities. The first morning of the workshop began with the presentation of invited papers from the regulatory, research, and public environmental communities. The speakers set the stage for the workshop by describing its mission, providing an overview of the species involved, and identifying the sources of potential impacts.

During the afternoon of the first day and the entire second day, the participants divided into working sessions to discuss distribution, abundance, physiology, ecology, behavior, population dynamics, and life history. The groups ranked areas for future study and techniques for obtaining needed information for each session's topic. Marine mammal and sea turtle sessions were held separately, and where the number of participants allowed, independent sessions on the same topic were held concurrently. This format encouraged participation and afforded the participants an opportunity to develop a consensus from a variety of approaches. At the end of each discussion, the group's conclusions were summarized, edited, and prepared for distribution. On the third morning, each session's summaries were distributed to the participants and were presented by a chairperson.

The afternoon of the third day, the chairs for the sea turtle and marine mammal sessions met separately to rank future data needs from among all the topics. This session also made specific study recommendations to obtain the needed data. The consensus of this session entitled Principal Findings and Conclusions is presented in Sections III and IV of this proceeding report.

Ms. Janice Blake, MMS, served as Contracting Officer's Technical Representative and coordinated preparations for the workshop and provided preworkshop support. Mr. Patrick Mangan, MMS, advised the invited attendees of the workshop's mission and as the workshop coordinator. Ms. Deborah Vanderhorst, Tucker & Associates, Inc., coordinated all the logistical aspects of the workshop and preparation of the proceedings.

SECTION II
PLENARY SESSION PRESENTATIONS

OPENING REMARKS

Mr. J. Kenneth Adams
Regional Supervisor, Leasing and Environment
Gulf of Mexico OCS Region
Minerals Management Service
New Orleans

Welcome to New Orleans and to this workshop.

The Gulf of Mexico is an environment in which many human activities take place. Some of these include commercial fishing, marine transportation, military training and weapons testing, offshore mining, strategic petroleum reserve development, waste disposal, and oil and gas development.

The Department of the Interior is the lead Federal agency for oil and gas development on the Outer Continental Shelf. We are charged with balancing orderly energy resource development with protection of the marine environment.

We can tell you with certainty that in the Gulf of Mexico there are currently more than 5,000 oil and gas leases and more than 3,000 petroleum-related structures. We can also tell you that there are more than 1,000 exploration plans filed with us each year, and that the trends are for oil and gas activities to move into the deeper waters of the continental slope and into previously unexplored areas in the eastern Gulf.

The Department of the Interior is also the lead agency in the administration of the Endangered Species Act and has definite responsibilities under the Marine Mammal Protection Act. We take these responsibilities seriously.

The purpose of this workshop is stated on the first page of your agenda. We hope to learn from this workshop, to engender better communication, and to promote rational decisions concerning human activities and the protection of these important species. We appreciate the fact that you have braved the threat of tropical storms to be here and to share your considerable expertise with us.

Thank you very much.

GENERAL INTENT AND PARTICULARLY RELEVANT PROVISIONS OF THE MARINE MAMMAL PROTECTION ACT OF 1972 AND THE ENDANGERED SPECIES ACT OF 1973

Dr. Robert J. Hofman
Scientific Program Director
Marine Mammal Commission
Washington, D.C.

The purpose of this paper is to briefly summarize the key provisions of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) as they relate to sea turtles and marine mammals in the Gulf of Mexico.

The Marine Mammal Protection Act

The general intent of the Marine Mammal Protection Act (MMPA) is to prevent the depletion of marine mammal species and populations as a result of human activities and to restore species and populations that have been depleted.* The stated primary objective of the MMPA is to maintain the health and stability of the marine ecosystem and, whenever consistent with this primary objective, to obtain optimum sustainable marine mammal populations, keeping in mind the carrying capacity of the habitat and the ecosystems of which the populations are a part.

---

* Note that both the Marine Mammal Protection Act and the Endangered Species Act are concerned with the conservation of populations as well as species.

Key Definitions

Several of the definitions in the MMPA merit mentioning relative to this workshop. Namely, the definitions of the terms *marine mammal, depleted, optimum sustainable population*, and *take* have a bearing on matters to be considered by the workshop.

The term *marine mammal* is defined by the MMPA to mean any mammal morphologically adapted to the marine environment and includes seals, whales, porpoises, walruses, manatees, dugongs, polar bears, and sea otters, and any part of such mammals, including teeth, and raw, dressed, or dyed fur or skin. The term "depletion" or "depleted" is defined to mean any case in which a species or population stock is below its optimum sustainable population level. By definition, any marine mammal species or population listed as endangered or threatened under the Endangered Species Act is considered to be depleted under the MMPA.

The term *optimum sustainable population* (OSP) is defined to mean, with respect to any population stock, the number of animals that will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element. (The National Marine Fisheries Service and the U.S. Fish and Wildlife Service have interpreted this statutory definition of OSP to mean a range of population sizes with the upper bound defined by habitat limitations and the lower bound defined by the population level that results is maximum net productivity (50 CFR 216.3).

The term *take* is defined to mean to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal.

Key Provisions and Exceptions

Section 101(a) of the MMPA established a moratorium on the taking of marine mammals in waters under U.S. jurisdiction and the importation of marine mammals and marine mammal products into the United States. Section 101(a) (3)(A) authorizes the Secretaries of Commerce and Interior to waive the moratorium on taking and importation in cases where it is determined, through formal rulemaking, that such taking would not be inconsistent with the purposes and policies of the Act–that is, would not cause the affected species or population to be reduced or maintained below its optimum sustainable level. The MMPA also provided several exceptions to the moratorium on taking. It provided, for example, that permits may be issued by the Secretaries of Commerce and Interior to authorize

- taking or importation of any marine mammal for purposes of scientific research;

- taking or importation of nondepleted species and populations of marine mammals for purposes of public display; and

- the incidental taking of nondepleted species of marine mammals in the course of commercial fishing operations.

The MMPA was amended in 1981 to authorize the Secretaries of Commerce and Interior to waive the permit requirement and to allow the incidental, but not intentional, taking of "small numbers" of nondepleted marine mammals by citizens of the United States engaged in commercial fishing operations or other specified activities, such as offshore oil and gas exploration and development, when such taking would have a negligible impact on the affected species or population. The MMPA was further amended in 1986 to authorize the Secretaries to allow the incidental taking of small

numbers of depleted, as well as nondepleted, marine mammals by U.S. citizens engaged in activities other than commercial fisheries–for example, offshore oil and gas exploration and development.*

Agency Responsibilities

Under the MMPA, the Secretary of Commerce is responsible for all cetaceans and pinnipeds except walrus; and the Secretary of the Interior is responsible for walrus, polar bears, sea otters, marine otters, manatees, and dugongs. The Secretaries have delegated responsibilities, respectively, to the National Marine Fisheries Service and the Fish and Wildlife Service. Responsibilities include

- enforcement of the Act's prohibitions on taking;
- making status-of-stocks determinations;
- developing conservation plans for species and populations determined to be depleted;
- issuing permits for scientific research and public display; and

* In 1988, the Act was amended to exempt commercial fishermen from the general permit and small-take provisions until 1 October 1993. During the 5-year period, the National Marine Fisheries Service is to categorize fisheries according to the frequency with which they take marine mammals; institute a reporting and observer system to obtain more reliable information on the species, numbers, ages and sex of marine mammals being taken incidentally in various fisheries; and, in consultation with the Marine Mammal Commission, recommend a system for authorizing and regulating the incidental take of marine mammals after 1 October 1993.

- advising other Federal agencies, such as the Minerals Management Service, of steps that they should be taking to assess and assure that these actions do not disadvantage marine mammals or the ecosystems of which they are a part. The Marine Mammal Commission was constituted by the MMPA and is responsible for overviewing all Federal activities bearing on the conservation of marine mammals and for recommending actions to further the policies and provisions of the Act.

Relevant Considerations

In the context of this workshop, it is important to keep in mind that the MMPA prohibits the taking (including disturbance) of marine mammals; and authorizes waiver of the moratorium on taking when such waiver would not be inconsistent with the purposes and policies of the Act. It assigns regulatory administrative and enforcement responsibilities to the Secretaries of Commerce and Interior and authorizes the Secretaries of Commerce and Interior to allow the unintentional taking of small numbers of both depleted and nondepleted marine mammals by U.S. citizens in cases where such take would have a negligible effect.

From these considerations, it follows that one of the key tasks of the workshop is to review available information to determine what, where, when, how, and to what extent marine mammals may be "taken" during the course of activities and events, such as oil spills, associated with offshore oil and gas exploration and development in the Gulf of Mexico. If available information is insufficient to make these determinations, the task is to identify the critical uncertainties; the research that would be required to resolve the uncertainties; and, if possible, the time, money, and logistic support that would be required to do the identified research.

It also follows, as is reflected in the stated workshop objectives, that the nature and extent of other possible sources of take, such as incidental marine mammal take during commercial fishing operations, must be considered in determining priority information and research needs.

The Endangered Species Act of 1973

The general intents of the Endangered Species Act (ESA) are to protect and encourage recovery of species (including subspecies and populations) of flora and fauna that are in danger of, or threatened with, extinction as a result of human activities and to protect habitats critical to the survival of endangered and threatened species. The stated purposes of the ESA are

- to provide a means for conserving the ecosystems upon which endangered and threatened species depend,

- to provide a program for conserving endangered and threatened species, and

- to take steps as may be appropriate to achieve the purposes of international conservation agreements, such as the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (the Western Hemisphere Convention) and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES).

Key Definitions

As with the Marine Mammal Protection Act, several of the definitions in the Endangered Species Act have a direct bearing on this workshop. The terms *endangered* and *threatened species, take, conserve*, and *critical habitat*, are particularly relevant in this regard.

The ESA defines the term *endangered species* to mean any species that is in danger of extinction throughout all, or a significant portion, of its range (other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of the ESA would present an overwhelming and overriding risk to the human species).

The term *threatened species* is defined to mean any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The term *take* is defined to mean to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. (This definition of *take* is much broader than the definition of *take* in the Marine Mammal Protection Act.)

The terms *conserve, conserving*, and *conservation* are defined in the ESA to mean to use and the use of all methods and procedures that are necessary to bring any endangered or threatened species to the point at which the measures provided pursuant to the Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking.

The term *critical habitat* is defined to mean the specific areas within the geographical area occupied by an endangered or threatened species at the time it is listed in accordance with the provisions of Section 4 of the Act. In these special areas are found those physical or biological features (1) essential to the conservation of the species and that may require special management and consideration for protection, and (2) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of Section 4 of the Act, upon a determination by the Secretary that such areas are essential for the conservation of the species.

Key Provisions

Two sections of the ESA are particularly relevant to this workshop. They are Sections 4(f) and 7. Section 4(f) directs that the Secretary (of Interior or Commerce) develop and implement plans for the conservation and survival of endangered and threatened species, unless he or she determines that such a plan will not promote the conservation of the species. Section 7 specifies cooperative actions that must be taken by Federal agencies to give effect to the Act.

Among other things, Section 7 directs that all Federal agencies use their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of species listed as endangered and threatened in accordance with the Act. It places a special burden on the Secretaries of Commerce and the Interior to review all programs administered by their departments and use such programs to further the purposes of the Act. It directs that each Federal agency shall, in consultation with, and with the assistance of, the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat critical to the survival of the species.

With regard to the preceding point, Federal agencies are required to consult the Secretaries of Commerce or Interior regarding any prospective agency action if there is reason to believe that an endangered or threatened species may be present in the area affected by the action, and that such action would likely affect the species. To facilitate consultation, the action agency is required to prepare a biological assessment to identify any endangered or threatened species likely to be affected by the action. Following review of the biological assessment and such other information as may be available, the Secretary is required to provide the action agency a written "biological opinion." The opinion is to indicate whether or not the proposed actions likely would jeopardize the continued existence of an endangered or threatened species or result in the destruction or adverse modification of habitat critical to the survival of an endangered or threatened species. It is to include a summary of the information upon which the opinion is based.

If the Secretary finds that a proposed action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat, he or she is required, whenever possible, to suggest reasonable and prudent alternatives that could be taken to avoid or mitigate jeopardy. In cases when the Secretary finds that a proposed action could result in the taking of listed species, but that the taking would not constitute jeopardy, he or she must explain the rationale for this finding in the "biological opinion" and issue an "incidental-take statement" indicating (1) the number of individuals authorized to be taken, (2) how individuals authorized to be taken are to be handled and/or disposed of, and (3) reasonable and prudent measures that should be taken to minimize the effects of the authorized taking. If the number of individuals authorized to be taken is reached, consultation must be reinitiated.

Agency Responsibilities

Under the ESA, as under the MMPA, the Secretary of Commerce has primary responsibility for endangered and threatened cetaceans and pinnipeds, and the Secretary

of Interior has responsibility for other endangered and threatened marine mammals (for example, endangered manatees and dugongs and the threatened California sea otter populations). Responsibility for endangered and threatened sea turtles is shared. Responsibilities include enforcement of the provisions of the Act, preparation of recovery plans, preparation of biological opinions on the likely effects of Federal actions that may affect listed species or habitats critical to their survival, and suggesting reasonable and prudent alternatives in cases where proposed Federal actions would jeopardize the continued existence of a listed species or result in the destruction or adverse modification of habitat critical to its/their survival.

Relevant Considerations

In the context of this workshop, it is important to keep in mind that the ESA requires that the Minerals Management Service consult the Secretary of Commerce (the National Oceanic and Atmospheric Administration/National Marine Fisheries Service) and the Secretary of Interior (the U.S. Fish and Wildlife Service). This consultation is to determine whether activities or events associated with offshore oil and gas exploration or development are likely to result in that taking or destruction or adverse modification of habitat that is likely to jeopardize the continued existence of any endangered or threatened species. It is also important to keep in mind that the Act requires that, whenever possible, the services suggest "reasonable and prudent alternatives" in cases where they determine that a proposed action is likely to jeopardize the continued existence of an endangered or threatened species or to result in the destruction or adverse modification of habitat critical to its survival. But, if that taking would not jeopardize the continued existence of the species, they must provide a written "incidental-take statement" indicating the number of individuals authorized to be taken, how individuals authorized to be taken were to be handled, and the "reasonable and prudent" measures that should be taken to minimize the effects of the authorized taking.

From these provisions, it follows that one of the key tasks of the workshop is to identify what, if any, additional information is needed to determine the where, when, how, and extent marine mammals and sea turtles, listed as endangered or threatened under the ESA may be taken (directly, or through habitat degradation/destruction) during the course of activities and events, such as oil spills, associated with offshore oil and gas exploration and development in the Gulf of Mexico. As noted earlier, it also follows that the nature and extent of other possible sources of take, such as incidental take during commercial fisheries operations, must be considered in determining priority information and research needs.

PROTECTED SPECIES CONCERNS IN THE GULF OF MEXICO

Dr. Tyrrell A. Henwood
Fisheries Biologist
Protected Species Management Branch
National Marine Fisheries Service
St. Petersburg, Florida

The responsibilities of federal agencies with regard to potential impacts of their activities to protected species are clearly described in the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). Specific language in the ESA which directly applies to this workshop is the requirement that federal agencies must "insure that any action authorized, funded, or carried out by such agency...is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species." This statement obligates federal agencies to ensure that their activities are only conducted after careful consideration of the potential consequences to endangered and threatened species and marine mammals. If adverse impacts are likely, the agencies should take appropriate actions to reduce/eliminate these impacts.

Section 7 Consultations

When Federal agencies permit or conduct activities that could negatively impact listed species, they are required to initiate consultation under Section 7 of the ESA. Federal agencies prepare a biological assessment (BA) describing the proposed action including a determination of whether this action is likely to affect listed species. If species may be affected, the Federal agency must initiate formal consultation. The National Marine Fisheries Service (NMFS) reviews the BA and prepares a biological opinion (BO) on the potential impacts of the proposed action to listed species. In this

opinion, NMFS must determine how many individuals of a species are likely to be "taken" as a result of this activity, and whether this "take" is likely to jeopardize the recovery of the species.

In the Gulf of Mexico, NMFS consults with Federal agencies on all major actions including channel dredging, rig removals, fisheries interactions, coastal development, and oil and gas production. In these consultations, we are always faced with the problem of assessing probable impacts of activities on the basis of limited or nonexistent information on species distributions, abundance, seasonality, population levels, etc. In determining whether a particular activity may jeopardize the recovery of an endangered or threatened species, we must be able to quantify the probable level of "take" and to determine whether this level is greater than the species can withstand. To make such determinations, we must have knowledge of the basic biology of the species.

Decisions in the Face of Insufficient Information

This workshop was organized in response to comments of the Marine Mammal Commission (MMC) and NMFS relating to lease sale environmental impact statement conclusions on potential impacts to protected species of oil and gas activities. The MMC and NMFS agreed that existing data were insufficient to support MMS conclusions that these activities were not likely to affect protected species. In situations where data are insufficient to adequately assess potential impacts of Federal activities, NMFS policy has always been that we must assume the worst and decide in favor of the species. MMS has been responsive to our concerns and has expressed a willingness to help identify data gaps and take positive actions to provide the needed information.

While MMS has acknowledged their responsibility under the ESA to provide needed information, many other Federal agencies have chosen to ignore this obligation. Those agencies not providing information on the probable impacts of their activities will

find themselves in a perpetual "may affect" situation. Endangered Species Act Section 7 consultations will be required until proof is provided by each agency that their actions do not affect listed species. NMFS will continue to require stringent monitoring of these activities, and the total cost of this monitoring could easily exceed the costs of research to provide the necessary information. It is our hope that this workshop will identify and determine research priorities needed to satisfy ESA and MMPA requirements, and that Federal agencies will work together in funding the necessary research.

Workshop Results

From the NMFS perspective, we would like to see this workshop result in a document reflecting the opinions of the foremost experts on sea turtles and marine mammals. This document should identify priority species and vital research needed to protect and manage these species in the Gulf of Mexico. It also should identify short- and long-term research projects that would provide information necessary to evaluate the impacts of man's activities on protected species. This document should be of value to NMFS and the U.S. Fish and Wildlife Service (FWS) in determining research efforts priorities, and to other federal agencies in identifying potential conflicts between protected species and proposed activities.

This workshop provides an important opportunity for the scientific community to influence the direction of Federal protected species research activities. We expect the scientists in this group to put aside personal biases and develop recommendations that will be the most beneficial to the species in question. We also expect Federal agency representatives to pay close attention to the recommendations of this group and to consider funding research that will provide needed information in areas where their activities could negatively impact protected species.

I hope this brief introduction has helped to explain why MMS is conducting this workshop. Endangered Species Act and MMPA obligations will provide the impetus for future research, but identification of data gaps and research needs is the logical first step in approaching the problem. NMFS has requested, and MMS has concurred, that this workshop not be limited to oil and gas activities and their potential impacts to protected species. The workshop should address the species and the overall state of knowledge in the Gulf of Mexico including what is known, what research is needed, what life stages may require protection, what are present population levels, how are individuals distributed, where and when do they move, and how are species impacted by activities of man. Looking at the species, we believe that data gaps will be obvious and information needs will be clear. Federal agencies conducting activities in the Gulf will have a better understanding of how their actions could negatively impact species and what research is needed to evaluate these potential impacts.

HUMAN ACTIVITIES AND SEA TURTLE CONSERVATION IN THE GULF OF MEXICO

Mr. Michael J. Weber
Vice President for Programs
Center for Marine Conservation
Washington, D.C.

I appreciate the opportunity to give you my views on human activities and sea turtle conservation in the Gulf of Mexico. Unfortunately, pressing litigation over regulations requiring some shrimp fishermen to use turtle excluder devices (TED's) prevents me from participating in your deliberations. I wish you success in developing a research agenda that will respond to the considerable conservation challenges facing sea turtles, marine mammals, other marine resources, and their habitats in the Gulf of Mexico.

Historical Perspective

Sea turtles were once abundant in some areas of the Gulf of Mexico. Just decades ago, there were commercial fisheries for green turtles-especially in Texas, Louisiana, and Florida. Even after these fisheries collapsed, commercial shrimp fishermen often incidentally captured sea turtles-which they later consumed themselves or sold. In Mexico, collectors were able to gather Kemp's ridley eggs by the tens of thousands and transport them in sacks on the backs of burros to distant urban markets.

The conservation status of sea turtles now is radically different. The International Union for Conservation of Nature and Natural Resources, (IUCN 1986) Species Survival Commission, selected the Kemp's ridley sea turtle as one of the 12 most endangered animal species in the world. Populations of green sea turtles that once supported

commercial fisheries have all but vanished. Sea turtles have become scarce enough in the Gulf of Mexico that shrimp fishermen complain they no longer catch them frequently.

Options for the Future

I draw this contrast in order to remind us all that sea turtles were once commercially valuable species and could be again, given some help and some breathing room. The goal of the Endangered Species Act is not to preserve these animals as museum pieces or in some remnant condition, but to return them to abundance. This goal is often forgotten as we attempt to condition present human activities to comply with the law. Our aim should be not simply to avoid jeopardizing the continued existence of sea turtles, to use the terms of the Endangered Species Act, but to recover them to abundance.

I urge this aim for a very practical reason: as the human population along the Gulf of Mexico increases due to real growth and shifting demographics, we will need every source of food available. I am not now advocating a return to exploitation of sea turtles, primarily because of their low and/or uncertain population size, and because sea turtle populations are already in trouble enough without exposing them to the manifest inadequacies commonly found in our management of marine fisheries. But, care taken in rebuilding sea turtle populations in the coming years will provide us with options that we will increasingly need in the next century.

The Research Agenda

I urge that you keep several other considerations in mind in preparing a research agenda. First, recovery of sea turtle populations in the Gulf of Mexico will require not just preventing or reducing threats in the future, but also in reversing damage that has

already been done. Our tools for preventing further damage are fairly limited and often difficult to apply: witness the 10-year effort to reduce the incidental capture and drowning of sea turtles in the shrimp fishery. Even so, our tools for reversing damage, particularly damage to key turtle habitats like seagrass beds, are experimental at best and very expensive. In general, protection of species and their habitats is a cheaper and more predictable management tool than is restoration.

Second, population growth and settlement in areas that are directly or indirectly important to sea turtles–together with increased recreational and commercial activities on Gulf waters–must be reckoned with. By the year 2000, the population of Florida alone is expected to increase by 5 million people to 12 million people, or 900 people a day. And, if one considers the watersheds that affect the Gulf, one can see that it is very easy to have too narrow a focus: the Mississippi River alone drains lands from Montana to Pennsylvania.

While the conservation needs of sea turtles deserve some concentrated attention, we must not fail to see them as members of the food webs and habitats of which other species of animals are also members. The drastic loss of seagrass beds in the lagoons of south Texas, in Galveston Bay, in Tampa Bay, and in Florida Bay, just to name a few critical areas, have already led to losses in populations of finfishes and shellfishes. And unless these beds are restored, I must wonder whether increasing numbers of juvenile green turtles, for instance, will be short-lived, or whether these animals will move to less suitable habitats.

I raise this issue to suggest that sea turtle conservation efforts will gain by being holistic, by drawing upon the knowledge and commitment of individuals and institutions whose concern may appear removed. In this sense, however much at odds conservationists and fishermen may be over means to end the drowning of sea turtles, we

share deep concerns over the loss and degradation of coastal habitats. Frankly, I don't think we have a choice in the matter–at least not one that any of us will want to live with in the next century.

Finally, let us not forget that the conservation of sea turtle populations depends upon the actions of Mexico and Cuba. Although the commitment of Mexico to the conservation of its sea turtle populations is most often questionable, new government agency leaders are attempting to change the ways of the past. We should make every effort to enhance their ability to do so. And while I don't expect this workshop to reestablish diplomatic relations with Cuba, our inability to factor Cuba into sea turtle research and conservation efforts is a major liability.

Priority Impacts

With this general background, let me move on to more specific considerations. There is a wide range of human activities that affect sea turtles and their habitats directly or indirectly. My discussion of these activities will begin with the most direct and proceed to indirect effects. The effects of some of these activities have already been extensively studied, while others have not been evaluated at all.

Surely the next several days of discussions will help determine priorities in research to address the most pressing needs.

Historically, sea turtles have been intentionally killed for a variety of purposes. Eggs have been used as a source of protein and supposed enhancement of sexual prowess. Juvenile, subadult, and adult turtles have been used for food and for materials in the manufacture of objects as diverse as jewelry and table tops. Populations of sea turtles in the Gulf of Mexico are not nearly so subject to human predation as they once were, although human predation persists.

Predation in the United States is minimal due to Federal and state prohibitions; collection of eggs and killing of sea turtles have been substantially reduced in some areas of Mexico, as on the Kemp's ridley's nesting beach at Rancho Nuevo, but continue at excessive rates elsewhere.

As long as trawls have been dragged, or hooks deployed on lines, or gill nets set in estuarine or nearshore areas, sea turtles have been intentionally and unintentionally captured. When the Florida green turtle fishery closed in 1974, all its landings were from trawls. The greatest present concern is the shrimp fishery that is pursued in both U.S. and Mexican waters. Use of turtle excluder devices would eliminate this source of mortality, but resistance persists in the U.S. fishery, and only minimal steps have been taken by the Mexican fishery. There may be some consolation in the reduced size of the Mexican fleet.

Other fisheries that must be of concern were reviewed by Debby Crouse in 1987 (Crouse 1987) and by myself in 1987 (Weber 1987). I also understand that the National Marine Fisheries Service has just completed a biological opinion on the effect of fisheries on endangered and threatened species.

The longline fishery for swordfish and tuna, which has expanded rapidly in the Gulf, is a certain cause of sea turtle mortality, as is the groundfish trawl fishery off Mississippi and Alabama. However, little documentation exists with which to evaluate the magnitude and impact of these incidental captures. Sea turtles are also captured and drowned in drift-net fishing for pelagics such as mackerel. Finally, hook-and-line sport fishermen incidentally capture sea turtles in the Gulf; there is little information on the number of these captures or any consequent mortality.

Dredging of ship channels in Florida, Georgia, and South Carolina has led to the death of small numbers of sea turtles in their foraging habitats. There is little information on the impact of dredging on sea turtle populations in the Gulf of Mexico. The tremendous amount of dredging conducted in the region demands more investigation.

The explosive removal of oil rigs in nearshore waters of the Gulf of Mexico has been implicated as the cause of death for some sea turtle stranding along the Texas and Louisiana coasts. Specifically, the stranding of large numbers of turtles along the Texas coast in the spring of 1986 coincided more or less with the explosive removal of a number of rigs. The persistence of strandings long after the rig removals persuades me that the direct impact of rig removals on sea turtles is less than has been suggested in the past. Nonetheless, the indirect nature of existing evidence prevents a quantitative assessment, and the large number of rigs awaiting removal demands that we investigate this source of mortality further. Current efforts to survey rigs beforehand and to use lower-velocity explosives appear to be adequate measures at this time.

Increasingly, improperly disposed debris, particularly plastic debris, has become a source of sea turtle mortality. If amounts of debris collected from beaches are a true indication, the Gulf of Mexico presents particular problems for sea turtles. In an assessment of data from beach clean-ups around the nation, the Center for Marine Conservation (O'Hara and Debenham 1989) determined that the amount of trash reported per mile of beach was consistently higher in states bordering the Gulf of Mexico. Louisiana had approximately 2,337 pounds per mile, Mississippi about 3,000 pounds per mile, and Texas 3,549 pounds per mile. The 12 most common debris items were plastic pieces, small foamed plastic pieces, plastic eating utensils, metal beverage cans, foamed plastic cups, glass beverage bottles, plastic caps and lids, paper pieces, plastic trash bags, miscellaneous types of plastic bags, glass pieces, and plastic soda bottles.

Debris may affect sea turtles in several ways. Pieces of netting, plastic bags, and other similar types of debris may entangle sea turtles, making it difficult for them to swim, feed, digest, or evade predation. A study by Plotkin and Amos (1988) reported at the Eighth Annual Workshop on Sea Turtle Conservation and Biology found turtles entangled in fishing line, shrimp trawls, onion sacks, net/rope, tar, crab traps, and trotlines.

Sea turtles also ingest both large and small pieces of debris. In the same study, Plotkin and Amos found that many necropsied turtles had ingested plastic bags, hard plastic pieces, styrofoam, monofilament fishing line, polyethylene beads, plastic strapping, pieces of balloons, pieces of aluminum foil, glass and cardboard. At times, the debris appears to have contributed to the death of the animals, at other times not.

Known sources of debris are commercial and recreational fishermen who discard nets and other gear; offshore oil rigs and service vessels; cargo ships, research vessels, and recreational boaters.

In emptying their bilges, commercial tankers and freighters release into surrounding water oil that later forms tar balls. Ross Witham (1983) and others have documented that sea turtles may attempt to ingest such tarballs. Tarballs may cling to the mouth of the turtle, preventing it from eating; if ingested, the toxic components of the tarballs can have fatal consequences. Tarballs together with other debris also collect in nearshore areas and in the rafts of sargassum that are used by hatchling turtles.

Research reported on in a similar Minerals Management Service workshop in 1982 demonstrated that sea turtles have no ability to avoid oil slicks and suffer adverse reactions to oil (Witham 1983) (see also Lutz and Lutcavage in literature cited). Oil spills of any magnitude thus present a clear threat to individual animals and could have catastrophic consequences in areas where sea turtles aggregate for breeding and nesting.

Finally, increases in the number of pleasure boats in nearshore and estuarine areas are no doubt leading to increased numbers of collisions with sea turtles. Expansion of current marinas and the construction of new marinas, such as a proposed 600-slip marina near Naples, Florida, will only further increase collisions with sea turtles.

Before I turn to indirect sources of mortality, I wish to emphasize that the endangered status of sea turtles makes the loss of even small numbers of these animals very risky. Thus, while we should first attempt to reduce the greatest known sources of mortality, such as incidental capture in trawls, we should not forego addressing those other, lesser sources of mortality. I remind us all of an observation made years ago by the late Dr. Archie Carr: when the shrimp fleet was small and sea turtle populations were large, the impact of incidental drowning was relatively small. But that changed as sea turtle populations declined and the shrimp fleet increased. The same reversal may occur with one of the above sources of mortality that does not seem so serious now.

Nearshore Marine Habitats

Most observers believe that the gravest long-term threat to sea turtle populations, indeed to most species, is the degradation and destruction of habitat. And here, we enter into an area of conservation that provides us with very few tools and with very little public support. In the Gulf of Mexico, the lack of tools to protect important sea turtle habitat is hampered by a number of things. With a few notable exceptions, there are few nesting habitats in the Gulf. Likely important sea turtle habitats in the Gulf are marine. Since most previous sea turtle research has focused almost exclusively upon nesting habitat in the Atlantic, there is little guidance for sea turtle biologists in the Gulf of Mexico.

Only relatively recently have concerted efforts been made to understand how, when, and why sea turtles use Atlantic and Gulf marine habitats. A glance at present recovery plans for sea turtles, or the proceedings of any of the numerous sea turtle conferences and workshops that have been held since 1979, shows quite clearly how little has been done to elucidate the use of marine habitats by sea turtles and how much progress can be made. If I could have one wish for this workshop, I would wish that this workshop would lead to much greater investigation of the use of nearshore marine habitats by sea turtles, since these habitats and life stages are often the most vulnerable and the most exposed to human disturbance.

The challenge posed is not much different than the challenge we face in trying to pass on a healthy environment to the next generation of our own kind. Assuming that our efforts to enhance the survivorship of the young turtle are successful, we must ask what kind of developmental, foraging, and breeding habitats those surviving turtles are likely to find as they mature.

I can summarize what I know fairly quickly. Kemp's ridley sea turtles are often found in areas that are also favorable for blue crabs. The sheltered estuaries, bays, and lagoons, especially in Louisiana and in the Panhandle of Florida, may be primary developmental areas and feeding ground. Across the Gulf, the Tabasco-Campeche area of Mexico is also a major feeding ground. Larry Ogren (National Marine Fisheries Service, Panama City, Florida) has devoted many years to investigations on the use of these environments by Kemp's ridleys, but we need to do more. These nearshore areas are most exposed to habitat degradation from land-based pollution and loss of adjacent nursery habitats such as marshes. Human activities such as fishing and dredging are also concentrated in these areas.

Green sea turtles favor seagrass beds that seem to be disappearing at an alarming rate. In 1980, hundreds of thousands of pounds of green sea turtle were taken from south Texas lagoons, but no more. Both the turtles and the seagrasses seem to be gone from those lagoons. Like Kemp's ridleys, green sea turtles are exposed to the variety of environmental insults found in nearshore areas. Loggerhead sea turtles use hardbottom or offshore reef areas, such as the Flower Garden Banks, and have been sighted around oil rigs. Tantalizingly little information has been gathered on the use of these environments by loggerheads. They also enter estuaries, coastal streams, saltmarshes and the mouths of large rivers.

Hawksbill sea turtles are regularly, but less and less frequently, found in the Gulf of Mexico, particularly off the Yucatan peninsula of Mexico. In the United States they are found using coral reefs, as well as lagoons, shoals, and vegetated bays.

Finally, leatherbacks are often associated with pelagic rather than coastal environments, although they will pursue their prey principally-jellyfish into coastal areas. There have been reports of leatherbacks in the bays of Alabama, for instance.

Although these general characterizations of sea turtle habitats can be amplified by others in this room, it is nonetheless remarkable that the seasonal distribution of sea turtles is not better known. As Larry Ogren has remarked to me, our understanding of sea turtle biology and behavior is more that of a naturalist than that of quantitative scientists. Without foregoing the opportunistic advances that are available to the observant naturalist, we must try to become more systematic and dedicated in our surveys. This will require the long-term commitment of resources.

Pollution Stresses Marine Environment

Even our rather generalized understanding of how and when sea turtles use Gulf marine environments must give cause for concern if we also consider that nearshore and estuarine environments are those most under the stress of human activities. Yet, our understanding of cause and effect in the alteration of Gulf of Mexico environments and their effects of alterations on sea turtles are little understood. For instance, point and nonpoint source discharges of agricultural and industrial chemicals, petroleum products, and domestic sewage may have indirect effects by reducing food sources such as seagrasses. There maybe direct effects on individuals, such as reduction in health and fitness, which may be manifested by mortality and the disruption of various physiological functions.

Little work has been done to determine historical and present levels of toxics in sea turtles, much less the effect that elevated levels of toxics might have on the fitness and reproductive success of individual animals. We must embark on a program to determine to what extent various pollutants may be affecting sea turtle populations. This program should be linked with efforts to identify and reduce sources of coastal pollution.

In its 1987 study "Wastes in Marine Environments," the Congressional Office of Technology Assessment (U.S. Congress 1987) concluded that "estuaries and coastal waters around the country receive the vast majority of pollutants introduced into marine environments. As a result, many of these waters have exhibited a variety of adverse impacts, and their overall health is declining or threatened. In the absence of additional measures, new or continued degradation will occur in many estuaries and some coastal waters around the country during the next few decades.

Catastrophic spills of oil and the discharge of industrial chemicals and domestic sewage are easy enough to identify as sources for pollution, although our ability to reduce even these identifiable pollutant sources deserves much improvement. In its study, the Congressional Office of Technology Assessment identified 113 municipal and 347 industrial dischargers in the Gulf of Mexico. The major industrial discharges are associated with refineries and the petrochemical industry, especially in Louisiana and Texas.

By comparison with point sources, however, nonpoint sources of coastal pollution are even less tractable to immediate action and deserve greater attention. The greatest sources of pollutants in the northern Gulf of Mexico are the Mississippi and Atchafalaya Rivers that drain 40 percent of the continental United States. Storm-water runoff from urban and agricultural areas throughout the region contributes pollutants ranging from hydrocarbons to heavy metals and pesticides.

Elevated pollutant levels have already had an effect upon the availability of some commercially valuable fish: in the Gulf of Mexico, of 80,000 acres of classified shellfish waters that have been reclassified since 1971, more than 90 percent have been placed partially or entirely off limits to shellfishing. Shellfishing is limited in another 2.7 million acres due to point and nonpoint pollution. Eutrophication and hypoxia, contamination by pathogens, metals, and organic chemicals are stressing marine fishery resources in Mississippi Sound. Extensive periods of hypoxia reduced shrimp and finfish catches off Louisiana in 1983. Although exact causes have not been established, these incidents may reflect increased nutrients deposited by the Atchafalaya and Mississippi Rivers, nutrients that have run off from upstream agricultural fields.

Interlocking Concerns

Our lack of knowledge and understanding about this suite of habitat issues gives me great concern. My concern arises from reports and studies certainly. But my concern has been deepened by descriptions of former times given me by fishermen who have doubtless disagreed with me on turtle excluder devices, but have expressed concern whether their children would enjoy the independence available to one who seeks his living from the productivity of our nearshore waters. Who would have imagined that the oyster beds of Appalachicola would have been found fruitless? But many fishermen are barely making a living. The culprits, as it were, are legion: fishermen dragging trawls over oyster reefs, upstream farmers spraying for that last box of tomatoes, pesticide and fertilizer salesmen, dredgers and channelizers, realtors purveying riverside property, homeowners striving for the greenest lawn and reddest rose, city councilmen granting zoning waivers, members of Congress securing special appropriations for Corps of Engineers projects, conservationists too tired to raise a voice, and scientists too poor to gather and publish information.

The Environmental Protection Agency's Gulf Initiative has given all of us a useful focus for addressing these complex and interrelated problems. I suggest that every effort be made to incorporate broader concerns into your agendas for sea turtles and marine mammals and to insure that concerns for these species are incorporated into the programs of other agencies such as EPA.

Some Successes

Let me clearly acknowledge human activities that are beneficial to sea turtles. The virtual elimination of Kemp's, ridley nest predation in Mexico and the pending use of TED's in the U.S. Gulf shrimp fishery will certainly benefit the conservation of Kemp's ridleys and other species of sea turtles. More experimental efforts, such as the

headstarting program of the National Marine Fisheries Service, may yet prove to be a reliable conservation tool. Legal prohibitions on killing sea turtles or selling sea turtle products, together with education of the general public about the conservation needs of sea turtles, have led to changes in behavior that are beneficial to sea turtle populations in the Gulf of Mexico.

Science Alone Is Not Sufficient

Before I close, I wish to pass along a cautionary note about data and politics. There is no doubt that additional information on the habits and needs of sea turtles is critical to their conservation. Equally important, however, is the acceptance of that information by the decisionmakers who ultimately make the decisions with which we and the turtles must live.

My own experience with industry, the conservation community, and government efforts to address the incidental drowning of sea turtles has underscored the limitations of scientifically gathered evidence. Consider that a Gulf senator, who has exerted an extraordinary influence over application of the Endangered Species Act to sea turtles, continues to publicly maintain that the Kemp's ridley sea turtle may not be endangered and that sea turtles may be eaten by other sea turtles. Or consider that shrimpers who regularly extrapolate from test tows to determine good shrimping areas question the very notion of extrapolation for determining the number of sea turtles captured or drowned in shrimp nets.

My point is simply that a gap among the public, policymakers, and scientists continues to erode our efforts to reverse the decline of sea turtle populations, and indeed the populations of other species. People fear what they do not understand. And people, including some of the most powerful politicians in this country, do not understand or respect the scientific method.

You should be aware that the National Academy of Sciences is due to complete a study on sea turtle conservation that was mandated by Congress in the 1988 amendments to the Endangered Species Act. The study panel is scheduled to complete its work by February 1990–a very short time for the kind of comprehensive review that Congress apparently wanted. While I do believe that the study may provide useful confirmation of previous studies and helpful suggestions for additional conservation measures, I also believe that the study will not satisfy critics of the TED regulations who suggested the study largely as a means of delaying the TED regulations. Indeed, several shrimpers have assured me that they will not use TED's regardless of the findings of the National Academy of Sciences.

When you next plan a conference on the conservation of sea turtles and marine mammals in the Gulf of Mexico, I urge that you involve politicians, not simply as dinner speakers but as participants and students. Likewise, I urge you to come to grips with this odd machine called democracy. Neither data nor votes alone will insure a healthy quality of life for us or for the turtles or for any other part of our environment.

Thank you. And best of luck in the coming days.

References cited

Crouse, D.T., L.B. Crowder, and H. Caswell. 1987. A stage-based population model for loggerhead sea turtles and implications for conservation. Ecology 68:1412-1413.

International Union for Conservation of Nature and Natural Resources. October 11, 1986. Species on the verge of extinction. Press release.

Lutz, P.L. and M. Lutcavage. The effects of petroleum on sea turtles: applicability to Kemp's ridley. p. 30. In: Caillouet, C.W., Jr. and A.M. Landry, Jr. (eds). Proceedings of the first international symposium on Kemp's ridley sea turtle biology, conservation and management. Texas A&M University, Sea Grant College Program, Special publication. In press.

Lutz, P., M. Lutcavage, and D. Hudson. 1986. Physiological effects. In: Final report, study of the effects of oil on marine turtles. MMS Contract No. 14-12-0001-30063.

National Research Council. 1990. Decline of the sea turtle: causes and prevention. Washington D.C.: National Academy of Sciences.

O'Hara, K.J. and P. Debenham. 1989. Cleaning America's beaches: 1988 National Beach Cleanup results. Center for Marine Conservation. September 1989.

Plotkin, Pamela and A.F. Amos. 1988. Entanglement in and ingestion of marine debris by sea turtles stranded along the south Texas coast. In: Proceedings of the eighth annual workshop on sea turtle conservation and biology, pp. 79-82. NOAA Technical Memorandum NMFS-SEFC-214. National Marine Fisheries Service, Southeast Fisheries Center. Miami, Florida.

U.S. Congress, Office of Technology Assessment. 1987. Wastes in marine environments. 1987 April. Available from: U.S. Government Printing Office, Washington, D.C. 0TA-0-334.

Weber, M.J. 1987. TED's: Salvation for sea turtles? Defenders 62:8.

Witham, R. 1983. A review of petroleum impacts on sea turtles. pp. 7-8. In: Keller, C.E and J.K. Adams (eds). Proceedings on a workshop on cetaceans and sea turtles in the Gulf of Mexico. Prepared by U.S. Fish and Wildlife Service for the Minerals Management Service. Metairie, Louisiana.

HUMAN IMPACTS ON CETACEANS

Dr. Bernd Wursig
Marine Mammal Research Program Director
Texas A&M University at Galveston
Galveston, Texas

When the general public thinks of dangers to cetaceans, it thinks of whaling for the great whales–hurling exploding harpoons into the backs of massive seagoing mammals. And, indeed, whaling was a tremendous threat to the large whales–especially right, bowhead, and gray whales-a century ago and blue, fin, sei, and sperm whales until very recently. But, whaling has all but ceased. The demand for baleen and oil has become virtually nonexistent, and in most cases, meat and blubber can be replaced by other animal products. Furthermore, an extremely strong antiwhaling force, spearheaded by conservationists and researchers from the United States and England, has succeeded in calling a worldwide moratorium to commercial whaling. The moratorium is in effect until 1992, and it is to be hoped that it will be renewed, perhaps with several exemptions for stocks of whales known to be in good shape.

Status

Meanwhile, several large whale species are presently quite depleted. First and foremost of these is the northern hemisphere right whale, which has been almost totally wiped out in the north Pacific, and appears to hang from a rather tenuous thread in the north Atlantic, where current population estimates range in the low hundreds. Humpback and blue whales number around 10,000 for each species worldwide and appear to be making a comeback. Bowhead whales, like right whales, have not been hunted extensively for over 60 years, yet their numbers are strongly reduced from estimates of pre-exploitation populations, with only 7,000 bowheads existing in the

Bering, Chukchi, and Beaufort Seas, and only a few hundreds remaining in the eastern Canadian stock. Unfortunately, bowheads are still being taken, up to about 40 animals per year, in a so-called noncommercial subsistence hunt by Alaskan Inuit Eskimos.

Modern Threats

However, with the possible exception of the northern right whale, no large whale is in danger of extinction at this time. We must now recognize that commercial whaling is no longer the powerful threat to cetaceans that it was until relatively recently, and we must focus our attention and energies to the real threats that do exist today. Some of these threats consist of habitat degradation due to (1) chronic long term pollution, (2) shipping, (3) oil and gas exploration and development activities, (4) possibilities of catastrophic oil spills, and (5) overfishing of particular areas and concomitant competition with cetaceans in those areas. Each of these potential threats is difficult to measure, for it may involve behavioral, migratory, or physiological changes that may affect efficient group sizes, mating and feeding patterns, reproduction, longevity, or related life history parameters. The potential threats may also act synergistically, so that an animal weakened by chemical poisoning, for example, may not as readily withstand a habitat shift due to food decrease or exclusion from a preferred shallow bank by the presence of shipping or oil activity. We will address some of the potential threats for marine mammals in the Gulf of Mexico in the present workshop. I've spent a major part of my research efforts the last 10 years in assessing the behavioral response of bowhead whales to various types of industrial activity, and perhaps some of this information will have relevance for our workshop as well.

The Major Threat

But there is another threat not yet mentioned, a threat that affects large whales to a relatively small degree, but that is decimating some of their smaller cousins, the

toothed whales, in many parts of the world. This is the threat of purposeful or accidental entanglement by fishing gear, and it is a threat that is only recently becoming recognized as the major problem facing cetaceans at this time. Let me elaborate on it here.

Around Sri Lanka, 15,000 to 40,000 dolphins of various species are taken annually by gill nets and up to 100,000 common and bottlenose dolphins may be killed per year in the Black Sea. Japanese fishermen take many thousand of Dall's porpoise directly for food, and incidentally to other fishing operations. On a smaller but even more devastating scale-because of tiny population sizes, the Baiji, or Chinese river dolphin, is being decimated by habitat destruction and entanglement, in long lines of bottom-set hooks termed "rolling hooks." And, the Vaquita, the Gulf of California harbor porpoise, is dying in gill nets set for the croaker, totoaba. As a matter of fact, both the Baiji and Vaquita exist in small numbers (estimated to be in the low hundreds) in relatively restricted habitat that recently has been affected tremendously by humans. They are gasping their last breaths unless rapid management action is taken to save them. These then will be the first cetaceans to go extinct in modern times, and possibly before we even know anything substantial about their ways of living, social organizations, diel and seasonal habitats, and physiological parameters.

Let me describe for you a few more species and populations of concern before attempting several recommendations that may also be useful for the particular situation of cetaceans in the Gulf of Mexico.

Other Direct and Fishery-Related Takes

One of the largest-scale purposeful catches of cetaceans consists of about 10,000 to 13,000 Dall's porpoise killed per year off Japan for human consumption. This is more than 10 percent of the estimated 100,000 animals that migrate through Japanese waters

per year. At the same time, an unknown but certainly large number of Dall's porpoise is killed incidentally to drift-gill net sets for salmon and squid in the North Pacific, and one wonders how long the populations of Dall's porpoise will be able to take this decimation of their numbers. Mainly off Peru, Chile, and southern Argentina, thousands of dusky dolphins, Commerson's dolphins, and Burmeister's porpoises are killed annually for crab-trap bait.

Although there are many millions of spinner and spotted dolphins of the genus *Stenella* in tropical waters worldwide, several widespread populations have been decimated drastically by the tuna industry. As is well-known, in the eastern tropical Pacific, yellowfin tuna and *Stenella* travel together, with the tuna below the dolphins. Fishermen set up to 1-mile-long nets around the dolphin school, then close, or purse, the net at the bottom. This large-scale fishing method is an amazing technological feat, but it also manages to kill thousands of dolphins per year. In 1986, an estimated 125,000 dolphins died, and in 1987, the estimate was 129,000. These are low numbers, which may be substantially higher in reality, however.

A Recommended Strategy

Robert Brownell, Katherine Ralls, and Willian Perrin recently published (1989) a description of the plight of the smaller cetaceans along with a recommended strategy for cetacean conservation. The strategy consists of three important interlinked parts: (1) evaluate the status of all species, (2) revise endangered species lists to more accurately reflect which species are and are not endangered, and (3) refocus conservation and management efforts to the species that actually need the help.

In past conservation strategy, "Red Lists" of known endangered species have been compiled. It has been pointed out that this strategy is incomplete, for most people make the assumption that species not included are not endangered. But, many endangered

species are not on the list simply because we don't know whether or not they are endangered. As well, we should compile "Green Lists" of species known to be not endangered at present; and, Brownell *et al.* argue, "Gray Lists" from present data of those species with insufficient data. A thorough evaluation of all cetacean species from present data--there are after all less than 100, and, when necessary and feasible with new research, re-evaluation will help to categorize the status of each.

With this up-to-date evaluation, endangered species lists can be revised and will gain credibility. The present U.S. Threatened and Endangered Species list is not useful for cetaceans. It includes, for example, the gray whale, a species that has gone from near extinction to probably a total population recovery to pre-exploitation numbers, and it fails to include the Baiji, the Indus river dolphin, and the eastern spinner form of *Stenella*, species that are severely threatened. Delisting of nonendangered species and listing of truly endangered ones will focus attention to where the need to protect cetaceans is actually greatest. And for those species or populations for which insufficient data to list or delist exist, field studies are needed to resolve their status. Perhaps we can in the present forum come up with specific recommendations on where and what kind of studies are needed in the Gulf of Mexico.

Finally, we need to refocus conservation and management issues to those species, mainly the northern right whale and several of the endangered or threatened small cetaceans, most in need of help. Those of us in a position to know something about which species or populations are vulnerable, should strive to make that information available to government agencies, conservation organizations, and the general public. The Cetacean Action Plan edited by William Perrin (1988) lists specific research needs for species known or suspected to be threatened. It therefore provides a framework we can use in the next several years to guide management- and conservation-related

research of cetacean species and populations on a global level. I suspect that we will provide some of the finer-scale framework of what needs to be done to learn enough about cetaceans to assure their health and well-being in the Gulf of Mexico.

Cetaceans as Indicator Species

We must remember that cetaceans are only a small part of the ecosytem that we are capable of affecting by our human-made changes of the environment. But, cetaceans are also long-lived, generally social mammals which come to the surface and therefore can be seen and counted. We have an arsenal of techniques capable of recognizing, tracking, and counting large and small whales. We can now think about using these highly visible, upper-level predators of the marine environment as monitoring agents of habitat degradation and long-term ecological change.

References cited

Brownell, R.L. Jr., K. Ralls, and W.F. Perrin. 1989. The plight of the "forgotten" whales. Oceanus 32:5-11.

Perrin, W.F. 1988. Dolphins, porpoises, and whales--an action plan for the conservation of biological diversity: 1988-1992. Gland, Switzerland: International Union for Conservation of Nature and National Resources. 30 pp.

GOALS FOR SEA TURTLE RESEARCH IN THE GULF OF MEXICO WITH RESPECT TO THE OIL AND GAS INDUSTRIES

Dr. Karen A. Bjorndal and Dr. Alan B. Bolten*
Archie Carr Center for Sea Turtle Research
University of Florida
Gainesville, Florida

The objectives of this workshop are to (1) review the status of our knowledge of sea turtles in the northern Gulf of Mexico and the ways in which sea turtles have been or could be affected (directly or indirectly) by industrial activities in this region; (2) identify the data needed for endangered species consultations and management; (3) reach a consensus with respect to research priorities; and (4) identify appropriate research protocols necessary to obtain the needed data.

Within these guidelines, the emphasis of this paper is the development of a research approach to attain the needed information. Previous workshops, conferences, and reports have provided the background and identified the appropriate questions (e.g., Fritts and Reynolds 1981; Fritts *et al.* 1983a, b; Keller and Adams 1983; Owens *et al.* 1983). At this workshop, we should not spend time reviewing what we already know, but rather we should set research priorities and develop research methodologies necessary to gather the data that are lacking. Our ultimate goal should be to develop a predictive model to quantitatively assess the impact of industrial activities on sea turtle populations in the northern Gulf.

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* Speaker

Sea Turtle Species and Life History

Five species of sea turtle are found in the waters of the Gulf of Mexico: the Kemp's ridley (*Lepidochelys kempi*), loggerhead (*Caretta caretta*), green turtle (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*). Ranking for relative species importance in the Gulf of Mexico is easily established, at least for the first two species. Kemp's ridley–because of its extremely precarious survival status, because all nesting occurs on Gulf beaches and because the species is largely confined to the Gulf–must clearly be the species of first concern. The loggerhead would be the second species of concern because it is the most commonly encountered species in the waters of the Gulf. The other three species are relatively minor species in the Gulf and are of equal importance.

It is not our intention to discuss the basic biology of these species. Excellent reviews are available for each of the species: Kemp's ridley (Pritchard and Marquez 1973, Marquez ms), loggerhead (Dodd 1988), green turtle (Hirth 1971), leatherback (Pritchard 1971), and hawksbill (Witzell 1983). Reviews of various aspects of the biology of sea turtles can be found in Bjorndal (1982).

Sea turtles vary in their specific habitat requirements because of the differences in feeding habits, ecology, and behavior. However, all species have a similarly complex life-history pattern. Female sea turtles deposit eggs in sandy beaches. The embryos develop during a 50- to 60-day incubation, after which the hatchlings emerge, enter the sea and–it is hypothesized (Carr 1986)–enter convergence zones in the pelagic habitat. Juveniles remain in convergence zones for an unknown length of time, which may well vary among species, and then shift to relatively shallow areas and begin feeding in benthic communities. The exception is the leatherback, which continues to feed in the water column, but apparently most often over the continental shelf (Fritts *et al.* 1983a). During the long maturation period, juveniles and subadults move among various feeding

areas. When sexual maturity is attained, adult males and females make periodic migrations from benthic foraging areas to nesting beaches, where it is believed the majority of mating occurs.

The complex life cycle of sea turtles involves several very different and widely spaced habitats. This reliance on a variety of habitats increases the vulnerability of sea turtles to human activities, since all habitats must continue to support sea turtles if the species are to survive.

The extent of our understanding of sea turtle biology varies among the life stages. The great majority of research has focused on the nesting beach, probably for two reasons. First, the life stage at the nesting beach is the critical time of reproduction and, as such, deserves great attention. Second, logistics of beach studies are much easier than those of in-water studies. At nesting beaches, sea turtles congregate in large groups at predictable times in a habitat where it is easy for researchers to work. A number of studies are now underway in benthic foraging areas. The biology of sea turtles in the pelagic habitat is almost totally unknown. We need a greater research emphasis on in-water studies.

Distribution of Sea Turtles in the Northern Gulf of Mexico

The three major habitats in which sea turtles are found (nesting beaches, pelagic developmental habitats, and benthic feeding habitats for juveniles and adults) all exist within the Gulf. Our knowledge of where turtles are distributed in these habitats in the Gulf is incomplete. What we do know about sea turtle distribution within the Gulf is based on a combination of data from historical accounts (e.g., Hildebrand 1982, Doughty 1984), tag returns (e.g., Chavez 1969, Ogren, in press), aerial surveys (e.g., Fritts and Reynolds 1981, Fritts *et al.* 1983a, Lohoefener *et al.* 1988), netting (e.g., Ogren, in press), telemetry (e.g., Mendonca and Pritchard 1986, Byles 1988), stranding data (e.g.,

Rabelais and Rabelais 1980, Schroeder and Warner 1988), interviews (e.g., Fuller *et al.* 1987, Hildebrand 1987), incidental capture (e.g., Bullis and Drummond 1978, Witzell 1984), and opportunistic sightings (e.g., Rosman *et al.* 1987). In addition, the Gulf is characterized by a complex pattern of ocean currents. Knowledge of these currents can help us predict and interpret sea turtle distribution (Collard and Ogren, in press).

No one survey methodology can provide all necessary data on the distribution of sea turtles by species, size class, and season. With aerial surveys, small turtles cannot be seen (a serious drawback for mapping ridley distribution), and species identification is often difficult. Stranding data often reflect intensity of offshore fishing activity, rather than sea turtle abundance in the region. Telemetry is expensive, labor intensive (except satellite tracking), and only limited numbers of animals can be monitored. Data from interviews can be misleading, and, understandably, fishermen are sometimes reluctant to report incidental captures, and to return tags from captured turtles.

To compile the necessary maps of sea turtle distribution in the Gulf of Mexico, a careful combination of all of the above techniques, along with new techniques, will be required. Clearly, mapping the distribution of sea turtles by species, size class, and season in the Gulf of Mexico must have priority.

Negative Effects of Human Activities on Sea Turtles

Sea turtles are negatively affected by a wide variety of human activities. To assess the effects of the various sources of man-induced mortality on sea turtles, we must quantify the mortality resulting from each factor. Also, we must begin to measure the sublethal effects of many of these activities. Chronic exposure to sublethal effects will not kill a turtle outright, but may significantly reduce its potential for productivity (growth and reproduction). In the long term, such sublethal effects may be as damaging

to the survival status of a species as would be the immediate death of affected individuals, but will be more difficult to detect. Negative human impacts must therefore be assessed for their overall impact on populations, rather than on individuals alone.

Directed take of sea turtles, both on a commercial and subsistence basis, has had a major impact on the species in the Gulf. Now, laws in both Mexico and the United States prohibit intentional harvest of sea turtles in Gulf waters. However, greater enforcement of these regulations is needed.

Although turtles in the Gulf are protected from directed take, human activities continue to take a considerable, although unintentional, toll on sea turtle populations. The impacts of human activities under the jurisdiction of the Minerals Management Service (MMS) include–but are not limited to–pollution from oil exploration, drilling and shipment; persistent marine debris discarded during these and other activities; activities associated with the construction, maintenance, and removal of oil rigs (for example, site preparation, explosives, increased boat and air traffic, discarded trash); and lights on offshore structures and vessels. An excellent review of some of the negative aspects of these activities for sea turtles is in Fritts *et al.* (1983b).

Recovery plans are now being prepared for all species under the auspices of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. When completed, the Recovery Plans will provide descriptions of threats to the survival of the species and detailed plans to counteract these threats.

Potential threats to the survival of sea turtles cannot be considered in isolation; their effects are cumulative. The dramatic decline of Kemp's ridley has been well documented (Marquez, ms). The initial decline was primarily a result of a directed harvest by humans. The continued decline of the species, despite complete protection of

the nesting beach, has been attributed to other factors, primarily incidental take in shrimp trawls. The loss of pelagic-stage ridleys to oil pollution and debris concentrated in convergence zones has not yet been assessed.

A Coordinated Research Approach

The ultimate goal is to identify where sea turtles are in the Gulf, when they are there, and how they are affected by activities under the jurisdiction of MMS. In studying the negative impacts of the oil and gas industries on sea turtles, we need to consider sub-lethal as well as lethal effects. For this research effort to be successful, a coordinated approach is needed so that the research design is consistent, and the results can be synthesized into a cohesive final product. In this discussion, we will identify research goals and give a rationale for each. Specific research protocols will be developed by the discussion groups.

Research Goal 1: Distribution and Abundance

Description. We need to know the distribution and relative abundance of sea turtles within the Gulf of Mexico by species, size class, and season. This should be the research priority.

Rationale. The rationale for this research priority is obvious. We need to know where turtles are, relative to the distribution of those activities under the jurisdiction of MMS that could negatively affect sea turtles.

Research Goal 2: Movements of Sea Turtles among Regions

Description. Once we begin to understand the distribution of turtles within the Gulf, we need to establish patterns of movements, including those among sequential developmental habitats, seasonal movements, and migrations between foraging regions and nesting beaches.

Rationale. There are two rationales for this research. First, plotting the routes taken by turtles as they move within the Gulf will allow us to determine if activities under the jurisdiction of MMS negatively affect these movements, and to protect these vital corridors. Second, if turtles are exposed to sublethal effects in different areas, these sublethal exposures will be cumulative if turtles move among the affected areas. Knowing the patterns of movements among areas will allow us to evaluate the potential for cumulative sublethal effects.

Research Goal 3: Index In-water Habitats

Description. Once we begin to understand the distribution and movements of sea turtles in the Gulf, appropriate index in-water habitats should be identified. Index habitats should be predictable areas that support sea turtles in relatively high abundance and that represent critical life stages and the geographic range of each species. To be cost-effective, index areas that represent more than one species should be selected when possible. For example, Cedar Key may be a good index habitat for small Kemp's ridleys and green turtles; the Chandeleur Islands may be a good index habitat for loggerheads in the northern Gulf. We may not be able to determine absolute population sizes, but relative abundance can be monitored in these selected locations. For each index habitat, baseline sea turtle parameters (species composition, relative abundance of each species, size class composition, sex ratio, and seasonal changes in composition) can be evaluated.

Rationale. Establishing index in-water habitats will allow us to monitor population fluctuations for juvenile size classes, just as we monitor numbers of adult females at nesting beaches. When changes in the baseline parameters are detected, causes for the changes can be investigated and the responsible agency (e.g., MMS, NMFS) can be alerted.

Research Goal 4: Community Structure

Description. Information from intensive studies of sea turtle ecology (particularly trophic relationships) will allow us to understand the role of each sea turtle species within its biological community. These studies would include both physical-chemical and biotic factors and would define habitat requirements of sea turtles. When possible, these ecological studies should be conducted at the index in-water habitats.

Rationale. Understanding the relationship of sea turtles to their environment (both abiotic and biotic) will allow us to evaluate any perturbation to that system. For example, because toxic substances from the oil and gas industries can accumulate at different rates and at different trophic levels in the various food webs, determining the trophic relation of each sea turtle species will allow us to evaluate the potential for sea turtles to accumulate toxic compounds with both lethal and sublethal results.

Research Goal 5: Toxicological Experiments

Description. Experimental programs are needed to determine the levels of oil and gas industry-related toxic compounds that result in sublethal and lethal effects. These programs would also develop protocols to measure levels of exposure in the field and assess sublethal effects, both physiological and behavioral, on productivity.

Rationale. We need to know the effects on sea turtles of toxic compounds used or produced by the oil and gas industries.

Research Goal 6: Daily and Seasonal Behavior Patterns

Description. Daily activity patterns for the different species and size classes within species need to be described. Seasonal changes in these patterns (for example, brumation, migration) need to be documented.

Rationale. Knowledge of normal daily and seasonal behavior patterns will allow us to evaluate potential negative impacts on sea turtles and to lessen the effects. For example, disruptive activities, such as rig removals or dredging, could be timed to minimize their effect on sea turtles. Abnormal behavior resulting from negative effects of the oil and gas industries could be recognized.

Research Goal 7: Predictive Model

Description. A model of sea turtle biology in the Gulf of Mexico should be developed from the results of the studies described above. The model would include the distribution, movements, ecology, behavior, and physiology of sea turtles.

Rationale. The model could be used to predict the effect of activities under the jurisdiction of MMS on sea turtles. Quantification of these effects would aid in management decisions.

References Cited

Bjorndal, K. A. (ed). 1982. Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C. 583 pp.

Bullis, H. R., Jr., and S. B. Drummond. 1978. Sea turtle captures off the southeastern United States by exploratory fishing vessels 1950-1976. Florida Marine Research Publications 33:45-50.

Byles, R. 1988. Satellite telemetry of Kemp's ridley sea turtle, *Lepidochelys kempi*, in the Gulf of Mexico. Report to the National Fish and Wildlife Foundation. 40 pp.

Carr, A. 1986. Rips, FADS, and little loggerheads. BioScience 36:92-100.

Chavez, H. 1969. Tagging and recapture of the lora turtle (*Lepidochelys kempi*). International Turtle and Tortoise Society Journal 3:14-19,32-36.

Collard, S. B., and L. H. Ogren. In press. Dispersal scenarios for pelagic post-hatchling sea turtles. Bulletin of Marine Science.

Dodd, C. K., Jr. 1988. Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758). U.S. Fish and Wildlife Service, Biological Report 88(14):1-110.

Doughty, R. W. 1984. Sea turtles in Texas: a forgotten commerce. Southwestern Historical Quarterly 88:43-70.

Fritts, T. H., W. Hoffman, and M. A. McGehee. 1983a. The distribution and abundance of marine turtles in the Gulf of Mexico and nearby Atlantic waters. Journal of Herpetology 17:327-344.

Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Collum, W. Hoffman, and M. A. McGehee. 1983b. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters. U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D.C. FWS/OBS-82/65. 455 pp.

Fritts, T. H., and R. P. Reynolds. 1981. Pilot study of the marine mammals, birds, and turtles in OCS areas of the Gulf of Mexico. U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D.C. FWS/OBS-81/36. 139 pp.

Fuller, D. A., A. M. Tappan, and M. C. Hester. 1987. Sea turtles in Louisiana's coastal waters. Louisiana Sea Grant College Program, Baton Rouge. 39 pp.

Hildebrand, H. H. 1982. A historical review of the status of sea turtle populations in the western Gulf of Mexico. Pp. 447-453. In: K. A. Bjorndal (ed.), Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

Hildebrand, H. H. 1987. A reconnaissance of beaches and coastal waters from the border of Belize to the Mississippi River as habitats for marine turtles. Report prepared for National Marine Fisheries Service, Southeast Fisheries Center, Panama City Laboratory, Contract No. NA-84-CF-A-134. 63 pp.

Hirth, H. F. 1971. Synopsis of biological data on the green turtle *Chelonia mydas* (Linnaeus) 1758. FAO Fisheries Synopsis No. 85. 71 pp.

Keller, C. E., and J. K. Adams (eds). 1983. Proceedings of a workshop on cetaceans and sea turtles in the Gulf of Mexico: study planning for effects of outer continental shelf development. Prepared by the U.S. Fish and Wildlife Service for the Minerals Management Service, Metairie, La. 42 pp.

Lohoefener, R. R., W. Hoggard, C. L. Roden, K. D. Mullin, and C. M. Rogers. 1988. Distribution and relative abundance of surfaced sea turtles in the north-central Gulf of Mexico: spring and fall 1987. Pp. 47-50. In: B. A. Schroeder (comp), Proceedings of the eighth annual workshop on sea turtle conservation and biology. National Oceanic Atmosphere Administration, Technical Memorandum NMFS-SEFC-214.

Marquez, R. (1980). Synopsis of biological data on the Kemp's ridley sea turtle *Lepidochelys kempi*. Unpubl. Ms. 142 pp.

Mendonca, M. T., and P. C. H. Pritchard. 1986. Offshore movements of post-nesting Kemp's ridley sea turtles (*Lepidochelys kempi*). Herpetologica 42:373-381.

Ogren, L. H. Distribution of juvenile and subadult Kemp's ridley turtles: Preliminary results from the 1984-1987 survey. In: C. W. Caillouet, Jr. and A. M. Landry, Jr. (eds), Proceedings of the first international symposium on Kemp's ridley sea turtle biology, conservation and management. Texas A&M University Sea Grant College Program, Special publication, College Station. In press.

Owens, D., D. Crowell, G. Dienberg, M. Grassman, S. McCain, Y. Morris, N. Schwantes, and T. Wibbels. 1983. Western Gulf of Mexico sea turtle workshop proceedings. Texas Sea Grant College Program, College Station. 74 pp.

Pritchard, P. C. H. 1971. The leatherback or leathery turtle *Dermochelys coriacea*. International Union for Conservation of Nature and National Resources. Monograph No. 1. 39 pp.

Pritchard, P. C. H., and R. Marquez. 1973. Kemp's ridley turtle or Atlantic ridley, *Lepidochelys kempi*. International Union for Conservation of Nature and Natural Resources. Monograph No. 2. 30 pp.

Rabalais, S. C., and N. N. Rabalais. 1980. The occurrence of sea turtles on the south Texas coast. Contributions in Marine Science 23: 123-129.

Rosman, I., G. S. Boland, L. Martin, and C. Chandler. 1987. Underwater sightings of sea turtles in the northern Gulf of Mexico. OCS Study/MMS 87-0107 U.S. Department of the Interior. Minerals Management Service. Gulf of Mexico OCS Regional Office, New Orleans, LA. 37 pp.

Schroeder, B. A., and A. A. Warner. 1988. 1987 annual report of the sea turtle stranding and salvage network Atlantic and Gulf coasts of the United States, January - December 1987. CRD-87/88-28. National Marine Fisheries Service, Miami, FL. 45 pp.

Witzell, W. N. 1983. Synopsis of biological data on the hawksbill turtle *Eretmochelys imbricata* (Linnaeus, 1766). FAO Fisheries Synopsis No. 137. 78 pp.

Witzell, W. N. 1984. The incidental capture of sea turtles in the Atlantic U.S. fishery conservation zone by the Japanese tuna longline fleet, 1978-81. Marine Fisheries Review 46:56-58.

MARINE MAMMALS OF THE GULF OF MEXICO: PAST, PRESENT, AND FUTURE

Dr. David J. Schmidly and Mr. David L. Scarbrough*
Department of Wildlife and Fisheries Sciences
Texas A&M University
College Station, Texas

The year 1977 saw a critical change in the way we handled our most important source of information on cetaceans–incidental sightings and strandings. During this year the Southeastern United States Stranding Network (SEUS) was formed and began systematically to accumulate and report on all available marine mammal events.

Before this date, our knowledge of marine mammals was primarily confined to miscellaneous published accounts of sightings and strandings, which usually dealt only with rare or unusual species and often contained serious misidentifications. This database, which represents our historical record of marine mammals, was summarized by Schmidly (1981) and is vital to understanding marine mammals in the Gulf.

The SEUS Information Base

The SEUS, which assembles our modern record of marine mammals, is organized into a series of state, local, and regional networks along the Gulf coast from Texas to Florida and in the Southeastern United States from Florida to Virginia. Data from these networks are archived in a centralized system maintained by the stranding network coordinator, Dr. Dan Odell of the Sea World Research Institute in Orlando, Florida. In the decade from 1978 to 1987, network volunteers reported over 2,400 strandings and

* Speaker.

sightings of cetaceans. The number of reports for these 10 years was greater than the entire historical record for the same regions. This modern data has been summarized by Odell (1989).

As described, the historical and modern records both contain information on marine mammals from the Gulf of Mexico (Texas to Florida) and the Southeastern United States from Florida to Virginia. There is some temporal overlap between the two for the years 1977–1980. However, for the most part, these two sources represent separate time periods for the same geographic areas, a comparison of which highlights some interesting trends in the cetacean fauna of these regions.

An important, third source of information on marine mammals is also available–the results of systematic aerial and boat surveys conducted to census cetaceans. For the most part, these surveys were limited in scope and focused on the bottlenose dolphin (Shane 1977, Leatherwood *et al.* 1978, Odell and Reynolds 1980, and Gruber 1981) However, the Minerals Management Service (MMS) sponsored a series of comprehensive aerial surveys for marine mammals in three subunits of the Gulf (off the coasts of southeast Texas, Louisiana, and southwest Florida) and one off the Florida Atlantic coast from 1979 to 1981 (see Figure 1). Data from these reports have not been included in either the historical (Schmidly 1981) or modern (Odell 1989) records, but they represent an extremely important source of information for Gulf marine mammals (Fritts *et al.* 1983).

Report Objectives

The objectives of this report are (1) to describe the Gulf fauna, including its taxonomic and faunal composition, (2) to discuss the sources of information about the Gulf fauna with emphasis on the most critical documentation, (3) to briefly summarize

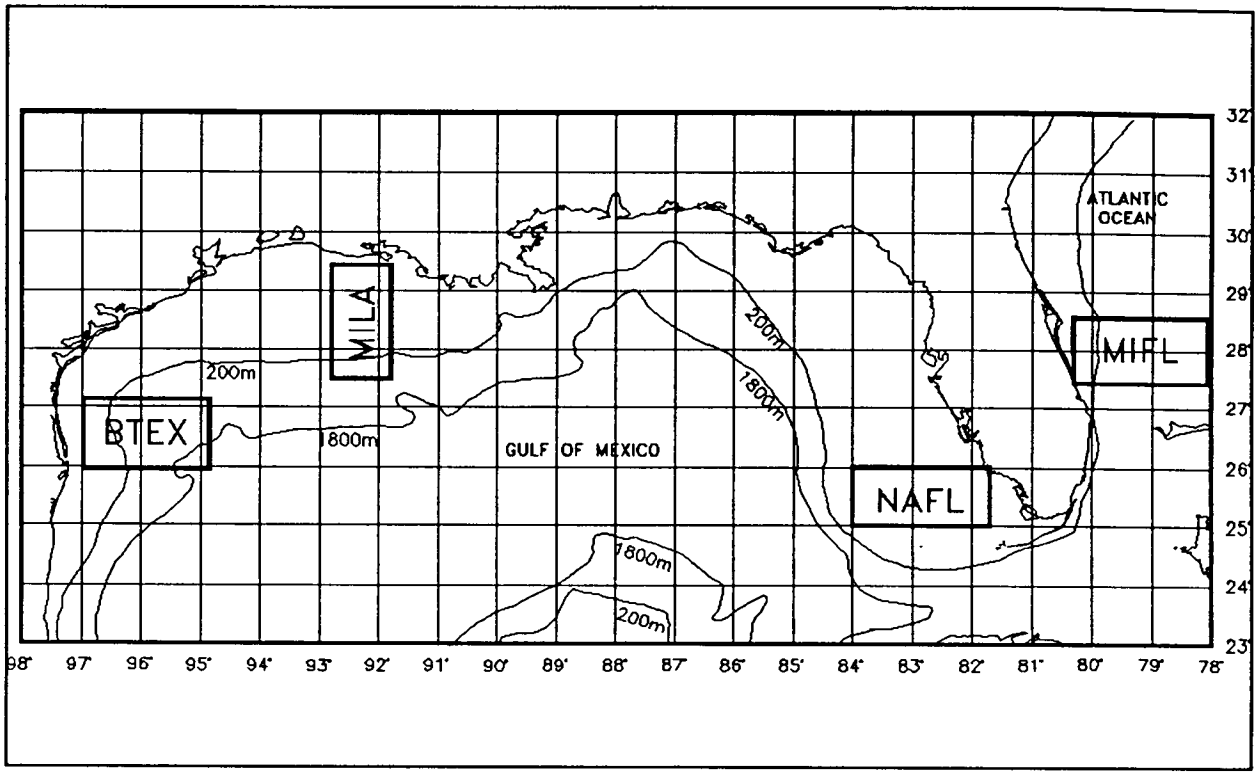

Figure 1. The survey subunits (quadrangles) samples on a bimonthly schedule from May 1980 through April 1981. From left to right: Brownsville, Texas (BTEX), Marsh Island, Louisiana (MILA), Naples, Florida (NAFL), and Merritt Island, Florida (MIFL). (Source: Fritts *et al.* 1983)

the current status and trends of each species as illustrated by comparison of the historic and modern records, and (4) to consider some of the crucial conservation and management needs of Gulf of Mexico marine mammals.

General Description of Fauna

Within the Gulf of Mexico, 31 species of marine mammals have been documented (see Table 1)*. Cetaceans (28 species) comprise the major portion of the fauna, with pinnipeds (2) and sirenians (1) constituting only a minor fraction of the assemblage. Of the two pinnipeds, one (the West Indian Monk seal) is now extinct and the other (California sea lion) occurs only in the feral condition. The 28 cetaceans represent both suborders in the order, 5 of the 9 families, and 17 of the 38 genera. Within the Gulf, 40 percent of the genera and 35 percent of the cetacean species in the world have been recorded. So, the Gulf cetacean fauna clearly is not depauperate.

Species from several widely distributed faunal assemblages occur in the Gulf. Of the 28 cetacean species, 12 are cosmopolitan taxa that occur in most major oceans; these are eurythermic species with a broad range of temperature tolerances. These are *Balaenoptera musculus, B. borealis, B. physalus, Megaptera novaeangliae, Physeter macrocephalus, Ziphius cavirostris, Pseudorca crassidens, Orcinus orca, Delphinus delphis, Tursiops truncatus, Grampus griseus, and Stenella coeruleoalba.*

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* The melon-headed whale (*Peponocephala electra*) was reported from the western Gulf of Mexico between the dates of the workshop and publication of the proceedings. The count of 31 marine mammal species and 28 cetacean species includes *P. electra.* It has been included in Table 1 but is not considered in the text (Haubold and Schiro 1990).

Table 1. Marine mammals of the Gulf of Mexico

Order Cetacea		
Suborder Mysticeti	baleen whales	
Family Balaenidae	right whales	
Eubalaena glacialis	northern right whale	R*
Family Balaenopteridae	rorquals	
Balaenoptera musculus	blue whale	R*
Balaenoptera borealis	sei whale	R*
Balaenoptera physalus	fin whale	R*
Balaenoptera edeni	Bryde's whale	R
Balaeanoptera acutorostrata	Minke whale	R
Megaptera novaeangliae	humpback whale	R*
Suborder Odontoceti	toothed whales	
Family Physeteridae	sperm whales	
Physeter macrocephalus	great sperm whale	C*
Kogia breviceps	pygmy sperm whale	C
Kogia simus	dwarf sperm whale	U
Family Ziphiidae	beaked whales	
Mesoplodon densirostris	Blainville's beaked whale	R
Mesoplodon europaeus	Antillian beaked whale	U
Mesoplodon bidens	North Sea beaked whale	E
Ziphius cavirostris	goosebeaked whale	U

C = common, U = uncommon, R = rare, E = extralimital record, I = introduced, Ex = extinct,
* = endangered

Table 1. Marine mammals of the Gulf of Mexico (*continued*)

Order Cetacea (*continued*)		
Family Delphinidae	oceanic dolphins	
Orcinus orca	killer whale	R
Feresa attenuata	pygmy killer whale	U
Pseudorca crassidens	false killer whale	U
Globicephala macrorhynchus	short-finned pilot whale	C
Steno bredanensis	rough toothed dolphin	R
Delphinus delphis	saddleback dophin	R
Peponocephala electra	melon-headed whale	R
Grampus griseus	grampus	U
ursiops truncatus	Atlantic bottlenose dolphin	C
Stenella frontalis	Atlantic spotted dolphin	C
Stenella attenuata	pantropical spotted dolphin	R
Stenella clymene	short-snouted spinner dolphin	U
Stenella longirostris	long-snouted spinner dolphin	U
Stenella coeruleoalba	striped dolphin	C
Order Carnivora		
Suborder Pinnipedia	pinnipeds	
Family Otariidae	eared seals	
Zalophus californianus	California sea lion	I, R
Family Phocidae	hair seals	
Monachus tropicalis	West Indian monk seal	Ex
Order Sirenia		
Family Trichechidae	manatees	
Trichechus manatus	West Indian manatee	C*

C = common, U = uncommon, R = rare, E = extralimital record, I = introduced, Ex = extinct, * = endangered

Nine cetaceans have distributions peculiar to tropical-warm temperature waters of both hemispheres and may be considered as warm-stenothermal forms. These include *Balaenoptera edeni, Kogia breviceps, K. simus, Mesoplodon densirostris, Feresa attenuata, Globicephala macrorhynchus, Steno bredanensis, Stenella attenuata*, and *S. longirostris.* Three species (*Eubalaena glacialis, Balaenoptera acutorostrata*, and *Mesoplodon bidens*) have disjunct polar (antitropical) distributions, and are regarded as cold-stenothermal forms.

Several of the larger whales from the Gulf have been placed on the Endangered Species List of the U.S. Fish and Wildlife Service. These include *Balaenoptera borealis, B. physalus, B. musculus, Eubalaena glacialis, Megaptera movaeangliae* and *Physeter macrocephalus*. None of the dolphins or other odontocetes in the study area is considered endangered anywhere at the species level, although *Stenella longirostris* and *Stenella attenuata* have received considerable attention as locally endangered species in the eastern Pacific.

Comparison of Historical and Modern Stranding/Sighting Records

Tabulations of marine mammal records, as compiled in the historic (Schmidly 1981) and modern sources (Odell 1989), are presented in Table 2. Comparison of the two columns reveals that *Tursiops truncatus* is overwhelmingly the most common species in both samples (39.3% in the historic vs 65.4% in the SEUS sample). The three most common other species in the historic sample are *Kogia breviceps, Globicephala macrorhynchus*, and *Stenella frontalis*. In the SEUS sample, the other common species are *Kogia breviceps, Globicephala macrorhynchus*, and *Stenella clymene*. Fourteen species occur in less than 1 percent of the combined samples, and must be considered as rare in the Gulf. These are *Eubalaena glacialis* (all but two of the records shown in the table are from the southeast Atlantic), *Balaenoptera musculus, B. borealis, B. physalus, B. edeni,*

Table 2. Summary of Marine Mammal Observations for the Gulf of Mexico and Southeastern U.S. Coast (1)

	No. of Records		Frequency of Records (%)		(%) Change in Number	(%) Change in Frequency
	Historic(2)	Modern(3)	Historic	Modern	of Records	of Records
Eubalaena glacialis (4)	45	40	2.3	1.8	- 11	- 22
Balaenoptera musculus	2	0	0.1	0	-100	-100
Balaenoptera borealis	5	0	0.2	0	-100	-100
Balaenoptera physalus	23	5	1.2	0.2	- 78	- 83
Balaenoptera edeni	11	6	0.6	0.3	- 45	- 50
Balaenoptera acutorostrata	12	3	0.6	0.1	- 75	- 83
Megaptera novaeangliae (4)	33	10	1.7	0.4	- 70	- 76
Physeter macrocephalus	234	39	12.1	1.7	- 83	- 86
Kogia breviceps	147	224	7.6	10.0	52	32
Kogia simus	37	50	1.9	2.2	35	16
Mesoplodon densitostris	8	5	0.4	0.2	- 38	- 50
Mesoplodon europaeus	29	24	1.5	1.1	- 17	- 27
Mesoplodon bidens	0	1	0	0	100	0
Ziphius cavirostris	39	21	2.0	0.9	- 46	- 55
Orcinus orca	20	24	1.0	1.1	20	10
Feresa attenuata	6	16	0.3	0.7	167	133
Pseudorca crassidens	27	38	1.4	1.7	41	21
Globicephala macrorhynchus	137	92	7.1	4.1	- 33	- 42
Steno bredanensis	11	12	0.6	0.5	9	- 17
Delphinus delphis	32	0	1.6	0	-100	-100
Grampus griseus	13	30	0.7	1.3	131	86
Tursiops truncatus	762	1472	39.3	65.4	93	66
Stenella frontalis	199	35	10.3	1.6	- 82	- 84
Stenella coeruleoalba	34	17	1.8	0.8	- 50	- 56
Stenella attenuata	7	9	0.4	0.4	29	0
Stenella longirostris	15	7	0.8	0.3	- 53	- 63
Stenella clymene	5	69	0.2	3.1	1280	1450
Monachus tropicalis	21	0	1.1	0	-100	-100
Zalophus californianus	24	0	1.2	0	-100	-100
TOTALS	1938	2249	100.00	99.9	16	-.001

(1) Includes only species known from the Gulf of Mexico.
(2) Adapted from Table 3 in Schmidly (1981)
(3) Adapted from Table 1 in Odell (1989)
(4) Most Records from southeast Atlantic

B. acutorostrata, Megaptera novaeangliae, Mesoplodon densirostris, M. bidens, Feresa attenuata, Steno bredanensis, Delphinus delphis, Stenella attenuata, and *S. longirostris*.

Of the remaining 13 cetaceans, 5 occur in approximately equal incidence in both samples (*Kogia breviceps, K. simus, Mesoplodon europaeus, Orcinus orca*, and *Pseudorca* crassidens); 3 occur in a substantially higher incidence in the SEUS sample (*Grampus griseus, Tursiops truncatus*, and *Stenella clymene*); and 5 occur in a substantially higher incidence in the historic sample (*Physeter macrocephalus, Ziphius cavirostris, Globicephala macrorhynchus, Stenella frontalis*, and *S. coeruleoalba*).

It is difficult to ascertain whether the changes in incidence in the two samples are reflective of population trends or sampling bias. In a few cases the answer is obvious. For example, the higher incidence of *Stenella clymene* records in the SEUS samples undoubtedly is a reflection of the fact that this species was only recently distinguished from *S. longirostris*. Of more interest, however, are the substantial declines in incidence between the historic and SEUS samples with respect to some of the most common species in the Gulf (*Physeter macrocephalus*, 86% decline; *Globicephala macrorhynchus*, 42% decline; and *Stenella frontalis*, 84% decline).

Mass strandings are of interest with regard to cetaceans, although there have been very few of these events in the Gulf. Only 23 mass strandings (5 or more animals), representing 4 species (*Pseudorca crassidens*, 3 events; *Globicephala macrorhynchus*, 15; *Steno bredanenesis*, 3; and *Stenella longirostris*, 2) have been reported along the Gulf coastline. *Globicephala macrorhynchus* was by far the most common species involved, with 15 events. Eight of the mass strandings occurred during the last decade, with the remainder occurring within the historic period of records.

Aerial Population Surveys

There have been several aerial attempts to census cetaceans in the Gulf of Mexico, with all but one of these being nearshore efforts focused on estimating numbers of *Tursiops truncatus* (Leatherwood *et al.* 1978; Odell and Reynolds 1980). However, the MMS-sponsored surveys, conducted by Fritts *et al.* (1983), represented a comprehensive, concerted effort to survey cetaceans within three subunits of the Gulf (Brownsville, Tex., (BTEX); Marsh Island, La (MILA); Naples, Fla. (NAFL)), and one subunit of the Atlantic off Florida (Merrit Island, Fla. (MIFL)). The subunits were rectangular areas (111 x 222 km) that each encompassed 24,642 km^2 and extended from the shoreline to over the continental slope. Each survey subunit was sampled using a similar flight pattern on a bimonthly schedule (alternating months), and opportunistic flights were conducted to take advantage of exceptional conditions (Fritts *et al.* 1983).

These workers observed 9,350 cetaceans in 1,253 separate sightings, including opportunistic surveys, from June 1980 to April 1981 (Table 3). Most of the sightings came from Florida waters (64.2% of sightings, 5,282 animals). Louisiana waters had 13.1% and 9.5% came from Texas waters (959 animals). Opportunistic surveys accounted for 13.3% (1,822 animals) of the sightings. Species diversity was highest in Florida waters (12 positively identified species). Texas was second with eight positively identified species, and Louisiana had five species.

Special Comments and Notes on Selected Groups

Many marine mammals from the Gulf are of such rare occurrence that a detailed account for each species is not warranted. When these marine mammals are considered as groups, however, basic trends in abundance and distribution become evident. Following are brief summaries of the available information for all groups of Gulf marine

Table 3. **Number of Cetaceans Sighted by Fritts et al. (1983) During Aerial Surveys Conducted in the Gulf of Mexico and Atlantic Coast of Florida from June 1980 to April 1981.**

Taxa	Survey Subunits								Opportunistic Surveys	
	BTEX		MILA		NAFL		MIFL			
Eubalaena glacialis	0		0		0		2	(1)*	0	
Balaenoptera acutorostrata	0		0		0		7	(4)	0	
Physeter macrocephalus	23	(9)	4	(1)	1	(1)	2	(2)	2	(1)
Kogia breviceps	0		0		0		1	(1)	0	
Unidentified Mesoplodon	7	(2)	0		0		0		0	
Ziphius cavirostris	0		0		0		1	(1)	0	
Unidentified beaked whale	1	(1)	0		0		3	(1)	4	(2)
Feresa attenuata	22	(1)	0		0		0		0	
Pseudorca crassidens	0		0		0		24	(6)	0	
Globicephala macrorhynchus	86	(2)	33	(2)	0		674	(69)	31	(4)
Tursiops truncatus	417	(70)	1011	(135)	1380	(322)	511	(94)	261	(63)
Grampus griseus	9	(1)	0		0		67	(7)	201	(21)
Stenella frontalis/ Stenella attenuata	52	(3)	5	(2)	196	(16)	442	(29)	337	(13)
Stenella coeruleoalba	71	(2)	10	(1)	359	(28)	378	(20)	48	(4)
Stenella longirostris/ Stenella clymene	85	(1)	0		34	(5)	15	(1)	82	(2)
Unidentified Stenella	7	(1)	12	(1)	201	(19)	191	(10)	132	(15)
Unidentified dolphin	176	(22)	212	(22)	463	(95)	303	(65)	715	(38)
Unidentified whale	3	(3)		0	0		27	(7)	9	(3)
TOTALS	959	(118)	1,287	(163)	2,634	(9486)	2,648	(318)	1,822	(166)

*BTEX = near Brownsville, Tex. MILA = near Marsh Island, La; NAFL = near Naples, Fla.:
MIFL = near Merrit Island, Fla.
*Number in parentheses = nubmer of sightings

mammals (baleen whales, sperm whales, beaked whales, delphinids, and pinnipeds), with detailed reference to certain, interesting trends in selected species.

Baleen whales. All but three of the world's baleen whale species have been reported in the Gulf. *B. physalus* and *B. edeni* are the most frequently reported species, with reports available from throughout the year, suggesting that small, isolated populations of these whales may inhabit Gulf waters. The other species apparently are represented only as migrants or vagrants. These included *B. musculus, B. borealis, B. acutorostrata, Megaptera novaeangliae*, and *E. glacialis*. Fritts *et al.* (1983) did not sight any baleen whales in the Gulf of Mexico.

Sperm whales. *P. macrocephalus* is the most commonly reported great whale in the Gulf, with many of the records associated with the high incidence of 19th century whaling. Collum and Fritts (1985) observed 47 adults and 12 young sperm whales while conducting aerial and shipboard surveys in the Gulf from August 1979 through March 1981. Most of their sightings were at the continental shelf edge (200 m) or over the slope, and 72% of the sightings occurred off the Texas coast. Sperm whales have been reported in every month of the year, and young whales are often observed, suggesting there may be a stock unique to the Gulf region.

The smaller sperm whales (genus *Kogia*) strand frequently in the Gulf, which is interesting in that these are usually considered to be rare, offshore whales. In the last decade, reports of *K. breviceps* have increased 52 percent and *K. simus* 35 percent, indicating that these whales may be more common than once thought.

Beaked Whales. Beaked whales are rare to uncommon in the Gulf. Of the four species known from this region, *Z. cavirostris* is reported most often. *M. bidens* is known from only one, extralimital record (Bonde and O'Shea 1989). Fritts *et al.* (1983) sighted eight beaked whales off Texas, but they were unable to identify these animals to species.

Delphinids. The most diverse group of Gulf cetaceans, delphinids, shows some remarkable trends in occurrence over the past decade. Of the 13 species in this group, the incidence of occurrence in the modern compared to the historic sample has declined for five species, increased for four species, and remained about equal for four species.

Records for one of the most common cetaceans in the Gulf, *Globicephala macrorhynchus*, occur with 42% less frequency in the modern compared to the historic sample. However, in aerial surveys by Fritts *et al.* (1983) (Table 3), 824 of these whales were seen, comprising 6.1% of the total number of sightings. Similarly, *Stenella coeruleoalba* showed a 56% decline in frequency between historic and modern records but comprised 4.4% of the aerial sightings, for a total of 866 animals. *S. frontalis*, which declined 82% in the modern record, made up 5% of the aerial sightings (1,032 animals). Interestingly, *Delphinus delphis* has not been recorded in the last decade, either in the modern stranding record or the aerial survey.

Conversely, significant increases in modern reports were noticed for several members of this group. These included *Feresa attenuata* (167%) *Grampus griseus* (131%) *Tursiops truncatus* (93%), and *Stenella clymene* (1,280%). The increase in *S. clymene* reports is no doubt due to the recently clarified taxonomy of this species (Perrin *et al.* 1981). All sightings of *F. attenuata* made by Fritts *et al.* (1983) were in Texas waters.

T. truncatus is unquestionably the most common species in the Gulf fauna, and it is the only cetacean for which census techniques have yielded useful population estimates in the Gulf. These estimates do not include offshore dolphins, which are difficult to census and are confined to highly localized geographic regions. Fritts *et al.* (1983) spotted 3,580 *T. truncatus*, which comprised 54.7% of the total sighting records.

The increased incidence of *G. griseus* reports during the last decade is primarily a reflection of sightings made during aerial surveys in Florida and Texas waters (Fritts *et al.* 1983; Jennings 1982). These pelagic sightings occurred in water depths that ranged from 200 to 1,530 m.

Although significant declines in modern reports of some delphinids are apparent in the modern record, it is equally apparent that incidental stranding and sighting reports do not adequately convey a sense of relative abundance for cetaceans. To augment this deficiency, we need continued aerial surveys which, taken with our stranding network data, will better establish population trends for Gulf cetaceans.

Pinnipeds. No pinnipeds have been reported in the modern record of marine mammals from this region. *Monachus tropicalis* was last observed at Seranilla Bank, midway between Honduras and Jamaica, in 1952 and probably became extinct shortly afterwards. Sporadic reports of feral *Zalophus californianus* have been reported for the Gulf, but it is doubtful that a sustainable population of these sea lions will ever become established in the Gulf.

The Future

As we look to the future, it is clear that developing an adequate information base remains the crucial factor in formulating a conservation plan for marine mammals in the Gulf of Mexico. The monitoring of the overall status and ecological vulnerability of marine mammals remains the most basic approach to environmental assessment of these animals. Such studies potentially identify problems by focusing on measures of abundance, group size, relative age structure, and distribution. These attributes vary widely when environmental alteration affects local demes (a closely related group) and

populations. An understanding of the ecology and overall biology of species is essential for evaluating specific environmental problems related to exploitation of petroleum resources.

Two programs that provide these kinds of data have been initiated in the Gulf during the past two decades. The SEUS stranding network continues to be a model of success and remains the most cost-effective source of information available on the marine mammal fauna in the Gulf. In the early 1980s, a systematic aerial survey program was initiated in critical areas of the Gulf where intensive oil and gas development was expected. These surveys should be resumed so that population trends can be assessed periodically.

We live in a time when resources for biological monitoring are limited. Thus, it is imperative that we use resources, both monetary and human, wisely and effectively. Comprehensive planning, involving close collaboration and cooperation among academic and private institutions, Federal and state agencies, and private companies and corporations, will be required to achieve effective resource management. The focus of this planning should be on balancing conservation and sustainable development perspectives. It should not be weighted totally on the heels of the preservationist perspective. To adopt that perspective will alienate critical clientele and invite failure.

None of the necessary research will be possible without the human talent trained in the appropriate procedures and perspectives needed to study and manage marine mammals. Already, there are tremendous amounts of unused, stock-piled data associated with stranding networks due to a shortage of professors and graduate students committed to the pursuit of scientific inquiry on marine mammals. I am extremely pleased that Texas A&M University at Galveston is developing an academically based

graduate education program staffed by some of the leading marine mammalogists in the field. This has great potential to contribute to the future of marine mammal research and management in the Gulf.

Finally, we must constantly seek to educate the public. These are the people who will vote, influence politicians, and ultimately determine the availability of suitable funding to conserve the marine mammal fauna. Here again, progress has been made in the Gulf region. Sea World has now located two major parks in the Gulf where millions of people each year learn about marine mammals and the importance of their conservation.

All-in-all, the future for marine mammal conservation in the Gulf looks brighter than ever before. We have made giant strides, especially in the last two decades. However, there is much to be done, and the time frame for achieving success is rapidly dwindling. We need action now!

References Cited

Bonde, R. K., and T. J. O'Shea. 1989. Sowerby's beaked whale (*Mesoplodon bidens*) in the Gulf of Mexico. Journal of Mammals. 70:447-449.

Collum, L. A., and T. H. Fritts. 1985. Sperm whales (*Physeter catodon*) in the Gulf of Mexico. Southwestern Nat. 30:101-104.

Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Collum, W. Hoffman, and M. A. McGehee. 1983. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters. U.S. Fish and Wildlife Service, Office of Biological Services. FWS/OBS 82/65. Washington, D.C. 455 pp.

Gruber, J. A. 1981. Ecology of the Atlantic bottlenosed dolphin (*Tursiops truncatus*) in the Pass Cavallo area of Matagorda Bay, Texas. M.S. thesis. Texas A&M University, College Station. 182 pp.

Jennings, R. 1982. Pelagic sightings of Risso's dolphins, *Grampus griseus*, in the Gulf of Mexico and Atlantic Ocean adjacent to Florida. Journal of Mammals 63:522-523.

Leatherwood, S., J. R. Gilbert, and D. G. Chapman. 1978. An evaluation of some techniques for aerial censuses of bottlenosed dolphins. Journal of Wildlife Management 42:239-250.

Odell, D. K. 1989. A review of the southeastern United States marine mammal stranding network: 1978-1987. In: Proceedings, 2nd marine mammal stranding workshop. National Marine Fisheries Service. Technical Report. In Press.

Odell, D.K. and J. R. Reynolds, III. 1980. Abundance of the bottlenose dolphin, *Tursiops truncatus*, on the west coast of Florida. Report to the U.S. Marine Mammal Commission, Washington, D.C. National Technical Information Service. PB 80-197650.

Perrin, W. F., E. D. Mitchell, J. G. Mead, D. K. Caldwell, and P. J. H. VanBree. 1981. *Stenella clymene*, a rediscovered tropical dolphin of the Atlantic. Journal of Mammals. 62:538-598.

Schmidly, D. J. 1981. Marine mammals of the Southestern United States coast and the Gulf of Mexico. U.S. Fish and Wildlife Service, Office of Biological Services. FWS/OBS 80/41. Washington, D.C. 163 pp.

Shane, S. H. 1977. The population biology of the Atlantic bottlenose dolphin, *Tursiops truncatus*, in the Aransas Pass area of Texas. M.S. thesis. Texas A&M University, College Station. 239 pp.

SECTION III
SEA TURTLE DISCUSSIONS

PRINCIPAL FINDINGS AND CONCLUSIONS

Mr. Patrick Mangan
Minerals Management Service

Dr. Karen A. Bjorndal and Dr. Alan B. Bolten
Center for Sea Turtle Research, University of Florida

Representatives from the U.S. Fish and Wildlife Service, U.S. National Marine Fisheries Service, Southeast Fisheries Center, U.S. Minerals Management Service, and members of the sea turtle research community convened on the last afternoon of the Sea Turtle and Marine Mammal Workshop to rank sea turtle research efforts in the Gulf of Mexico. The group agreed that, because of the precarious survival status of the Kemp's ridley sea turtle, research efforts to enhance its survival should have top priority.

The group recognized that the development of an integrated and quantitative research program would require a long-term funding commitment to guarantee success. The group also recognized that long-term funding may not be practical for Federal agencies. In lieu of this commitment, and being realistic about funding potentials, the group chose to develop and recommend a program that can be broken into a series of modules within an overall research framework. This approach would allow sections of the research program--the individual modules--to be undertaken separately. These modules would fit into the defined framework and build an overall synthesis. The following research priorities were set during the meeting.

Synthesis of Existing Data

Kemp's ridley. Priority was given to locating, compiling, and publishing existing data on Kemp's ridley. A scientist fluent in both English and Spanish, and familiar with sea turtle research, should be contracted to compile and synthesize the existing data. The compiler and field researchers would collaborate to publish the data, perhaps as a U.S. government technical report. The format of the technical report would allow for publication of raw data and allow future re-analysis of data as new demographic models are developed. Support for the publication of the data collected by Dr. Rene Marquez would be the first stage.

Loggerhead, green turtle, leatherback and hawksbill. Existing data on these four species should be compiled and published as described above for Kemp's ridley.

Distribution and Abundance of Sea Turtles in the Gulf of Mexico

A habitat approach to the study of distribution and abundance of sea turtles was decided upon for practical purposes. A habitat approach is similar to a life history stage approach because of the association of the different life history stages with specific habitats: pelagic, benthic, and nesting beach. The pelagic habitat was given priority because it is the least understood. The following research recommendations were made.

Pelagic. Because of the importance of Kemp's ridley, and because it has one point of entry (Rancho Nuevo, Mexico), movements during the early life history stages of Kemp's ridleys should be modeled. The first studies conducted should be indirect-using current maps, drift buoys, and remote sensing to determine speed, direction, and seasonal variation of currents most likely to affect ridley distribution. Satellite-linked buoys (drifters) should be deployed before, during, and after the hatching season in the areas where ridleys complete the swimming frenzy off the nesting beach. Results from

these studies will allow the development of testable predictions of where posthatchling turtles should be in the pelagic zone. Vessel surveys should then be conducted at the predicted locations.

Benthic. First, existing benthic habitat resource survey information should be compiled. Where inshore benthic areas have not been described, a systematic survey should be conducted with preference given to Mexican waters of the Gulf. Once the habitat types have been mapped, distribution of sea turtles should be correlated with specific habitats. Distribution data should be a combination of existing information and newly initiated surveys. Consistent survey methodologies should be developed and employed for each habitat type so that relative abundance among regions and years can be estimated. Critical corridors between habitats or between geographic regions need to be identified.

Nesting beach. This habitat was given the lowest ranking because of past and ongoing emphasis. But, it was stressed that nesting beach habitat study is essential, and that funding for existing beach-monitoring programs needs to be continued. If additional funds become available, beach surveys should be conducted in those areas suggested as important satellite nesting beaches for Kemp's ridley.

Technology Development

Marking techniques. A critical component of many research programs is an effective marking technique. Techniques used to mark turtles vary with the needs of the study and the size of the turtle. No one marking system will satisfy all needs. The group gave priority to developing an external marking technique for turtles between hatchling and 40-cm carapace length. A multidisciplinary approach with biologists working with engineers was recommended.

Biotelemetry techniques. A critical component for distributional, behavioral, and ecological studies is the development of biotelemetry technology. Emphasis should be given to development of packages that can be attached to smaller turtles and packages that maximize collection of biological data.

Ecology, Behavior, and Demography

Index in-water habitats. Index in-water habitats should be selected. These habitats should be areas with abundant sea turtle populations that represent species, size class, habitat, and geographic diversity.

Long-term ecological, behavioral, and demographic studies. Studies of ecology, behavior, and demography should be conducted at these index areas. Studies should be interdisciplinary and modular to allow for an integrated approach and final synthesis. These studies should be funded for at least three to five years. The focus of these studies would be to elucidate the trophic relationships and growth rates of sea turtles within each of the designated habitats, daily and seasonal behavior patterns, and differential survivorship of age classes. It was recognized that biotelemetry would be an important element for the behavioral studies.

Physiological Ecology

Task force. Priority within physiological ecology should be given to the designation of a task force to respond quickly to environmental crises, such as oil spills. The task force would be prepared to measure physiological parameters to assess negative impacts of that particular crisis. The task force would also develop methods for rehabilitating sea turtles.

Physiological limits to sea turtle distribution. Factors limiting sea turtle distribution (for example, temperature and salinity) would be quantified, and the underlying physiological mechanisms would be described. Aspects of diving physiology that affect sea turtle distribution and habitat use also should be studied.

Toxicological experiments. Effects of various toxins, particularly oil, on the different life stages of sea turtles should be studied. Sublethal effects should be considered.

Permits

It was recommended that the regulatory agencies facilitate the permitting process for sea turtle research.

DISTRIBUTION, ABUNDANCE, AND SURVEY TECHNIQUES FOR SEA TURTLES IN THE GULF OF MEXICO

Chairs:
Dr. Alan B. Bolten, Center for Sea Turtle Research, University of Florida
Mr. Larry Ogren, National Marine Fisheries Service

Co-chairs:
Dr. Nancy Thompson, National Marine Fisheries Service
Dr. Robert W. Middleton, Minerals Management Service

The objective of this session was to identify research needs and methodologies to both define sea turtle distributions and estimate abundance in the Gulf of Mexico. Existing information indicates that turtles demonstrate differential distributions that are species-specific and life-history stage-specific. Most of the available information on turtles is focused on nesting beaches. Relatively little comprehensive research has been conducted in the in-water or habitats. In addition, less research has been conducted in the Gulf of Mexico compared to the western Atlantic.

There is a need to ensure that research that focuses on the distribution and abundance of turtles be completed in a consistent fashion to allow for comparisons between areas and periods of time. In addition, the relatively long generation time requires that long-term research commitments be made to ensure that changes in distribution and abundance can be detected. These two considerations, long-term research and consistency in sampling design, are the goals of all research programs on marine turtles.

If long-term funding cannot be committed to guarantee a successful, integrative research program, discrete research modules within the overall framework need to be identified.

Life history stages were defined as pelagic post-hatchling, benthic juvenile and subadult, and adults. Non-nesting adults may use the benthic environment in the same way as juveniles and subadults. Because of the relatively large amount of information available on nesting females, we believe it is critical to focus research efforts on in-water habitats. We have not established research priorities on a life history stage or habitat use basis; each has equal priority.

The research recommendations advanced by the group included both the compilation and synthesis of existing data, and the listing of new research efforts. Details are provided below.

Research Recommendations

Synthesis of existing data. Priority is to synthesize the existing data to provide direction for future research. This would include compiling and synthesizing existing data relevant to the distribution and abundance of sea turtles (sources of information to include aerial surveys, vessel surveys, strandings, interviews, netting, tagging, historical, telemetry, incidental catch). These survey methods usually are species- and/or life-history-stage specific, but are a first step to defining any research program on marine turtles.

Kemp's ridley. Because of Kemp's priority status, we recommend a separate synthesis that has priority.

- A separate synthesis of existing data may be accomplished more rapidly than one involving all five species.
- The synthesis is to include data from both U.S. and Mexico databases.

Loggerhead, green turtle, leatherback, and hawksbill. During the synthesis of data on Kemp's ridley, some or most of the existing information on these species could be gathered.

Platforms-of-opportunity (fishery-dependent data). It was felt that, considering the state of knowledge, platforms-of-opportunity could provide valuable data. Therefore, a network should be established to identify potential sources of information (for example, divers, yachts, commercial vessels, recreational and commerical fisheries). A standardized method should likewise be developed to collect the sea turtle sightings. Finally, a single archiving repository should be established for data that would be available to all researchers.

Development of an integrative and quantitative research program. If long-term funding cannot be committed to guarantee a successful, integrative program, discreet research modules within the overall framework need to be identified. Because of the Kemp's ridley's survival status, a separate but equally integrative and quantitative research program for Kemp's ridley needs to be developed.

Use of habitat approach for future research. In regard to a habitat approach, we reached the consensus that, for all practical purposes, a habitat approach is similar to a life history stage approach because of the association of the different life history stages with specific habitats. We did not assign relative rankings for the three major habitats (nesting beach, benthic, and pelagic) for sea turtles in the Gulf.

Pelagic habitat (post-hatchlings). Describing the distribution and other characteristics of the post-hatchling turtles in the pelagic environment will involve drawing inference from studies of currents and oceanographic features, direct observations from shipboard surveys, and radio-tracking. Studies of pelagic habitats should make use of indirect and direct observations and data acquisition. In regard to

indirect data acquisition, the group recommends the use of drift buoys to determine movements of hatchlings following the initial swimming frenzy. On the working hypothesis that posthatchling turtles are in drift lines/convergence zones within the pelagic habitat, we recommend using remote sensing and aerial surveys to determine the locations of these drift lines. Finally, using data acquired by drift buoys and remote sensing, researchers should develop testable hypotheses as to the location of post-hatchlings in the pelagic habitat. Direct observations can be achieved through vessel surveys for post-hatchlings conducted in those areas identified from the testable hypotheses developed from indirect data. Appropriate technologies should be developed (or existing sources of technologies be identified) to be able to radio- and/or satellite-track post-hatchlings.

Benthic/coastal habitats. From existing data on benthic characteristics, potential marine turtle habitats can be identified. The known distributions of turtles overlayed with these habitat maps will result in the identification of in-water index habitats. After an initial sampling program to establish baselines is made, these areas can be monitored to evaluate trends.

- The first of the group's recommendations here was to map habitat types within the Gulf. Data for each state already exist; there is a need to synthesize the data for the Gulf as a unit. These habitat types should be overlaid with distributions derived from the synthesis of existing data (Section 1 above). Following this, index in-water habitats should be identified. Gulf regions that require further information from direct surveys should be identified. Breeding habitats should also be mapped.

- The second recommendation was to develop consistent survey methodologies for each micro-habitat type (for example, grass flats,

reefs, mud bottoms, sandy/rocv cky bottoms) to monitor index in-water habitats. Methods should be statistically valid and allow for the detection of change (for example, abundance, physiological parameters).

- Third, a randomized/stratified survey protocol to determine distribution by habitat should be developed. The habitats will have been identified by synthesis of data for each state (above).

- Fourth, baseline parameters for index habitats (species composition, size class distribution, sex ratios, seasonal abundance, etc.) are to be developed. Both abiotic factors limiting sea turtle distribution within the Gulf and biotic factors are to be identified.

- Fifth, the group recommends determining the community ecology of sea turtles by species and by habitat through studies of trophic relationships (for example, food source surveys) and predator/prey inter-relationships.

- Finally, the group recommends that a predictive model for sea turtle distribution within the Gulf be developed.

Nesting beach habitats. Nesting beach survey methodologies exist and can be standardized. Nesting beach surveys in the Gulf were given lower ranking relative to in-water surveys and were therefore not discussed any further.

POPULATION DYNAMICS AND LIFE HISTORY OF SEA TURTLES

Chairs:
Dr. Nat B. Frazer, Mercer University
Dr. James I. Richardson, University of Georgia

Co-Chairs:
Dr. Debby Crouse, North Carolina State University
Mr. Earl Possardt, U.S. Fish and Wildlife Service
Mr. Jack Woody, U.S. Fish and Wildlife Service

As Dr. Bjorndal mentioned during the opening plenary session, the ultimate goal of sea turtle research is the development of predictive models. Demographic "fisheries-type" models that incorporate information on basic life-history characteristics will enable us to predict the effects of potential or actual impacts due to human activities. Such models also may help us to design recovery programs that will most effectively ameliorate any detrimental effects by drawing our attention to stages in the life history that are most amenable to manipulation or have the greatest resulting impact on the population's rate of growth or decline. Even sea turtle population models that are constructed with incomplete or preliminary data (for example, Crouse *et al.* 1987) have their uses:

- Models allow us to put together all we know about a population's dynamics and life history in an explicit fashion. This enables us to examine the consequences of what we know and to identify clearly the areas of missing information or assumed knowledge.

- Models allow us to assess the consequences of alternative assumptions concerning values for unknown aspects of a population's life history.

- Models allow us to assess the sensitivity of our predictions to errors in assumed or "known" values. That is, they allow us to ask the question: "How wrong do I have to be, or how wrong can I be, before it makes a difference in my predictions?" Answers arising from such sensitivity analyses help to focus our attention and research efforts on critical areas for which additional data are needed. This, in turn, helps us to focus new research and allocate research funds into areas that will be most productive in advancing our knowledge of the population under scrutiny.

Key Life-History Characteristics

Participants in our sessions identified five life history characteristics that are necessary for understanding, monitoring, and predicting the population dynamics of sea turtles with respect to impacts due to human activities in the Gulf of Mexico:

- Survivorship (age- or stage-specific)
- Fecundity
- Age at Maturity
- Sex Ratio
- Stock Identification

For the most part, present knowledge concerning most of these aspects of sea turtle biology centers on information gleaned from studies of loggerheads in the Atlantic and green turtles in the Caribbean. Much remains to be done to assess populations in the Gulf.

Survivorship. Survival rates have been determined for adult female green turtles at Tortuguero, Costa Rica, (Bjorndal 1980) and for adult female and large juvenile

loggerheads in Georgia (Frazer 1983, 1987). Preliminary estimates of survival of Kemp's ridley were provided by Marquez *et al.* (1982), but need to be revised with the incorporation of more recent data. In any case, we know nothing about survival rates of small, post-hatchling juveniles of any species. Participants cautioned against using known adult survival rates of Atlantic or Caribbean turtles as representative of rates in the Gulf of Mexico, even for the same species.

Participants agreed that determining age- or stage-specific survival rate was a key element required to begin to address population dynamics of sea turtles, and that the bits and pieces available today were, for all practical purposes, of limited value. We remain ignorant of the posthatchling stage ("lost years"), have bits and pieces of juvenile and subadult information, and are not able to measure turnover rates in the adult class. We discussed why we have not been able to address this issue and focused on the very basic and long-standing need to have available long-term, identifiable marking techniques. Until such methodology is developed and implemented, the blanks in our data base will remain.

Therefore, the priority needed to address survivorship (as well as age at maturity, fecundity, etc.), is the research, development, and implementation of a long-term marking technique(s).

Until this is accomplished participants agreed to the following recommendations:

1. Continue analysis of in situ clutches to monitor survival.

2. Identify and negate animal and human predators on nesting beaches.

3. Sample eggs/hatchlings for contaminant levels, but except for exceptional cases, do not use healthy hatchlings/eggs. Do the same for other size

classes as the opportunity arises. As deemed appropriate, also carry out analysis for contaminants of the nesting environment. This was not deemed a high priority unless there is reason to suggest problems.

4. Again, little is known of nearshore hatchling survival, and it was agreed that ocean current models be analyzed to determine for how long a period the hatchlings are subjected to nearshore attrition and to try to identify and quantify the sources of the mortality. Does the seasonal escapement of hatchlings concentrate predatory fish in the immediate area of nesting beaches? In some cases (Kemp's), local inhabitants may provide some insight into hatchling dispersal and predation (for example, Mexican snapper fisherman who operate 5 to 60 miles offshore in small boats).

5. In relation to juvenile animals and survival of this group, it was again argued that a reliable marking methodology was demanded before the question could be adequately addressed. Until then we should continue to use existing methodology, and to document all identifiable mortality cases. This is standard procedure.

6. In relation to adults, it was suggested that tagging on nesting beaches not be given across-the-board priority until new marking methods are made available. Consideration should be given to comparison studies between U.S. human-impacted loggerhead populations and nonimpacted foreign populations (Australia).

7. It was agreed that population models are needed but must remain primarily as research tools with limited management value until such time

as aspects such as survival and age-of-maturity can be estimated and plugged in. This also requires research and development of long-term marking methods.

Fecundity. Much information is available on clutch sizes and clutch frequencies of sea turtles in Atlantic and Caribbean waters. Neither clutch size nor clutch frequency seems to vary substantially from year to year (Frazer and Richardson 1985, Bjorndal and Carr 1989) and we do not expect that these characters will vary much due to human impacts at sea.

What is not known, however, is the cause of the fluctuations in the numbers of nesting females from year to year. Presumably, the proportion of adult females that are reproductively active may vary widely in a sea turtle population, just as it does in fresh water turtles (Frazer *et al.*, 1990). If so, it will be difficult to determine whether an observed reduction in the number of nesting females is due to human impact or to natural variability in the proportion of females that are reproductively active. Only long-term research efforts can shed light on such phenomena.

It was agreed that the most essential information was already available on clutch sizes and frequencies for Gulf sea turtles. Techniques are available and being implemented in most areas in a standardized way. The ongoing process can be refined in some areas. For instance, we could expand current efforts to include Gulf populations of nesting hawksbills (Mexico) and gather data on clutch size, remigration intervals, internesting period, clutches per season per female, etc. It was also agreed to encourage the data refinement/analysis and publication of the Kemp's synopsis by Marquez, at the soonest possible time.

Age of maturity. Due to the absence of a reliable aging technique, it is not possible to assess age at maturity with any certainty for sea turtles. Using capture-

recapture methods to construct growth curves for Atlantic greens and loggerheads, Frazer and Ehrhart (1985) have provided initial estimates. Given that Bjorndal and Bolten (1988) found that Bahamian loggerheads grow more quickly than Floridian loggerheads, estimates of growth rates or age at maturity for a species in one location should not be applied to the same species in another locality. Thus, additional work should be done specifically with Gulf of Mexico turtles.

It was agreed that efforts should continue to develop and refine available aging techniques, such as skeletochronology (Zug *et al.* 1986), and that encouragement be given to research directed at methods to age live animals. However, even good techniques for dead animals would be of help. New avenues for development of aging techniques should be explored–(for example, antibody titers [concentrations], isotope ratios).

Tagging/marking using present techniques should continue on juveniles and subadults as opportunities arise. However, extreme care should be exercised when mutilation marking is under consideration. The priority is research and development of new long-term marking techniques.

Sex ratio. Natural sex ratios of sea turtles are not well known. Initial indications are that sex ratios of hatchlings and of large juveniles may be very different from 50:50. Research is clearly needed to determine natural sex ratios occurring at all stages of the life history, as well as to determine whether the sexes are evenly distributed within the available habitat.

A great deal of discussion time was devoted to this subject–questioning past published work on sex determination, discussing what hatchling sex ratios were appropriate for "helping" populations/species such as the Kemp's, etc.

The majority of participants at both sessions agreed to the following:

- As possible, we must determine natural sex ratios of juvenile, subadult, and adult populations. This work could be incorporated into present studies, perhaps by collecting blood samples (Demas *et al.* 1990).

- We should continue to sample hatchling sex ratios for all species.

- We must use existing data on other comparable long-lived organisms to assess the effects of sex ratios on optimizing fecundity, genetic restrictions, etc. From knowledge of other species, attempts should be made to draw conclusions regarding sea turtles to provide research design guidance.

- We should initiate studies to gather additional environmental parameters (besides temperature) to correlate with natural sex ratios. We must establish laboratory pivotal temperatures for hawksbills and investigate, under controlled conditions, the potential impacts on sex determination of other factors (for example, pH, humidity, etc.).

Stock identification. Some participants felt that with the exception of Kemp's ridley, it is difficult to decide whether any given activity is impacting only one small deme (local population) or an entire species, because we know little concerning the structure of stocks. Biochemical information currently available for Atlantic and Caribbean green turtles indicates that they are remarkable similar (Bowen *et al.* 1989). At present, discussants were unsure whether this indicated that there was only one great population of green turtles in the area, or whether the similarity was simply a result of

our inability to identify and elucidate any underlying stock structure. Further work is clearly needed to assess stocks of Gulf of Mexico sea turtles.

Research Recommendations

The combined deliberations of the working groups on this topic generated the following list of research priorities:

1. Information and data already gathered (for example, by Marquez and his associates on Kemp's ridleys, and by LeBuff and his associates on loggerheads) must be analyzed and made available to the scientific community in technical reports or in the open literature. This should be accomplished as rapidly as possible in order to elucidate avenues for future research and to provide much-needed baselines for Gulf populations.

2. Research must be conducted into the development and assessment of reliable marking techniques. Until better techniques are available, studies of survivorship, time to maturity, etc., cannot be effectively conducted. Investigations should address the following:

    - An assessment of currently available technologies to determine appropriate uses of each. For example, although it may not be possible to develop a mark for hatchlings that will be discernible in adults, it may be possible to mark and follow different life stages separately. There may be existing techniques that could be used to mark hatchlings which would be discernible when the turtles reach a carapace length of 30-cm. Upon recovery of these turtles, another technique might be more suitable for marking the 30-cm turtles–which would remain until they reached the subadult stage.

Upon recovering these turtles, still another technique might be best suited for following subadults into adulthood.

- Development of additional technologies in concert with electrical and/or biomaterials engineers (electronic or immunologic techniques). Most currently available techniques for marking sea turtles were originally developed for other species (for example, livestock ear tags used as flipper tags). It should be possible to develop new methods specifically designed for sea turtles to meet our special needs.

3. Research must continue on developing reliable aging techniques for all species of sea turtles. If turtles could be aged, we could then fairly easily determine survivorship of juveniles based on size-frequency distributions and catch-curve analyses. Such methods could be applied either to stranded carcasses or to turtles caught alive at sea. Accurate determination of age at maturity would also be facilitated by reliable aging techniques.

Present research into skeletochronology (Zug *et al.* 1986) should be continued and expanded. In addition, researchers studying turtles in areas where recapture probabilities are high should be encouraged to measure sizes of any marked turtles, so that growth-increment methods can be used to construct growth curves. (Frazer and Ehrhart 1985; Bjorndal and Bolten 1988). Wherever possible, the two techniques (skeletochronology and growth-increment methods) should be compared to construct growth curves on the same group of turtles.

4. Research must continue into determining stock identification. Current biochemical methods (Bowen *et al.* 1989) should be complemented by additional morphological work. In addition, new avenues should be

explored (for example, determination of parasite loading) to see if they can shed light on the subject.

5. Additional research should be conducted into determining techniques (e.g., Demas *et al.* 1990) for assessing natural sex ratios of:

   - Hatchlings
   - Juveniles/Subadults
   - Adults

Care must be taken to ensure that capture methods (in the case of juveniles/subadults and adults) or handling techniques (in the case of hatchlings), do not result in inaccurate data being collected. Furthermore, long-term monitoring of sex ratios should be encouraged to determine whether findings from initial years of study were truly representative and to assess natural variance among years. Research should also be conducted to determine whether there are areas of habitat in which sexes segregate in their distributions. Such additional studies could be carried out as a normal part of determining the distribution and abundance of each species.

References Cited

Bjorndal, K. A. 1980. Demography of the breeding population of the green turtle, *Chelonia mydas*, at Tortuguero, Costa Rica. Copeia 1980:525-530.

Bjorndal, K. A., and A. B. Bolten. 1988. Growth rates of immature green turtles, *Chelonia mydas*, on feeding grounds in the southern Bahamas. Copeia 1988:555-565.

Bjorndal, K. A., and A. Carr. 1989. Variation in clutch size and egg size in the green turtle nesting population at Tortuguero, Costa Rica. Herpetologica 45:181-189.

Bowen, B. W., A. B. Meylan, and J. C. Avise. 1989. An odyssey of the green sea turtle: Ascension Island revisited. Proceedings of the National Academy of Sciences, USA. 86:573-576.

Crouse, D. T., L. B. Crowder, and H. Caswell. 1987. A stage-based population model for loggerhead sea turtles and implications for conservation. Ecology 68:1412-1423.

Demas, S. M. , M. Duronslet, S. Wachtel, C. Caillouet, and D. Nakamura. 1990. Sex-specific DNA in reptiles with temperature sex determination. Journal of Experimental Zoology 253:319-324.

Frazer, N. B. 1983. Survivorship of adult female loggerhead sea turtles, *Caretta caretta*, nesting on Little Cumberland Island, Georgia, USA. Herpetelogica 39:436-447.

Frazer, N. B. 1987. Preliminary estimates of survivorship for wild juvenile loggerhead sea turtles (*Caretta caretta*). Journal of Herpetology 21:232-235.

Frazer, N. B., and L. M. Ehrhart. 1985. Preliminary growth models for green, *Chelonia mydas*, and loggerhead, *Caretta caretta*, turtles in the wild. Copeia 1985:73-79.

Frazer, N. B., and J. I. Richardson. 1985. Annual variation in clutch size and frequency for loggerhead turtles, *Caretta caretta*, nesting at Little Cumberland Island, Georgia, USA. Herpetologica 41:246-251.

Frazer, N. B., J. B. Gibbons, and J. L. Green. 1990. Life tables of a slidor turtle population. Pp. 183-200. *In* J. W. Gibbons (ed.) Life history and geology of the slidor turtle. Smithsonian Institute Press, Washington, DC.

Marquez, R., A. Villanueva, and M. S. Perez. 1982. The population of Kemp's ridley sea turtle in the Gulf of Mexico *Lepidochelys kempii* [sic]. Pp. 159-164. In: K. A. Bjorndal (ed.) Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, DC.

Zug, G. R., A. H. Wynn, and C. Ruckdeschel. 1986. Age determination of loggerhead sea turtles, *Caretta caretta*, by incremental growth marks in the skeleton. Smithsonian Contributions to Zoology. Smithsonian Institution Press, Washington, D.C. 427 pp.

PHYSIOLOGY OF SEA TURTLES

Chair:
Dr. Molly Lutcavage, University of British Columbia

CoChair:
Dr. James R. Spotila, Drexel University

The sea turtle species that is most likely to be affected by human activities in the Gulf of Mexico is *Lepidochelys kempi*. However, all of the other sea turtle species are also of critical concern, and the database on their physiology is very limited.

The participants in this session recognized that in the long term, data are needed on the basic physiology and regulatory biology of sea turtles. Relevant research topics should include not only toxicological studies of sea turtles but also baseline studies of their metabolism, biochemistry, and environmental physiology. Because of current permitting requirements it is difficult to conduct physiological studies on endangered species. This is especially true in terms of establishing sublethal and lethal limits for various substances such as oil, drilling muds, dispersants, coagulants, heavy metals, pesticides, and other exotic materials.

Because of this, we recommend a three-fold approach to obtaining data that is critical for endangered species consultations. The first is assessment of current knowledge, the second is prioritization of gaps in knowledge that could be filled by carefully designed laboratory studies, and the third is verification and expansion of laboratory findings with field studies. The latter would benefit from the use of modern biotelemetric techniques and shipboard laboratories.

Summary of Existing Information

Our current understanding of the physiology of sea turtles with regard to the possible impacts of human activities on their health and welfare has been learned from a small but growing number of studies. These include both laboratory and field projects and, in some cases, information gleaned from salvage of approriate material from stranded or incidentally captured turtles.

Directed laboratory studies. These studies have included the physiological effects of forced and voluntary submergence, plastic ingestion, oil exposure, and thermal stress, as well as behavioral studies involving the detection of oil or other chemical products. Field studies have involved identification of heavy metals and pesticides in turtle carcasses, forced submergence in shrimp trawls, effects of oil on nests, thermal biology, platform removal effects, and seasonal blood biochemistry and nutrition. In our review of current knowledge we found that sublethal toxicological effects are poorly documented (e.g., Lutcavage *et al.* 1984), but that the incidence and causes of dermal fibropapillomas are under investigation (Jacobson *et al.* 1989).

In general, human activities that have documented physiological effects on sea turtles includes ocean dumping of nonbiodegradable refuse; oil spills and containment operations; toxic substance release and nonpoint pollution; fishing-related mortality, platform construction and removal, and harbor dredging operations. General findings are highlighted below:

Ingestion of plastic substance. Plastic ingestion by sea turtles may result in asphyxiation or chronic starvation. One study showed that green and loggerhead turtles incidentally ingested plastic if offered with food, and, in fact, ingestion of plastic increased with appetite (Lutz, in press). Gut passage time of nonbiodegradable plastic pieces ranged from 11 to 44 days. In some cases, plastic pieces were consolidated into a

bolus and showed evidence of degradation in the gut. The physiological impact of plastic ingestion was a decline in blood glucose (the energy currency of the turtle) until the plastic was excreted. Whether hypoglycemia resulted from mechanical disruption of digestion or biochemical changes remains unknown.

Petroleum exposure. Turtles exposed under laboratory conditions to chronic and acute oiling situations showed adverse reactions in several areas (Lutz *et al.*, 1986). Initially, diving and respiratory patterns changed in the presence of oil. Under prolonged exposure to a surface film, the skin and mucosal areas (eyes, mouth, nostrils) became inflamed. The turtle's skin lacked the usual leathery texture and within 7 to 9 days showed loss of structural integrity. Possible results of inflammatory change included lowered resistance to infection and disease and impaired vision and olfaction. The skin of turtles that were cleaned and returned to clean sea water healed spontaneously, but long term effects of oil on the epidermis remain unknown. The increase of dermal papillomas in sea turtles suggests that skin is an important target organ for further toxicological study (Bossart 1986; Jacobson *et al.* 1989).

Turtles exposed to chronic and acute levels of crude oil had increased white blood cell counts suggesting an immunological response. Whether immune response is induced by oil per se or by stress remains unknown.

Normal salt gland function was impaired by exposure to oil. This function maintains the osmotic or "salt" balance of sea turtles, and the loss of this function has lethal consequences as it leads to dehydration. Salt glands of turtles exposed to acute levels of crude oil ceased to function following 48 hrs. These effects were reversible, but limited data suggest that loss of salt gland function for even short periods of time could be harmful (Lutz *et al.*, 1986).

Field Studies. A limited number of field research projects have focused on toxicology, pollution biology, or baseline environmental physiology of sea turtles.

Petroleum exposure. Fritts and McGehee (1981) made a preliminary study of the effects of weathered crude oil on the embryonic development of loggerhead and ridley turtles, but suggested that their results were inconclusive and that the matter merited further study. Bellmund *et al.* (1985) provided an analysis of aromatic hydrocarbons found in stranded Virginia sea turtle carcasses, but similar studies are lacking from other coastal areas.

Postmortem studies and the examination of stranded, oiled turtles have demonstrated high white blood cell counts, hypoglycemia, and disruption of digestion (Bossart 1986). Similar responses were documented in the laboratory studies described above (Lutz *et al.* 1986).

Dispersants and coagulants. Studies are completely lacking regarding the effects of dispersants and coagulants on sea turtles. This information is vital in regard to assessing potential impacts that cleanup operations will have in the event of oil spills. In regard to other toxic substances, very little information exists on the impact of groundwater runoff, heavy metals, fertilizers, and drilling muds on Gulf sea turtles. The presence of toxic substances in other sea turtle habitats, and in their tissue, has been reported by Hillestad *et al.* (1974), Thompson *et al.* (1974), Stoneburner *et al.* (1980), and Clark and Krynitsky (1980), and merits further monitoring and study.

Explosive removal. There is some evidence that the use of explosives in removing Gulf petroleum platforms may have lethal effects on sea turtles (Klima *et al.* 1988). Information pertaining to how turtles may be killed or injured by explosions is not presently available.

Incidental Mortality. Finally, incidental mortality of sea turtles associated with fishing, dredging operations, and derelict fishing gear has received wide attention in recent years. Asphyxiation and drowning from prolonged submergence are documented immediate causes of death related to the above activities.

Laboratory studies of forced and voluntary diving indicate that a combination of factors affect how long sea turtles tolerate forced submergence. These include size of the turtle, ambient temperature, the turtle's activity, and general state of health. Turtles forced to dive accumulate a metabolic oxygen "debt" that must be paid off by breathing air for prolonged periods. The presence of a lactic acid load in the blood partially explains why turtles submerged forcibly are less able to tolerate repeated submergence. Field studies using biotelemetry are needed to better define physiological and environmental conditions that might reduce or enhance turtle survival in trawls and fishing gear. It should be pointed out that setting trawling tow limits of a single time (for example, 90 minutes) ignores the biological realities regarding a sea turtle's ability to hold its breath.

Research Recommendations

The sea turtle physiology committee recommends the following research approaches.

1. The greatest need in the field of sea turtle physiology is to establish a rapid response team of physiologists to carry out research and rehabilitation in response to oil spills and similar incidents. The nucleus of the team would be centered at a university and be composed of a coordinator and small core group of student assistants who would assemble research supplies and who would be ready to go to a field site on short notice (1 or 2 days). The rest of the team would be composed of researchers (physiologists) at other

institutions; they would be available to travel to the site of an incident to carry out applied physiological research on impacted animals. This research would seek to determine physiological responses of the turtles to the contamination, and to devise the most effective means of rehabilitation of affected animals. This effort would allow us to obtain tolerance and other physiological data on turtles without harming animals from unaffected populations. It would also minimize the effect of an oil spill on impacted sea turtles.

This team would have to function at a baseline level and would have to hold occasional practice exercises to perfect and test assembly procedures and research methodologies. These would be essentially dry runs or drills.

The core group could also respond to stranding events when these events provide animals suitable for analysis of stomach contents, it levels of toxicants (heavy metals, pesticides, hydrocarbons, etc.), in tissues and the digestive system, and of other physiological and cellular processes, and may be coordinated with efforts targeting marine birds and mammals.

2. The next need is for an assessment of our current knowledge of the physiology of sea turtles. Two reports should be prepared. The first should be a compilation of unpublished data on the causes of death of, the ingestion of plastics by, and the physiological state of stranded sea turtles. These data are available in the files and notebooks of researchers, government laboratories, and members of the sea turtle stranding network. A study should be commissioned for a researcher to travel to these sites and assemble these data into a technical report.

The second report should be a review of the published literature on the physiology of sea turtles and their response to oil, contaminants, and toxicants. There is no up-to-date compilation of these data. These reports would provide current information needed for management decisions and endangered species consultations.

3. The third approach is to conduct a series of studies on the baseline sea turtle physiology, which is extremely important in obtaining data needed for endangered species consultations. In order of priority these are the studies:

Study No. 1. The effect of stranded oil on the development and survival of sea turtle eggs in nests. This study should simulate the effect of an oil spill washing ashore and covering a nesting beach and should test the effect of different types of oil (light crude, heavy crude, refined oil, etc.).

Study No. 2. A second study would investigate the metabolism and physiological responses of turtles to sublethal stresses of oil, drilling mud, dispersants, coagulants, and other toxicants.

Study No. 3. The study of the diving behavior and physiology of turtles under controlled conditions in the laboratory (effect of temperature, handling, etc.) and under natural conditions in the field (using telemetry) can be of predictive value.

Study No. 4. A fourth endeavor would study sensory physiology in the laboratory and field. The behavioral and physiological responses to acoustic, auditory, olfactory, magnetic, and electric stimuli would be measured.

Study No. 5. The behavioral and physiological responses of turtles to artificial structures, including oil rigs, pipelines, artificial reefs, etc. (using biotelemetry) should also be studied.

Study No. 6. The sixth area of study is the effect of environmental stress on the disease response of sea turtles. This study should involve the relationship of the incidence of bacterial and viral infections and tumors in sea turtles to the presence of levels of toxicants (heavy metals, hydrocarbons, pesticides, etc.) in turtle tissues. This study could focus on necropsy data from stranded animals and natural populations in polluted ecosystems.

Comments

The present implementation of the Federal Endangered Species Permit process presents a serious obstacle to the initiation of physiological studies of sea turtles. Guidelines should be provided by the appropriate Federal agencies to inform researchers about allowable activities and application procedures. Permit applications should be reviewed by expert physiologists to judge the scientific merit of the research and the appropriateness of the experimental protocols.

References Cited

Bellmund, S. A., P. Defur., C. Su, and J. A. Musick. 1985. An aromatic hydrocarbon analysis of Virginia sea turtles: Methods and implications. P. 56. In Proceedings of the Fifth Annual Workshop on Sea Turtle Biology and Conservation. J. I. Richardson (Comp). University of Georgia. (Unpublished).

Bossart, G. D. 1986. Clinicopathological effects. In: final report study of the effects of oil on marine turtles. U.S. Department of the Interior, Minerals Management Service, New Orleans. MMS Contract No. 14-12-0001-30063.

Clark, D. R., and A. J. Krynitsky. 1980. Organochlorine residues in eggs of loggerhead and green sea turtles nesting at Merritt Island, Florida, July and August, 1976. Pesticides Monitoring Journal 14:7-10.

Fritts, T. H. and M. A. McGehee. 1981. Effects of petroleum on the development and survival of marine turtle embryos. Report to U.S. Fish and Wildlife Service. Contract No. MOVAA 851 MVO-21.

Hillestad, H. O., R.J. Reimold, R. R. Stickney, H. L. Windom, and J. H. Jenkins. 1974. Pesticides, heavy metals and radionuclide uptake in loggerhead sea turtles from South Carolina and Georgia. Herp. Rev. 5(3):75.

Jacobson, E. R., J. L. Mansell, J. P. Sundberg, L. Hajjar, M. E. Reichmann, L. M. Ehrhart, M. Walsh, and F. Murru. 1989. Cutaneous fibropapillomas of green turtles (*Chelonia mydas*). J. Comp. Pathol. 101:39-52.

Klima, E. F., G. R. Gitchlag, and M. L. Renaud. 1988. Impacts of the explosive removal of offshore petroleum platforms on sea turtles and dolphins. Mar. Fish. Rev. 50:33-42.

Lutcavage, M., P. L. Lutz, and D. K. Odell. 1984. Study of the effects of oil on on marine turtles. Revised literature survey and synthesis. MMS Contract No. 14-12-001-30063.

Lutz, P., M. Lutcavage, and D. Hudson. 1986. Physiological effects. In: final report study of the effects of oil on marine turtles. U.S. Department of the Interior, Minerals Management Service, New Orleans. MMS Contract No. 14-12-0001-30063.

Lutz, P. Studies on the ingestion of plastic and latex by sea turtles. Proceedings of 2nd international conference ocean debris, Hawaii, 1989. U.S. Department of Commerce. In press.

Stoneburner, D. L., M. N. Nicrora, and E. R. Blood. 1980. Heavy metals in loggerhead sea turtle eggs (*Caretta caretta*): Evidence to support the hypothesis that demes exist in the western Atlantic population. Journal of Herpetology 14:171-176.

Thompson, W. P., P. W. Rankin, and D. W. Johnson. 1974. Polychorinated biphenyls and P,P^1 DDE in green turtle eggs from Ascension Island, South Atlantic Ocean. Bull. Environ. Contam. Toxicol. 11:399-406.

ECOLOGY AND BEHAVIOR OF SEA TURTLES

Chairs:
Dr. L. M. Ehrhart, University of Central Florida
Dr. Karen Bjorndal, Center for Sea Turtle Research, University of Florida
Dr. Peter C. H. Pritchard, Florida Audubon Society

CoChairs:
Dr. Edward F. Klima, National Marine Fisheries Service
Dr. Tyrrell A. Henwood, National Marine Fisheries Service
Dr. Richard Byles, U.S. Fish and Wildlife Service

Consideration of the research needs relevant to the behavior and ecology of sea turtles in the Gulf of Mexico could be organized in a number of ways. The primary organizational breakdown could be along the lines of habitats, species, ecobehavioral subtopics, or by life-history stages. The chairs agreed that it would be productive to organize around the latter category, life-history stage, because there is some commonality in the threats and impacts of human activities in those stages that cross species lines.

Because "ecology" and "behavior" are broadly inclusive terms and could easily encompass topics dealt with in other workshop sessions, the selection of subtopics was necessarily arbitrary and restrictive. There was general agreement, however, that most of the relevant issues could be couched in terms of feeding ecology, habitat requirements and preferences, movements and activity, and community structure. Participants were free to introduce topics extemporaneously, whether or not they fit well into any of the four categories.

The groups followed Bjorndal, in her plenary address, and ranked the five species known from the Gulf in order of the urgency of directed research needs: (1) Kemp's ridley, (2) loggerhead, (3) green turtle, (4) hawksbill, and (5) leatherback. The position of the green turtle is viewed as only slightly below the first two and due only to the lack of any significant nesting by the species on Gulf beaches.

Following a brief description of each of the four categories-- feeding ecology, habitat requirements, movements and activity, and community structure-- this report will enumerate the research needs in each category.

Categories of Relevant Issues

Feeding ecology. While the food habits of all five species are known in a general way, the literature is essentially devoid of systematic, quantitative studies of Gulf of Mexico turtles. Certain well-established ideas about the foods of Kemp's ridley and the green turtle, in particular, were called into question by participants, and the need for comprehensive baseline studies in feeding ecology became quite evident.

Habitat requirements. Quantitative characterization of marine turtle habitats in the Gulf of Mexico is essentially lacking in the literature. Although there are a number of often-repeated qualitative generalities about the habitats of each species, the group felt that development of additional data on habitat characteristics and requirements had urgent priority.

Movements and activity. Recent studies by F&WS of the movements of adult ridleys in the Gulf have demonstrated the usefulness of satellite telemetry, but much more remains to be done. The group reaffirmed its earlier decision to regard Kemp's ridley having urgent priority, in this case with regard to the application of this relatively expensive technology.

Community structure. In addition to the topics and their appropriate priorities, many of which are of direct relevance to the assessment of the impact of MMS activities in the Gulf of Mexico, the panel identified several aspects of sea turtle community ecology that should be included in any integrated program of research in the Gulf of Mexico area.

Research Recommendations

Feeding ecology. For all species and all life stages, the following projects were developed for studying feeding ecology. The first two projects were ranked as higer priority than the rest.

1. That data on feeding habits and stomach contents of sea turtles that has already been gathered should be assembled and published, where that has not been done. The greatest body of information may be from analyses of stomach contents from stranded sea turtles.

2. Baseline diet studies are needed for all species of sea turtles. Information on diet should be collected from stranded animals, with appropriate caution, considering possible bias of the samples. Diet information should also be collected by sampling stomach contents (using noninjurious techniques) and feces of live animals and from direct observations of feeding animals. The advantage of working with live animals is that diet selectivity can be assessed by quantifying available food resources and comparing available food with that consumed. Diet studies need to be quantitative, not qualitative. Diet studies need to be quantified by sea turtle species, by size class within each species, by season, and by habitat.

The other three projects under the heading of feeding ecology were considered to be of equal importance and are not ranked here.

3. The study of food webs was considered to be critical, especially with regard to the accumulation of toxins in sea turtles. Because of differences among rates of toxin accumulation among food webs, some species or size classes

within species may be more vulnerable than others to toxin accumulation. Analyses of blood chemistry and tissues from fresh carcasses need to be performed.

4. The ingestion of debris by sea turtles needs to be quantified and the extent of both lethal and sublethal effects assessed.

5. The ingestion of oil/tar by sea turtles needs to be quantified, and the extent of both lethal and sublethal effects assessed. The oil/tar should be traced to its source, when possible.

Habitat requirements. The group recommended that the following habitat studies be made.

1. In the case of hatchling and posthatchling turtles, it was agreed that a better understanding of habitat characteristics might be obtained through studies of current patterns, sargassum distribution and movements, remote sensing, etc. However, there was unanimous agreement that studying turtles in the pelagic environment would be cost-prohibitive at this time and that major efforts to assess the ecology of hatchlings at sea should not be conducted until the probability of capturing and studying these animals was measurably improved. The group agreed that this work was needed, but recommended an effort commensurate with the possibility of encountering these turtles and the likelihood of obtaining good data at a reasonable cost. The area considered to offer the best chance of success was studies of current patterns though real-time satellite imagery. This was based on the hypothesis that hatchlings are passively transported by major current systems, and that the best chance of finding turtles is in these discrete and identifiable "corridors."

2. For juveniles, subadults, and adults, the group identified several areas of interest. They felt that depth, availability of preferred foods, and substrate types needed to be clearly identified for each species and age class. They also identified the questions of brumation (overwhelming) and thermal limitations as areas of interest. It was also suggested that areas in which mating occurred might be of major scientific interest. Loss of habitat (for example, seagrass losses as observed in Florida Bay) was identified as a question in the recovery of the species, assuming that trends are reversed and turtle populations begin to approach their former levels.

3. A final area of concern was the assessment of offshore oil/gas structures as potential habitat for turtles. The group felt that information about movements, residency, diet, etc. were of particular importance to MMS in assessing potential impacts of offshore activity. Also mentioned was the possible exposure to other risks (rig removals, entanglement, debris) associated with potential residency around or between these structures.

Movements and activity. Under the various topics and data needs, the group thought that large-and small-scale movement delineation was very important, and that biotelemetry was the best method for achieving this end. The transmitters selected for studies should maximize data collected (temperature, depth, etc.) so that behavioral data are obtained–as well as identify locations and movement corridors. Seasonal migrations and overwintering sites should be investigated.

Also important, but with no particular ranking or ordering of relative importance, were the following topics:

- Establishment of diel activity patterns such as feeding and resting, for all species; this study is best approached with biotelemetry.

- Investigation of sensory biology such as olfaction, magnetic-behavioral responses, and migratory cues. A combination of lab and field studies is needed.

- The attractant-repellant nature of, and response of turtles to, anthropogenic (human-produced) materials, especially by catch from fishing operations, organic waste dumped from offshore structures, and marine traffic and oil slicks, need to be studied.

Assessment of movements of head-started ridley turtles with biotelemetry and effective selection of release sites was also discussed. We must have wild-caught, similar-sized turtles to track and use as controls in that endeavor.

Community structure. The group delineated the following research in community structure needs.

Baseline parasite load. Data are almost lacking on the parasite load carrier tolerable by healthy sea turtles. Such data are important in the assessment of the overall health, up to the time of death, of turtles found stranded on shore, or found dead in the marine environment.

Baseline symbiant load. More data are available on the subject of symbiont load, external symbionts being easily quantified. Most barnacle species come under the heading of symbionts rather than parasites, although some barnacles bore though the shell of a turtle and derive nutrition from the blood of the host. Nevertheless the distribution and numbers of even non-parasitic barnacles and other epibiota can be an important index to both the activity level of the turtle and to its overall health.

Energy and nutrient cycling and flow. Sea turtle species show a wide divergence in feeding ecology, dietary species, assimilation rates, growth rates, and function in ecosystems. Little has been done about quantifying the flow of energy through ecosystems in which sea turtles play important roles, and this should be initiated.

Predation. For all life stages, more data are needed on natural predation. Each life stage, from hatchling to adult, may be subject to predation by a characteristic mix of species, but although nesting-beach and neonatal predators have been identified to a certain degree, few data exist on natural predation upon the larger life stages in the marine habitat. Elucidation of accurate life tables and population models will require these data. Human predation too–both directed and incidental–must be quantified and included in the formulas generated to predict population dynamics and replacement rates.

Concluding Remarks

Despite the breadth and diversity of issues and considerations, the overlap seen in the deliberations and conclusions of the two discussion groups was quite remarkable. While one group spent time recalling what is already known and formulating fewer, broader directions for research, the other went more directly to ranking perceived research needs. The results were not in the least disparate. With only slight adjustment in wording and tone, the chairs and cochairs were able to derive three principal concerns from the workings of the group.

The first of these was the need for a comprehensive search and compilation of extant data and literature. This is to include not only perusal of referenced scientific journals but also the expenditure of real effort to bring to light the multitude of data thought to reside in "the gray literature," stalled manuscripts, and lab files.

The second common concern was the need for quantitative baseline diet studies for all five species. The results of such studies are critical to our understanding of more complex trophic relationships and related issues such as food-chain multiplication of toxic substances.

The greatest agreement between the two discussion groups was in the perceived need for a broadscale, thoroughly planned, adequately equipped, biotelemetric study of sea turtle movements and activity. With proper forethought and instrumentation, such a study, probably involving a consortium of institutions, could provide the level of replication necessary for rigorous analysis, and address questions spanning the biological spectrum. A study of such proportions is feasible and would inevitably spawn and enhance quantitative studies of habitat characterization, which was another major concern voiced in this session.

SECTION IV
MARINE MAMMAL DISCUSSIONS

PRINCIPAL FINDINGS AND CONCLUSIONS

Dr. Robert J. Hofman
Marine Mammal Commission

Thirty-one species* of marine mammals, including the endangered West Indian manatee (*Trichechus manatus*) and six species of endangered cetaceans (see Table 1) have been observed in or found stranded along the coast of the northern Gulf of Mexico. The most common coastal species, and consequently one of the species most likely to be affected by both nearshore and offshore development and other human activities in the Gulf, is the bottlenose dolphin (*Tursiops truncatus*). The West Indian manatee is the endangered marine mammal most commonly seen in the Gulf and, because of its relative abundance and costal distribution, the endangered marine mammal species most likely to be affected by human activities in the Gulf.**

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* The melon-headed whale (*Peponocephala electra*) was reported from the western Gulf of Mexico between the dates of the workshop and publication of the proceedings. The count of 31 marine mammal species and 28 cetacean species includes *P. electra*. It has been included in Table 2 (Haubold and Schiro 1990).

** Research and management needs relative to the West Indian manatee have been clearly described in the West Indian Manatee Recovery Plan prepared and adopted by the U.S. Fish and Wildlife Service. Needed recovery actions, including research, also are subject of continuing review by the Service, in consultation with the Minerals Management Service, the Army Corps of Engineers, the Florida Department of Natural Resources, the Marine Mammal Commission, and other Federal and state agencies. Consequently, as noted in the Introduction, research needs relative to the West Indian manatee were not considered by the Workshop.

Of the six endangered whale species reported to occur in the northern Gulf, only the sperm whale (*Physeter macrocephalus*) is seen more than occasionally. The remaining five species–the right whale (*Eubalaena glacials*), the blue whale (*Balaenoptera musculus*), the sei whale (*B. borealis*), the fin whale (*B. physalus*), and the humpback whale (*Megaptera novaenglie*)–are seen or are found stranded only rarely in the Gulf (see Schmidly, this volume). The paucity of sightings and strandings suggests, but does not demonstrate, that only small proportions of the extant populations of these species ever visit the Gulf and that these populations, therefore, are unlikely to be affected significantly by offshore oil and gas development or other activities in the Gulf.

For other than the bottlenose dolphin, little is known about the biology, ecology, or demography of the cetacean species that occur in the northern Gulf of Mexico. Most of what is known has been derived from studies of live and dead stranded animals, from sightings during the several site-specific and regional marine mammal surveys done to date, and from opportunistic observations made during fishery resource surveys, and other studies in the Gulf (see Schmidly, Section II Plenary Session Presentations).

Although sparse, the available data suggest that the northern Gulf may constitute significant proportions of the range of the pigmy and dwarf sperm whales *(Kogia breviceps and K. simus*), the false killer whale (*Pseudorca crassidens*), the short-finned pilot whale (*Globicephala macrorhynchus*), grampus (*Grampus griseus*), several beaked whales (*Mesoplodon spp.* and *Ziphuis cavirostrus*), and several dolphins of the genus *Stenella.*

Activities Affecting or Potentially Affecting Marine Mammals in the Northern Gulf of Mexico

Workshop participants identified a number of human activities that are or could be affecting marine mammals and their habitat in the Gulf of Mexico. These activities include the following:

- Coastal development (particularly marine dumping and dredging), offshore oil and gas exploration and development, commercial and recreational vessel traffic, and military activities, all of which may be producing noise that interferes with cetacean communication. These activities may also be disturbing and stressing marine mammals and causing them to abandon or avoid traditional feeding areas, breeding areas, or migratory routes, and/or causing adverse changes in essential marine mammal prey species or other key components of marine mammal habitats in the Gulf.

- Commercial fisheries, such as the menhaden purse seine fishery and the shrimp trawl fishery, that may accidentally entangle and drown or injure marine mammals during fishing operations, or compete with marine mammals for the same fishery resources.

- Lost and discarded fishing gear and other persistent debris–such as plastic bags, bottles, and cups–that may entangle or be eaten by and kill or debilitate many marine mammals. (Such debris also may be responsible for the death or debilitation of large numbers of fish, birds, turtles, and other marine organisms.)

- Marine pollution from oil spills, agricultural runoff, industrial effluent, etc., that can poison and kill or debilitate marine mammals and adversely affect the food chains and other key elements of the ecosystems of which they are a part.

- Live-captures and removals for purposes of public display and scientific research. This activity may stress and affect the survival and productivity of animals that are chased and captured, but not removed, as well as animals that are removed from the wild.

- Illegal shooting. Several workshop participants noted anecdotal and verified reports of fishermen shooting and using dolphins for shark and crab bait, and of recreational boaters and others shooting marine mammals for "sport."

- Using explosives to remove offshore drilling platforms. This practice can kill or injure turtles, fish and other organisms, as well as marine mammals, that may be in the vicinity when charges are detonated.

- Whale and porpoise-watching and feeding. At present, there is not a substantial whale or porpoise-watching industry in the Gulf. There appears, however, to be a growing industry in which dolphins are attracted to and fed by paying passengers aboard tour boats. This activity could make dolphins dependent upon non natural food sources and more vulnerable to being hit by boats, malicious shooting, and accidental or deliberate food poisoning.

Workshop participants also noted that marine mammals and the ecosystems of which they are a part are affected by natural events, such as red tides, hurricanes, and climate change, and that understanding of natural variability may be necessary, in at least some cases, to detect and monitor the effects of human activities.

Critical Uncertainties and Research Needs

Workshop participants noted that the basic biology, ecology, and demography of most marine mammal species inhabiting the Gulf of Mexico either ar%unknown or are poorly known. They also noted that it was not known to what extent the marine mammal fauna of the Gulf has been or is being affected by coastal and offshore development, commercial fisheries, environmental pollution, other human activities, and natural variables. The following were determined to be the most critical uncertainties and research needs:

Better assess and develop programs. To detect and monitor the effects of human activities on the endangered sperm whale and other cetaceans throughout the Gulf of Mexico, better assess and develop programs are needed. As noted above, available information on the distribution, number, habitat-use patterns, feeding habits, and essential habitats of sperm whales and virtually all other cetaceans that occur in the Gulf of Mexico (except perhaps some coastal populations of bottlenose dolphins) is insufficient to predict or to provide an adequate baseline for detecting the possible effects of coastal development, offshore development, or other human activities. Workshop participants noted that three relatively large areas in the northern Gulf had been repeatedly surveyed in 1980 and 1981 by U.S. Fish and Wildlife Service (FWS) researchers under contract to the Bureau of Land Management to determine the number and relative abundance of marine mammal species potentially occurring in the northern Gulf (Fritts *et al.* 1983). The National Marine Fisheries Service (NMFS) had conducted or supported a number of site-specific and regional surveys to estimate the number and

vital rates of bottlenose dolphins present in coastal areas where dolphins have been or could be removed for purposes of public display and scientific research. NMFS had also conducted seasonal regional surveys of the northern Gulf during 1983-1986 from the coast out to the 100-fathom isobath (359,000 km^2 in area) to estimate distribution and abundance of marine mammals at different times of the year. Most of what is known about the diversity and basic biology of most of the species comprising the marine mammal fauna of the northern Gulf of Mexico has been derived from studies of live and dead stranded animals.

The participants concluded that priority should be afforded to establishing as soon as possible an adequate baseline and ultimately a long-term monitoring program capable of verifying the predicted effects, and detecting the unforeseen effects, of human activities on marine mammals and their habitat in the Gulf of Mexico. Towards this end, participants recommended that priority be afforded to designing and conducting a synoptic, aerial survey and companion studies aimed at determining when, where, and how many marine mammals–by species, age/size, and sex–occur in the Gulf, how distribution and abundance vary seasonally and annually (within and between years), and what factors (for example, water depth, water temperature, primary production, scale of human activities) appear to determine and affect distribution, abundance, productivity, behavior, and habitat-use patterns.

Establishing an adequate baseline and determining seasonal and annual variation in distribution, abundance, productivity, and habitat-use patterns will require that surveys be replicated three to six times each year for a period of at least two and probably three to five years. The surveys should focus on shelf and deep-water areas in the U.S. Exclusive Economic Zone and, as possible, be designed and carried out cooperatively with sister agencies and researchers in Mexico to cover adjacent areas off the Gulf coast of Mexico.

Surveys should be coordinated with oceanographic and fishery resource surveys being conducted by U.S. and Mexican ships to gather corollary data necessary to determine the possible cause-effect relationships between marine mammal distribution and movement patterns, and oceanographic variables such as water temperature, salinity, depth, and primary and secondary productivity. Trained marine mammal observers should be placed aboard cooperating survey vessels to collect independently marine mammal sighting and behavior data that can be used to help assess the probability of sighting and accurately identifying and estimating the numbers and sizes of various marine mammals during aerial surveys.

If the results of these cooperative surveys or the initial aerial surveys indicate that the aerial surveys may miss certain species, sizes, or groups of marine mammals, or that the survey data may be otherwise biased, a series of experiments, utilizing coordinated aerial and ship surveys, should be designed and carried out to quantify and determine how the bias might be avoided, reduced, or taken into account when converting sighting data into density and population estimates.

Development (design and implementation) of a long-term program for detecting and monitoring changes and trends in marine mammal populations in the Gulf will require completion of the aforementioned baseline survey and determination of what level of change and how rapidly change in various population parameters is necessary for detection. If, for example, there is reason to believe that populations are being or could be affected adversely by human activities, it may be necessary or desirable to be able to detect 10 or 20 percent changes in population size within 1 to 5 years after the change begins. If this were the case, it likely would be necessary to conduct high intensity surveys every year to have a reasonable expectation of meeting the program objectives.

On the other hand, if there is no reason to believe that populations have been or are being affected by human activities, it might be possible to conduct surveys in selected "index" areas, at 3 to 10 year intervals, simply to verify that there have been no major changes in distribution, abundance, or productivity. The survey should be designed to the maximum extent practicable to build on and collect data comparable to the data collected during the previous surveys conducted by the NMFS and FWS. The survey design should be as consistent as possible with previous surveys and in doing so should extend the time series available for areas previously sampled (i.e., the NMFS regional surveys and the FWS surveys of the northern Gulf). Ensuring consistency of effort implies using consistent field sampling methods and consistent archival of historical data and future data. National Marine Fisheries Service representatives estimated that acquiring and establishing a consistent format for archiving available survey sets would to cost approximately $60,000.

Workshop participants estimated that it would cost 1.5 to 2 million per year for a period of two to five years to conduct a synoptic aerial survey of the northern Gulf of Mexico. This would cover design and aircraft costs, data analyses and reporting, and personnel costs. The cost of training and placing marine mammal observers aboard several ships conducting oceanographic and/or fishery resource surveys in and near areas covered by the aerial survey included also. But it would not cover the cost of vessel charters if coordinated aerial and ship surveys are necessary to identify and quantify possible sources of bias in the aerial survey data.

Because of uncertainties concerning the distribution, movements, and abundance of marine mammals in the Gulf, and how various species are being or may be affected by human activities, it is not possible at this time to estimate the types or cost of periodic area-wide or regional surveys that ultimately may be required to monitor and detect changes and trends in vital population parameters.

Determine and monitor levels of environmental contaminants and natural biotoxins. In representative marine mammals in the Gulf of Mexico, levels of environmental contamiants and natural biotoxins should be determined and monitored. Available information indicates that the Gulf of Mexico, like many other marine areas, is being contaminated to varying degrees by fertilizers, herbicides, and pesticides from agricultural runoff, industrial effluents, oil spills, dumping of wastes, loss and discard of fishing nets and line, and pollutants from other sources. In addition, it has been hypothesized that the mass mortality of bottlenose dolphins that occurred along the United States central and south Atlantic coast in 1987 was caused by a natural biotoxin produced by the dinoflagellate, *Ptychodiscus brevis*, which commonly forms the so-called "red tides" in the Gulf of Mexico (Geraci 1989).

It is not known how various contaminants–for example, PCBs, organochlorides, anthropogenic hydrocarbon compounds, heavy metals–have affected or may be affecting marine mammals, their food supplies, or other components of the marine ecosystems of which they are a part in the Gulf of Mexico. Also, while red tide blooms occur frequently in the Gulf, there have been no confirmed reports of associated marine mammal mortalities, and it is not known whether bottlenose dolphins or other marine mammals that occur in the Gulf are affected by brevetoxin poisoning which, as noted above, is hypothesized to have caused or initiated the mass mortality of bottlenose dolphins that occurred along the central and south Atlantic U.S. coast in 1987-88.

As a first step towards determining what contaminants and natural biotoxins may be affecting marine mammals in the Gulf of Mexico, and how contaminant and biotoxin levels might be monitored most cost effectively, workshop participants recommended that a general survey or pilot study be done as soon as possible to determine the types and levels of contaminants and biotoxins present in representative species and age/sex groups of marine mammals from different parts of the Gulf. In this context, workshop participants noted the following:

- a number of researchers and institutions have collected and stored tissue samples from a variety of marine mammals found in different parts of the Gulf, and these collections could provide a source of samples for determining the types and levels of anthropogenic contaminants and natural biotoxins that were present in different species and areas in the past;

- bottlenose dolphins and other species that die in nearshore waters often wash up on beaches and may provide a readily accessible source of samples for long-term monitoring, as well as determining the present range of contaminant and biotoxin levels in different species and age/sex classes of marine mammals from different areas;

- animals caught for purposes of public display and scientific research and incidental to commercial fishing operations also may provide sources of tissue samples for baseline assessment and long-term monitoring of contaminant and biotoxin levels; and

- certain marine mammals may be good indicators of the types and levels of anthropogenic contaminants present in food chains and the ecosystems of which they are a part.

As part of the pilot survey, participants made the following recommendations:

- A literature survey be done to (a) compile available information and identify ongoing research and monitoring programs concerning the sources,

levels, fates (including dispersal), and effects of anthropogenic contaminants and natural biotoxins in the Gulf of Mexico; and (b) determine the reported ranges of various contaminants found in cetaceans from different areas; how and why levels of various contaminants differ by species, age/sex class, body tissue, geographic location, time of year, and general health and condition of the animals sampled; different methods that have been and are being used to measure levels of various contaminants; the apparent effects if any of various types and levels of contaminants on cetacean behavior, physiology, reproduction, and survival; and the best methods for measuring contaminant levels and for comparing measurements obtained by different methods;

- Individuals and institutions possibly holding useful tissue samples from cetaceans in the Gulf of Mexico be contacted to determine the types and number of samples being held and under what circumstances the samples would be made available for contaminant and biotoxin analyses;

- The coordinator and key members of the Southeast Regional Marine Mammal Stranding Network be contacted to determine the number of marine mammals, by species, age/size and sex, likely to be found stranded in a typical year on Gulf coast beaches in a condition that would yield tissue samples useful for contaminant and biotoxin analyses;

- The Southeast Regional Office of the NMFS be contacted to determine the number and types of tissue samples that could be obtained in a typical year from cetaceans collected in the Gulf for purposes of public display and scientific research and caught incidental to commercial fishing operations in the Gulf; and

- A set of tissue samples, representative of the species and age/sex classes of marine mammals that occur in different parts of the Gulf, be obtained and analyzed, using the best available methodology, to determine the present and, as possible, past range of brevetoxin levels and the types and levels of anthropogenic contaminants present in different species and age/sex classes of marine mammals from different parts of the Gulf.

The principal expense of the pilot study would be for the literature surveys, transporting tissue samples to the laboratory or laboratories to do the analyses, doing the analyses, and preparing the report describing the study results, assuming that adequate samples are available in storage or can be collected at little or no additional cost during other activities. The total cost of the pilot study would be between $41,000 and $77,000, assuming that the literature search and preparation of the final report would cost $20,000–$25,000, and 100 tissue samples would be collected, transported to laboratories (at a cost of $10–$20 per sample), and analyzed (at a cost of $200–$500 per sample).

Once the general nature of, and range of variability in, biotoxin and contaminant body burdens are known, it should be possible to determine the potential value and, if appropriate, to design a cost-effective monitoring program.

Determine and monitor umber and species of marine mammals. The number and species of marine mammals being caught and killed incidentally during commercial fishing operations in the Gulf of Mexico needs to be determined and monitored. Available information indicates that bottlenose dolphins and other marine mammals are caught and killed, at least occasionally, in the menhaden purse seine fishery, the shrimp trawl fishery, the experimental butterfish fishery, and several other commercial fisheries in the Gulf of Mexico. The level of take in most if not all of these fisheries may be small, but the effects could be causing, or contributing to, significant population declines

if the affected populations also are subject to live captures and removals, exposure to toxic pollutants, stress from offshore seismic exploration and drilling, and/or habitat degradation or destruction. Also, while the catch rate may be low, fisheries such as the shrimp trawl fishery with very large fleets, may be having significant impacts.

Available information is insufficient to assess the nature and extent of incidental take, its effect on the affected species and populations, or how it might be reduced or avoided. Recognizing the need to get better information on marine mammal-fisheries interactions, Congress amended the Marine Mammal Protection Act in 1988 to exempt U.S. fishermen from the General Permit and small-take provisions of the Act for a 5-year period (until October 1993), during which time fisheries and environmental groups are to assist the NMFS and the FWS in obtaining information necessary to better determine how fisheries affect and are affected by marine mammals. The amendments require that:

- The NMFS must classify all U.S. fisheries according to whether they take marine mammals frequently (Category 1), occasionally (Category 2), or seldom if at all (Category 3);

- Owners of vessels engaged in Category 1 and Category 2 fisheries obtain an exemption certificate and annually renew the certificate and provide reports to the NMFS indicating when, where, how, and how many marine mammals were killed, injured, or harassed during the reporting period (Owners of vessels engaged in Category 3 fisheries are required to report animals that are killed only. Renewal of exemption certificates for vessels engaged in Category 1 and Category 2 fisheries may be denied if reporting requirements are not met.)

- To the extent possible–consistent with safety considerations, funding appropriations, and the availability of qualified personnel–observers are to be placed aboard 20 to 30 percent of vessels engaged in Category 1 fisheries to verify the accuracy of interaction data being reported; and

- Alternative programs (for example, on-site observation by patrol boats, experimental fishing) are to be developed to verify the accuracy of reported information if safety or other considerations preclude placement of observers.

Most fisheries in the Gulf of Mexico were initially categorized as Category 3 fisheries. Recognizing that this precludes the mandatory placement of observers in these fisheries, and that the vessel owners are required only to report marine mammals killed during fishing operations, workshop participants recommended that all possible steps be taken to (a) get representative subsets of vessels engaged in Category 3 Gulf fisheries, particularly the shrimp trawl and menhaden purse seine fisheries, to voluntarily accept observers; and (b) advise owners and operators of Category 3, as well as Category 1 and 2, vessels of the importance of accurately recording and reporting all interactions with marine mammals.

Recognizing that the incidental take of marine mammals in one or more Gulf fisheries may not be infrequent, workshop participants also recommended that all available information on incidental take be compiled and evaluated to determine whether any of the Category 3 Gulf fisheries should be upgraded to Category 2 or, perhaps, Category 1. In this context, participants noted that there were several potential sources of information regarding the incidental take of marine mammals. They include animals found washed up on beaches with net marks or other evidence of having been

caught in fishing nets; observations made during experimental fishing operations carried out by research vessels or fishing vessels contracted by the NMFS; opportunistic observations made by observers placed aboard fishing vessels for other reasons; and reports made by vessel owners, operators, or crew.

With regard to beached and stranded animals, workshop participants noted that it is not known what proportion of animals entangled and killed in fisheries wash up on beaches, and what proportion of these are located and correctly recognized as having been caught and killed during fishing operations. They suggested that consideration be given to development of an experimental program in which animals caught and killed during experimental fishing operations or by cooperating fishing vessels would be marked and/or radio tagged and returned to the water. These animals would be followed to determine the proportions of animals that eventually are washed up and found on beaches, and recognized as having been killed incidental to fishing operations. The participants also noted that the value of retaining such animals for morphological and other studies should be considered before implementing such a program.

Workshop participants estimated that it would take 3 to 6 months, and cost $15,000 to $25,000 to compile and evaluate available information concerning the incidental take of marine mammals in Gulf fisheries, assuming that the assessment is not already being done or being planned by NMFS staff. The cost will depend to a large extent on the information sources to be accessed (for example, reports from past studies, log books maintained during fishery resource surveys, reports from the Southeast Regional Marine Mammal Stranding Network, etc.), the accessibility of the data, and the types of analyses to be done.

Participants noted that the value and cost of a mark-resighting or radio tagging-tracking program to determine the probability of finding and recognizing animals killed during fishing operations would depend to a large extent upon the number of animals

that can be marked and/or tagged and tracked. They were unable to determine where or how many animals might be available for such a program and consequently were unable to provide a time or cost estimate.

Better determine and monitor the demography and dynamics of bottlenose dolphin populations in the Gulf. As noted earlier, the bottlenose dolphin is the marine mammal most frequently seen in the coastal waters of the Gulf of Mexico and, because of its abundance and nearshore distribution is one of the marine mammal species most likely to be affected by human activities. Further, available information suggests that there may be a number of more or less discrete populations or subpopulations in major embayments along the coast and that offshore stocks may be distinct from inshore stocks.

Thus, while it is unlikely that the species as a whole has been or is being affected adversely by human activities, it is very possible that one or more local or regional populations have been and are being affected adversely.

Because of uncertainties concerning the possible effects of human activities, particularly live captures and removals for purposes of public display, the Southeast Fisheries Center (SEFC) of the NMFS initiated a research program in 1978 to: (1) obtain more reliable estimates of bottlenose dolphin abundance, particularly in areas where dolphins were being taken for purposes of public display; (2) determine the relative discreetness and boundaries of local populations or subpopulations; and (3) determine the reproductive potential or productivity of various populations, particularly those from which animals were being removed for purposes of public display.

The SEFC program, as planned, included research on census techniques; periodic census of dolphin abundance in areas where dolphins are being removed for public display and scientific research: genetic and mark-resighting studies to determine

population discreetness; regional surveys to determine seasonal distribution and abundance throughout the northern Gulf of Mexico to the 100 fathom isobath; and a series of site-specific studies aimed at determining the age-sex structure, habitat-use patterns, socio-biology, and reproductive potential of dolphin populations in different areas and habitat types.

Workshop participants noted that site-specific studies in the Indian-Banana Rivers of eastern Florida and in Sarasota Bay and adjacent areas on the west Florida coast were providing critically needed information on population structure and dynamics at relatively little cost. They also noted that different study techniques are being used in the two areas–for example, photo-identification and aerial surveys are being used in the Sarasota and Indian-Banana River areas, respectively, to determine and monitor seasonal and annual variation in distribution and abundance–and the two areas are not representative of all coastal and offshore habitats in which bottlenose dolphins are known to occur. Workshop participants recommended was that the ongoing studies be continued, that site-specific studies in Mississippi Sound be resumed and expanded, and that similar site-specific studies be initiated in at least one coastal site in Texas and at least in one offshore site. It was further recommended that sites be selected to include areas where there appears to be both substantial and little seasonal and annual variation in abundance, and that radio tagging and tracking, as well as photo-identification, be used where necessary to determine abundance, productivity, home ranges, and habitat-use patterns.

Participants noted that the ultimate goal is to develop population models that can be used to predict accurately the effects of live captures and removals and other human activities in different areas and habitat types. The participants estimated that it would take a minimum of 5 years, or possibly as many as 10 to 15 years, to obtain sufficient information to characterize and compare the structure and dynamics of dolphins in the selected study sites. They estimated that it would cost approximately $50,000 per year

per study site to carry out the long-term, site-specific studies. It was noted that it may not be necessary to invest the same level of effort in each study area each year, and that funding might be allocated disproportionately in different years to permit additional work in certain areas.

Complete bottlenose dolphin stock discreetness studies. As part of the bottlenose dolphin research program described above, several researchers have obtained blood and other tissue samples, primarily from animals taken for public display, and done karyotype, electrophoretic, and other studies to try to identify genetic-based differences in dolphins from different geographic areas (Duffield and Wells 1986). The studies have revealed differences, primarily in gene allele frequencies, which suggest, but do not provide conclusive evidence, that dolphins from certain geographic areas constitute genetically discrete populations or subpopulations. Further, the studies done to date have not had access to samples from dolphins known to be from deep-water areas and thus have not been able to assist in determining whether dolphins in inshore and offshore waters comprise the same or different populations. Also, the studies done to date have not been sufficient in size or scope to identify boundaries or the rate of gene flow between either inshore-offshore or coastal stocks.

Workshop participants noted that the regional marine mammal stranding networks provide a potentially useful source of tissues for genetic as well as other types of analyses; animals caught incidentally during commercial fishing operations may provide a good source of samples from animals that inhabit offshore as well as inshore areas; and the relative discreetness of inshore-offshore and coastal dolphin populations may be indicated by differences in the types, levels, or ratios of environmental contaminants and by differences in diet and parasite fauna, as well as by genetic-based differences.

Participants made the following recommendations:

- Fishermen be requested or required to collect and return tissue samples from, or preferably return the entire carcasses of, bottlenose dolphins and other marine mammals caught and killed incidentally during commercial fishing operations in the Gulf.

- The potential utility of contaminant analyses for bottlenose dolphin stock differentiation be factored into the design of the baseline contaminant study described earlier and the results of that study be analyzed to look for geographic differences in the types, levels, and ratios of contaminants found in bottlenose dolphins in the Gulf of Mexico.

- Available morphological, karyotype, enzyme, and DNA data be examined to determine the types of analyses and sample sizes that would be required to judge the genetic significance of observed differences. And based upon this examination, sufficient samples from different geographic areas be collected and analyzed to determine the management significance of genetic-based differences in bottlenose dolphins from different parts of the Gulf of Mexico.

- Available information concerning geographic differences in diet and internal and external parasites be examined to determine whether such information might contribute to identifying optimal management units/ areas and, if so, what if any further studies may be useful.

- One person be given overall responsibility for coordinating the various genetic and related studies.

As with the previously described pilot study to determine the types and levels of environmental contaminants present in marine mammals in the Gulf of Mexico, the primary cost of the recommended genetic studies will be for transporting and analyzing specimens (assuming that necessary specimen material can be obtained at little or no cost as an adjunct to other projects). Electrophoretic analyses of blood proteins and analysis of mitochondrial DNA are the techniques most likely to provide information useful for management purposes. Chromosome banding and DNA fingerprinting also might provide useful information. The costs for protein electrophoreses, mDNA analyses, DNA fingerprinting, and chromosome banding are $25, $50, $140 and $150, respectively. In some cases, substantial cost saving can be made by processing samples in batches.

Samples from 25 to 100 dolphins from different geographic areas should be sufficient to detect and assess the practical significance of major geographic differences in alleles, allele frequencies, mDNA, nuclear DNA, and chromosome structure. Thus, a preliminary screen aimed at detecting major genetic differences in dolphins from four coastal areas and one offshore area would require 125 to 500 samples. The screen would cost between $10,625 and $187,500 depending upon the number and types of analyses done. If only 125 samples are analyzed using only electrophoretic and mDNA techniques, the cost would be about $10,625 ($10 for shipment and $75 for analyses of each specimen). If 500 samples are analyzed using the full range of available techniques, the cost would be about $187,500 ($10 for shipment and $375 for analysis of each specimen). If required samples are not available from other sources and must be collected, the cost would be substantially greater. The time necessary to complete the study will depend largely upon the time required to obtain meaningful sample sizes.

Conducting a literature survey to determine whether diet and parasite information might be useful for identifying optimal management units or areas would take 3 to months and cost $3,000 to $6,000.

Evaluate and improve the Gulf of Mexico Marine Mammal Stranding Network. As noted above, the Gulf of Mexico Marine Mammal Stranding Network can provide an important source of information concerning the presence, relative abundance, general health of marine mammals in the Gulf of Mexico, and factors causing or contributing to the death. The value of the network might be enhanced by expanding coverage in certain geographic areas, creating "index" areas, standardizing search and response effort in certain areas, and expanding the training of certain key members to, among other things, improve determinations of cause of death.

Towards this end, workshop participants recommended the following:

- A workshop be held as soon as possible to determine and initiate steps that might usefully be taken to improve the value of the Gulf of Mexico Marine Mammal Stranding Network.

- Based upon the results of the workshop, such additional steps as possible should be taken to improve operations of the network and, in particular, to obtain the best possible information on sources and levels of human-caused mortality.

Participants estimated that the workshop could be organized and held within 3 to 6 months at a cost of $8,000 to $12,000. They also recalled the Stranding Workshop held at the University of Miami in December 1987 and noted that obtaining funds to purchase basic sampling equipment and supplies (for example, knives, syringes, plastic bags, etc.) had been identified by that workshop as one of the key things that could be done to improve operation of stranding networks.

Characterize and monitor key components of important marine mammal habitats in the Gulf of Mexico. The studies described above will provide the basis for characterizing and detecting changes in the distribution, habitat-use patterns, abundance, and productivity of marine mammals in the Gulf of Mexico. They will not, however, provide all of the information needed to determine the probable or possible causes of observed changes.

Ongoing and future changes in the demography and dynamics of marine populations in the Gulf of Mexico could be caused by a variety of things, including natural- and human-caused changes in the distribution, abundance, or productivity of important marine mammal prey species or other key components of marine mammal habitats in the Gulf. Long-term climate change and periods of unusually high or low rainfall and winds, for example, could affect the availability of many marine mammal prey species, some positively, some negatively. Likewise, overfishing could substantially reduce the availability of some species, while increasing the availability of others.

To help determine the probable cause or cause of observed changes in marine mammal demography or dynamics, workshop participants recommended the following tasks:

- Available information on the biology and ecology of marine mammals in the Gulf of Mexico be evaluated to identify natural and anthropogenic factors most likely to cause or contribute to detectable changes in the distribution, abundance, habitat-use patterns, and productivity of marine mammals in the Gulf.

- Existing programs for monitoring relevant variables (for example, fishery resource surveys, water quality surveys, etc.) be identified and evaluated to

determine whether they are obtaining the types and quality of information needed and, if not, steps that possibly could be taken to ensure collection of needed data.

- Whatever steps necessary and possible be taken to ensure collection and archiving of data in the most useful format possible.

Participants estimated that the first two tasks above would take 9 to 12 months, and cost $15,000 to $25,000 to complete.

References Cited

Duffield, D. A. and R. S. Wells. 1986. Population structure of bottlenose dolphins: genetic studies of bottlenose dolphins along the central west coast of Florida. Contract Report to National Marine Fisheries Service/Southeast Fisheries Center. Contract No. 45-WCNF-5-00366. 10 pp.

Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Callum, W. Hofman, and M. A. McGehee. 1983. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters: an overview based on aerial surveys of OCS areas with emphasis on oil and gas effects. U.S. Fish and Wildlife Service, Office of Biological Services, Denver Wildlife Research Center. 82/65. 455 pp.

Geraci, J. R. 1989. Clinical investigation of the 1987-88 mass mortality of bottlenose dolphins along the U.S. Central and south Atlantic coast. Final report to National Marine Fisheries Service, U.S. Navy Office of Naval Research, and Marine Mammal Commission. 63 pp.

DISTRIBUTION, ABUNDANCE, AND SURVEY TECHNIQUES FOR MARINE MAMMALS IN THE GULF OF MEXICO

Chair:
Dr. Douglas G. Chapman, University of Washington

Co-Chair:
Mr. Larry J. Hansen, National Marine Fisheries Service

The objectives of this session were to identify the research needs and methodologies for monitoring the distribution and abundance of marine mammals in the Gulf of Mexico and to establish priorities for research to meet these needs. It was also suggested that species, areas, and activities of critical concern should be identified.

The bottlenose dolphin, *Tursiops truncatus*, was identified as the species of primary concern, as it is the most abundant cetacean in the Gulf of Mexico and hence may be the one most likely to be impacted. However, other species should not be ignored, especially since basic life history and demographic data for other species are generally lacking, and the potential effects of development and other human activities on the these species are unknown.

Information on the distribution and abundance of marine mammals other than bottlenose dolphins in the Gulf is generally poorly known. While bays and estuaries are important habitats for some populations of bottlenose dolphins, other areas of the Gulf, such as seamounts, canyons, and the break of the slope are probably important habitats for offshore bottlenose dolphin populations and other species of marine mammals.

Surveys of different types may be useful in determining habitat use patterns and preferences. There may also be sex and age-class habitat preferences, which need to be better determined.

There was some discussion as to what kind of information is necessary to meet the legal requirements of the Marine Mammal Protection Act. If the expected take is negligible, then only population indices likely would be sufficient. However, if the take of all types is not negligible, then an accurate estimate of abundance and productivity would be necessary, since a determination of the stock relative to optimum sustained productivity (OSP) would be required. Relative indices may be sufficient in some areas, but not in others.

Another issue raised was the level of natural and human-caused change necessary for detection. Most past and present Gulf surveys can probably detect changes on the order of about 40 percent, the Wells *et al.* bottlenose studies of the Sarasota area about 10 percent. The level of change any particular method or study will be able to detect is dependent on many factors, including length of study, intensity of surveys, and knowledge of seasonal and interannual variability. When determinations of these factors have been made or are available from preliminary studies, it is a straight-forward statistical procedure to calculate the probability of detection of changes of various magnitudes.

Two general aspects of surveys were discussed. It was noted that it is desirable to take a holistic approach (food, habitat, etc.). Thus, in making recommendations this should be taken into consideration. The other aspect raised was that of getting information on age structure. Some information might be based on comparisons with live capture and incidental take, though the problem of eliminating bias from live-capture samples was noted. Also, incidental-take recoveries have been in very small

numbers. In any case, it was agreed that, at a minimum, surveys should provide information by species, on numbers of calves and relative size, as well as total numbers of all animals sighted.

Survey Techniques

Aerial and vessel line- and strip-transect surveys have been used in the Gulf. Both have advantages and disadvantages, depending on research needs. Both methods also have potential biases, both positive and negative. Which type of survey platform should be used may depend on methods used previously and the species of interest. Vessel-based surveys can also collect photoidentification information, which can provide data on individual animals over time, as well as be a basis of mark-recapture population estimates. Aerial-based surveys can collect photogrammetry data, which can be used to examine group structure. It was agreed that, for basic data on abundance, aerial surveys are most cost effective.

There was some discussion on the need to intercalibrate aerial and vessel survey data, as well as the need to carry out experiments to determine the magnitude of possible source variability and bias.

Platform-of-opportunity (POP) programs were considered to be of limited use in meeting research needs. Those POP's with dedicated observers are much more useful than those with untrained volunteers. Information from POP's could be used to supplement other surveys.

In view of the need for continuity and in the interest of obtaining the maximum amount of data quickly, priority should be for an aerial survey that would cover as much as possible of the U.S. Exclusive Economic Zone (EEZ) within the Gulf. In this

connection, the group recalled a 1982 workshop recommendation. Such a survey should be carried out over all seasons in each of at least two and preferably three years to determine interseasonal and interannual variability.

As a second or perhaps parallel priority, the group recommended that boat surveys should be carried out for special areas or for special purposes (for example, calibration experiments, to collect biopsy samples, or to do photo-identification work).

Stock Integrity and Migration

The differentiation of bottlenose dolphin stocks is currently being examined with genetic analysis of tissues from live-captured and stranded animals. The techniques used are capable of defining stocks to a relatively small scale. However, it is not possible to know from what area a stranded animal came (unless it had been previously photo-identified). Live-captured animals taken in the same area may not be of the same breeding population. Long-term behavioral studies should be used in concert with genetic studies. Contaminant ratios may also be a source for stock identification and possible migration patterns. Radio-tracking (VHF and satellite) can provide information on stock identity and migration, as well as on a variety of other questions.

Monitoring of Key Areas

The general consensus was that it would be necessary to first conduct broad-scale surveys in order to define key and/or potential index areas. One purpose of monitoring is to detect predicted effects and determine unpredicted effects. However, because baseline data are not yet adequate, it is first necessary to establish such baselines, including particularly interseasonal and interannual variability.

Summary of Recommendations in Order of Priority

- Carry out a synoptic aerial survey of the U.S. EEZ within the Gulf of Mexico. Line-survey data of all species should be collected and, as far as possible, the numbers of calves reported. Also, again as far as possible, photogrammetric work should be carried out on such surveys. The survey should be designed and carried out over two or preferably three years to determine intra- and interannual variability in distribution and abundance.

- Boat surveys should be carried out in limited areas and for specially identified purposes. As indicated, such boat surveys should be considered for calibration experiments, to collect photographs for photo-identification work, and to collect biopsy samples for stock discreteness and other studies. Also, behavioral and other biological and environmental data could be collected during such boat surveys.

- Genetic and DNA analyses should be continued on all available material, as well as new biopsy samples collected as noted in the previous recommendation.

- Radio-tracking (VHF and satellite) studies are recommended to collect information on migration, habitat use patterns, behavior, and stock identity etc.

The group noted that much of the recommended research needs to be coordinated between and possibly share-funded by a variety of agencies, Federal, state, and private.

NMFS Aerial Surveys 1983-1986

The NMFS Southeast Fisheries Science Center conducted seasonal aerial sampling surveys of the U.S. Gulf of Mexico waters between September 1983 and March 1986. Seasonal sampling of the 360,293 km^2 study area, which covered waters from the shoreline out to 9.3 km past the 183 m isobath, was completed to allow estimation of regionwide abundance and distribution of bottlenose dolphins (*Tursiops truncatus*) in the northwestern (144,025 km^2) and northeastern (216,268 km^2) regions, with the Mississippi River Delta as the divider. The regions were depth stratified into three zones: bay (waters of embayments and/or shoreward of barrier islands), inshore (waters other than bays out to the 18.3 m isobath), and offshore (waters from the inshore zone boundary to the 183 m isobath). The sampling platform was a twin-engine Beechcraft D-18S equipped with a glassed nose, which allowed an unrestricted forward, downward, and side view of the water surface for two observers. A total of 13,225 bottlenose dolphins, comprising 1,986 herds, were observed during the surveys. Bottlenose dolphin density was estimated using line-transect theory. Under the assumption of no net movement between sampling regions and periods, it was estimated that, on average, 35,000 to 45,000 bottlenose dolphins may live in the study area. The seasonal mean estimated abundance in the northwestern region was relatively constant, ranging from 9,995 to 15,260 animals. The seasonal mean estimated abundance in the northeastern region ranged form 21,577 to 36,148. The majority of these animals appear to inhabit waters of the offshore zones.

The bottlenose dolphin was by far the most frequently seen cetacean, accounting for 97.61 percent of the sightings and 93.92 percent of the animals seen. Nine other species of cetaceans accounted for the rest of the sightings. Dolphins of three species of the genus *Stenella* (spotted, *S. frontalis*; spinner, *S. longirostris*; and striped, *S. coeruleoalba*) were the next most frequently seen animals and made up 40 (1.80%) of the sightings (623 animals). There were three sightings (101 animals) of common dolphins

(*Delphinus delphis*) and three sightings (7 animals) of pygmy killer whales (*Feresa attenuata*). There was one sighting each of Risso's dolphins, *Grampus griseus* (35 animals), beaked whales, *Mesoplodon* spp. (2 animals), false killer whales, *Pseudorca crassidens* (4 animals), and one sighting of one fin whale (*Balaenoptera physalus*).

The Southeast Center has conducted and is involved with ongoing studies of a site-specific nature. These areas are shown in Figure 2.

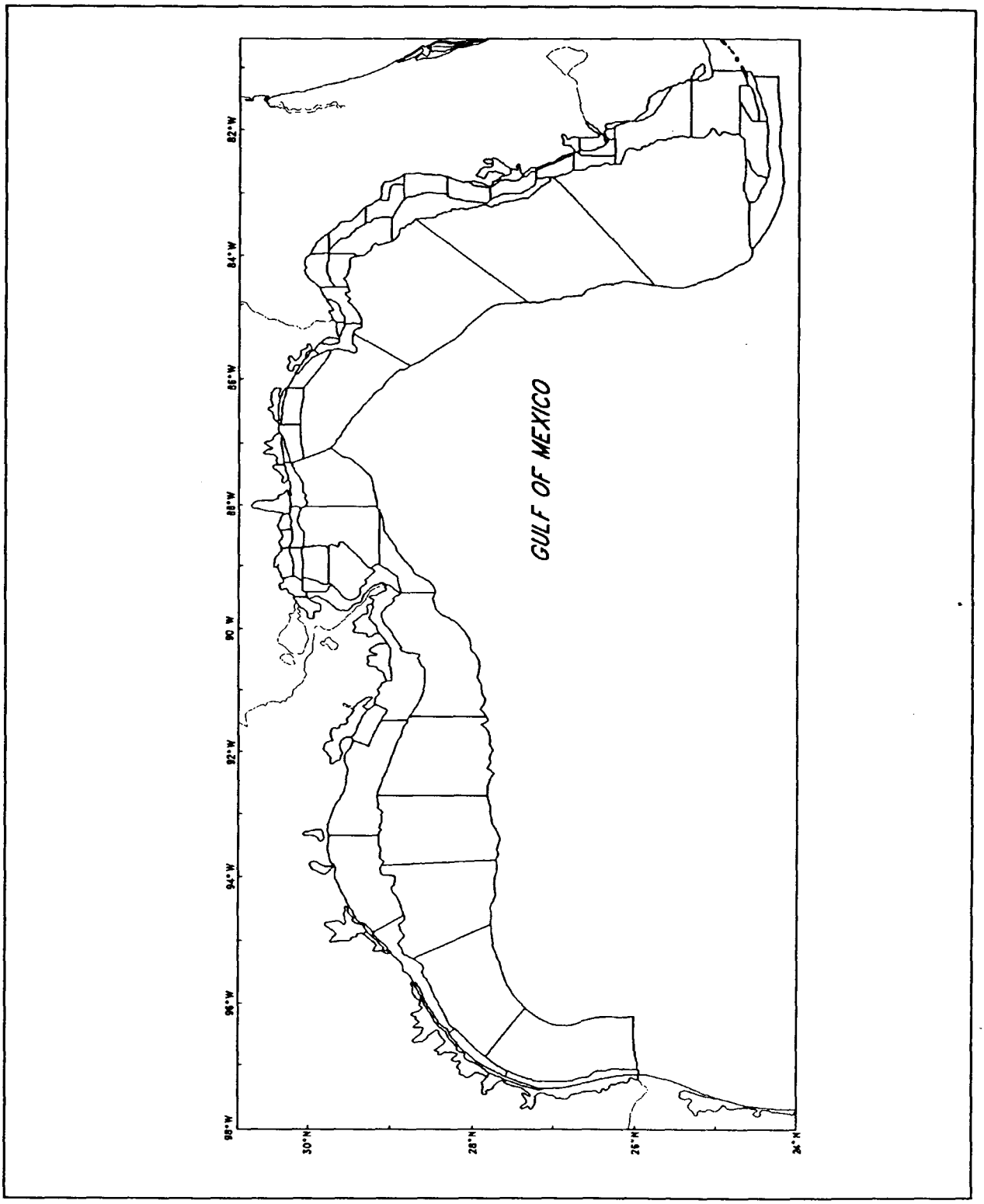

Figure 2. Bottlenose dolphin survey areas flown by the National Marine Fisheries Service in the U.S. Gulf of Mexico.

References Cited

Wells, R. S. 1986. Population structure of the bottlenose dolphins: behavioral studies along the central west coast of Florida. Contract Report to National Marine Fisheries Service/Southeast Fisheries Center. Contract No. 45-WCNF-5-00366. 70 pp.

POPULATION DYNAMICS AND LIFE HISTORY OF MARINE MAMMALS

Chairs:
Dr. John E. Reynolds III, Eckerd College
Dr. Robert L. Brownell Jr., International Whaling Commission
Dr. Daniel K. Odell, Sea World of Florida

Co-Chairs:
Dr. Charles Karnella, National Marine Fisheries Service
Dr. William H. Lang, Minerals Management Service
Mr. Larry J. Hansen, National Marine Fisheries Service

In April 1982, a "Workshop on Cetaceans and Sea Turtles in the Gulf of Mexico: Study Planning for Effects of Outer Continental Shelf Development" was held in Long Beach, Mississippi (Keller and Adams 1983). The objective of the 1982 workshop was to assess our knowledge of cetaceans and sea turtles in the Gulf of Mexico with respect to potential effects from offshore oil and gas development. Marine mammals were discussed in two sections entitled "Distribution and Abundance Studies of Cetaceans in the Gulf of Mexico" and "Behavioral and Ecological Studies of Cetaceans in the Gulf of Mexico." Each workshop section reviewed existing data and made specific recommendations for the collection of data necessary to meet the objectives of the workshop.

The West Indian manatee (*Trichechus manatus*) was specifically excluded from discussion in both 1982 and the present workshop in 1989 because an endangered species recovery plan had been prepared and data needs addressed therein. However, we point out that the manatee cannot be considered in isolation from factors that might affect cetaceans in the Gulf of Mexico. For example, bottlenose dolphins and manatees

have a general habitat overlap in bays and estuaries. Factors that may affect bottlenose dolphins may also affect manatees (e.g., habitat destruction, incidental take, pollution).

We also point out that marine mammals and sea turtles in the U.S. waters of the Gulf of Mexico should not be considered in isolation from the southern half of the Gulf. Collaborative studies (particularly with Mexico) should be pursued.

Similarly, marine mammal and sea turtle studies should not be carried out in isolation. For example, studies of the physical environment should be planned jointly. Aerial surveys for one group can (and do) gather data on other groups of animals. This secondary function should be used to the best advantage.

Status of Knowledge and Data Uncertainties

Biological Data

Bottlenose dolphin. The bottlenose dolphin (*Tursiops truncatus*) is the best known and most abundant cetacean in the Gulf of Mexico. Scott *et al.* reviewed the status and population estimates for this species in the Gulf (1989). Nevertheless, problems exist with population estimates. Specifically, uncertainties exist with assessing interannual and intra-annual variations at particular locations; studies have not included *Tursiops* outside the 100-fathom isobath; varibility is difficult to assess between surveys; and the overall distribution of the species is unclear.

Stock differentiation. Additional data are needed to better understand stock identification, specifically between inshore and offshore groups of dolphins and between coastal resident groups. Additional research using photo-identification, pollutant levels or ratios, parasitology, genetics, and other methods will provide a better understanding of dolphin populations.

Factors affecting population size. A major identified goal was the need to collect specific vital rate data that could be used in developing life tables. However, this requires following individuals within populations over long time periods. Total annual removals, including both live-capture and any other human-related take (for example, incidental take, shooting, pollution, etc.), must be known or estimated to assess the impact on the stock in question. Emigration and immigration have been documented in only one study, and additional studies are needed.

Habitat requirements for "healthy" dolphin populations. Several areas of concern were noted (for example, food, ecosystems, water quality, etc). Although some data are available on dolphin food habits from the examination of the stomach contents from stranded dolphins, little additional data are available for other habitat requirements or needs. Pollution of the habitat not only affects dolphins directly but also affects them indirectly by influencing the distribution and abundance of prey.

Other species. Among the endangered large whales (those listed used under the Endangered Species Act of 1973 and subsequent additions), the sperm whale was viewed as most critical species because existing studies suggest that it is the most common endangered cetacean in the Gulf and may have a resident population in the Gulf of Mexico. In terms of biomass, even a small resident population of sperm whales would be an important element of the Gulf ecosystem. Both species of small sperm whales, *Kogia breviceps* and *K. simus*, are found worldwide in tropical and temperate water, although the Gulf seems to be one of the few locations where they are reasonably abundant. Other important cetaceans in the area (based on strandings and sightings of live animals) include the following: *Globicephala macrorhynchus Stenella spp., Grampus griseus,* and the ziphiids. Data on abundance and distribution are lacking for most species (see Table 1 in Section II: Plenary Session Presentations).

Physical Oceanography

Due to currents, gyres, and tidal effects, toxicants (including oil), litter, and discarded (lost) nets, can exert impacts on marine mammals at locations other than sites of origin of the toxicants. It is important to understand the nature of those impacts wherever they occur, but it is also important to understand avenues of dispersal and transport. The intent herein is solely to recognize these factors as a part of the overall picture.

Human-related Threats

Discussion next focused on what human-related threats that could impact species found in the Gulf. Are there critical activities, species, or locations? The topics were

Table 4. Possible Effects of Offshore Oil and Gas Development on Marine Mammals (Compiled by Robert J. Hofman)

I. Disturbance/noise from ship and aircraft operations, seismic profiling, platform construction, drilling, etc., may

a. interfere with or disrupt vocal communications, feeding, breeding or other vital functions;

b. cause animals to avoid or abandon important feeding areas, breeding areas, resting areas, or migratory routes;

c. cause animals to use marginal habitat or to concentrate in undisturbed areas, which in turn may result in crowding, overexploited food resources, increased mortality, and decreased reproduction;

d. stress animals and make them more vulnerable to parasites, disease, and/or predation;

e. attract animals, making them more vulnerable to oil spills, hunting, harassment; and

f. alter the distribution, density, movements, or behavior of important prey species.

II. Dumping, dredging, drilling, and platform, pipeline, support facility, and storage facility construction may

a. damage or destroy haul-out sites, feeding areas, or other areas of similar importance; and

b. adversely affect the distribution, abundance, behavior, or productivity of important prey species.

Table 4. Possible Effects of Offshore Oil and Gas Development on Marine Mammals (Compiled by Robert J. Hofman) ***continued***

III. Oil from well blowouts, pipeline breaks, tanker accidents, and chronic discharges associated with routine operations may

a. kill or debilitate marine mammals by matting and reducing the insulating quality of fur; acute or chronic poisoning due to inhalation or ingestion of toxic hydrocarbon components or ingestion of contaminated food; irritation of skin, eyes, or mucous membrane; or fouling of baleen;

b. kill, debilitate, or otherwise reduce the abundance or productivity of important prey species and/or species lower in the marine food web, resulting in acute or chronic nutritional deficiencies, including starvation;

c. stress animals, making them more vulnerable to disease, parasitism, and/or predation;

d. interfere with the formation of mother-pup bonds and cause mothers (particularly colonial breeding pinnipeds) to abandon pups;

e. cause animals to abandon or avoid contaminated breeding areas, feeding areas, etc., and/or to concentrate in unaffected areas; and

f. attract animals to debilitated prey, making them more vulnerable to contact with oil and the ingestion of contaminated prey.

IV. Contaminants in drilling muds, waste discharge, etc. may

a. kill or debilitate animals that are exposed to the contaminants; and

b. contaminate, accumulate in, and kill or debilitate important prey species or species lower in the marine food web.

V. Increased ship traffic may increase the probability of collisions between ships and marine mammals.

activities can impact marine mammals directly as well as indirectly via influences on prey species. Further, such activities may have lethal (chronic and acute) and sublethal impacts on marine mammals.

Fishing activities. Fishing activities can impact marine mammals in several ways, including competition for marine mammal prey species and incidental take in fishing gear. Another impact associated with certain fisheries may be the deliberate take of marine mammals by shooting; such take has been alleged for some time, and recently two shark fishermen were prosecuted for shooting dolphins for bait.

Effects of competition are difficult to quantify. The importance of habitat assessment (including prey species abundance and distribution) is addressed.

Incidental take is also difficult to quantify, but levels of incidental take must be assessed to understand population dynamics for marine mammals generally, and for *Tursiops truncatus* specifically. Two fisheries that may take *Tursiops* and other cetaceans in the Gulf are the shrimp and menhaden fisheries, both of which were classified as Category III Fisheries when the Marine Mammal Protection Act was amended in 1988. Such classification permits these fisheries to operate without observers to monitor and verify by-catch. Workshop participants felt, nonetheless, that quantitative assessments of incidental take will ultimately occur only through an observer program.

Until such a program to assess marine mammal-fisheries interactions is initiated, efforts can still address incidental take. Three data sources were identified: (1) stranding data, (2) data from NMFS experimental fisheries, and (3) anecdotal or questionnaire/survey information. Through standardization of effort, training programs, use of highly patrolled index areas, and experiments to detect the probability that an incidentally taken animal will appear on a beach, a database that will allow an indirect

assessment of fisheries interactions can be compiled. The Southeastern United States Stranding Network (SEUS) could be particularly useful in defining locations or fisheries of special concern.

Participants noted that efforts to address incidental take must begin immediately and not await potential reclassification of fisheries.

Toxicants besides oil and gas. Human-produced toxicants have been studied to some extent in the Gulf; data exist for toxicant levels in water samples and bivalves in some locations. But data are insufficient to judge the following:

- the status of pollutant levels in the overall Gulf ecosytem;
- the levels of toxicants in marine mammal tissues;
- the effects (lethal and sublethal) of toxicants on marine mammals; and
- the extent to which marine mammals could function as indicators of environmental health through analysis of marine mammal toxicant bioaccumulation over time.

Live capture. Live *Tursiops* have been caught in the Gulf for many years, but good records are only available for permanent removals of *Tursiops* from the Gulf between 1973 and 1988. During this period, 465 dolphins were removed from five major subareas within the Gulf. Almost half (202) of these dolphins were caught in the Mississippi Sound area.

Other activities. Several additional activities that could or do kill, remove, or take dolphins were listed and deemed worth monitoring. These include "feed-the-dolphin"

enterprises, entanglement of marine mammals in lost or discarded nets, and habitat loss or modification. The latter category includes such activities as offshore dumping, dredge and fill activities, and competition for marine mammal prey.

Natural Threats

Toxicants in the Gulf are both natural and human in origin. The primary natural toxin that could impact marine mammals is brevetoxin, produced by the dinoflagellate *Ptychodiscus brevis*. Brevetoxin has been implicated in the catastrophic *Tursiops* die-off along the mid- and south Atlantic states in 1987-1988 (Geraci 1989).

Interestingly, *P. brevis* blooms are common in the Gulf, but there has been no apparent cetacean mortality there. However, two episodes of mass mortality of manatee (*Trichechus manatus*) in southwestern Florida have been attributed to *brevetoxin* (O'Shea and Rathbun 1983).

Research Recommendations

The working group offers the following recommendations:

Population Biology

Population size. A mixture of survey methods must be used to study dolphins and other cetaceans in the Gulf. The exact methods will vary according to species and locations. It is vital that calibrations be made to permit comparisons of survey results obtained through different survey platforms or by using different techniques. Following accumulation of baseline data through initial, broad-based surveys, subsequent surveys

should (1) last several years to permit long-term monitoring, (2) occur several times each year to assess seasonal parameters, (3) and be constructed in consultation with people expert in survey design and/or biometrics.

Stock differentiation. A variety of techniques should collectively be used to address discreteness of *Tursiops* stocks. These techniques include the (1) examination of contaminant levels/ratios, (2) DNA and protein analyses, (3) photo-identification of individual animals, (4) tagging and telemetry (to assess movement patterns), (5) parasite identifications, (6) stomach content analyses, and (7) morphometric analyses.

Most samples would come from stranded or live-captured animals. Another, as yet untapped, source of samples would be from animals taken incidentally by foreign or domestic fisheries. The latter sample source is especially important as a provider of specimens of "offshore" *Tursiops* that are in good health and for which the exact location of collection is known.

Factors affecting population size. Vital rate data (for example, age-specific mortality and reproduction) must be accumulated for certain index areas. Photo-identification, tagging, and telemetry are important tools or techniques. Data must be collected over as long a time period (in years) as possible.

Human-related mortality must be quantified and, if possible, reduced specifically. First, incidental take must be investigated immediately, using existing data bases. Observers are necessary to quantify incidental take levels, but strengthening the stranding network data is needed to pinpoint locations and fisheries of concern. Observers might be placed to record all by-catch, not just marine mammals.

Second, OCS-development impacts should be addressed specifically. Noise distribution and attenuation around rigs should be assessed, observers should be placed on rigs to record marine mammal and marine mammal prey abundance and behavior, and effects of OCS activities on critical life stages of prey should be investigated.

Third, if appropriate data are not already being collected on toxicant levels in the water column, their sediments, bivalves, and marine mammal tissues must be assessed. Toxicants, as used here, include human-produced chemicals as well as brevitoxin.

Finally, monitoring must occur of marine mammal entanglement in discarded or lost nets, the deliberate shooting of animals, "feed-the-dolphin" programs, and critical habitat destruction or modification.

Ecosystem-level Analyses

Ecosystem analysis. We recommend that during the gathering and interpretation of data on the distribution, abundance, population dynamics, life history, and behavior of marine mammals, serious attempts be made to describe important aspects of their habitats. Habitat descriptions, which lead to a knowledge of the ecology of a species or group of species in an area, will allow interpretation of movement patterns, site concentrations, and overall importance of certain areas to certain marine mammals, not just in the temporal (diel and seasonal) sense, but as related to other, not always seasonally linked, factors. For example, with enough information on habitat preference, a change in *Kogia* distribution in different years might be shown to be related to water temperature and subsequent prey availability effects, rather than to, say, oil exploration and drilling activities.

An ecosystems analysis includes a description of physical, chemical, and biological habitat attributes, along with cetacean distribution information. Depth, distance from shore, bottom type, temperature, salinity, currents, and indicators of primary productivity should all be described in relationship to occurrence patterns. Some of these data are available through the NMFS sea-maps source; others, temperature, currents, areas of upwelling, and primary productivity, may be available through NOAA satellite telemetry. Still more data may have to be measured concurrent with survey and behavioral observation efforts from surface vessels and by remote sensing such as colorimetry for temperature and primary productivity information from airplanes. In addition to describing oceanographic features, studies should also address cetacean prey availability patterns, water quality (for example, pollutant levels), and pollutant bioaccumulation in cetaceans.

Cetacean prey availability data consist of two interlinked steps: (1) we should ascertain what prey are important, and (2) we should describe the distribution and abundance of these prey relative to the occurrence patterns of the cetacean predator. Neither task is an easy one. Prey are known in part for coastal *Tursiops* from stomach samples of stranded animals. We suggest that prey information be gathered on all stranded and net-caught animals and that the feasibility of stomach lavage be investigated for *Tursiops* and other cetaceans caught and held temporarily.

Descriptions of prey distribution can be made by using databases of the NMFS sea atlas and of universities and other organizations that are gaining food information for their own purposes. Where such external data sources are inadequate, prey should be monitored concurrent with survey and behavioral studies specifically designed cetaceans.

Evaluation of the distribution of pollutants in the environment (i.e., water animals, and sediments) relative to tissue loads in cetaceans (both as a function of geographic area) may be of predictive value in determining geographically where

cetaceans are most likely to be affected. If different stocks have different tissue loads, the stock of origin may be determined for beached animals. Conversely, and probably more on the practical side, the levels of pollutants in beached cetaceans may be used to postulate the existence of stocks of a given species within the Gulf.

With this integrated approach, occurrence and movement patterns can be assessed relative to environmental parameters (including water quality) and measured against such potentially disturbing effects as human disturbance from oil and gas activities, fishing activities, and the presence of other human impacts on the environment.

Prioritization of Recommendations

Participants felt that all recommended actions were vital to understanding marine mammal population dynamics and life history as well as vital to the protection and conservation of stocks.

Activities judged to be particularly important for immediate action were

- the assessment of incidental take;
- the evaluation of toxicant levels; and
- the implementation of additional photo-identification and telemetry studies to address stock discreteness and vital rates of stock ID's;
- with regard to *Tursiops* populations, participants further noted that (1) some relevant data already exist but must be compiled and applied to marine mammals; (2) some activities require initial studies to create

baseline data, before beginning intensive, area-specific, studies; (3) a wholistic, long-term approach (and a similar type of funding commitment) is necessary–piecemeal approaches have very negative value; and (4) cooperative interagency efforts are likely to be far more productive than individual ones.

Review of 1982 Recommendations

The 1982 workshop/working group on Distribution and Abundance of Cetaceans recommended the following:

- systematic surveys to document overall distribution of marine mammals in the Gulf on a seasonal and annual basis, with particular reference to physico-chemical factors, submarine geology, etc.; expansion of existing surveys into offshore areas; and continuation and expansion of NMFS *Tursiops* surveys;

- qualitative sampling, including support of the stranding network, use of platforms-of-opportunity, and use of acoustic equipment to detect the presence of cetaceans in certain areas;

- tagging and tracking to study short- and long-term movements of individuals; and

- the use of remote sensing to monitor various environmental parameters.

The 1982 workshop working group on behavioral and ecological studies of cetaceans recommended the following:

- aerial observation of cetacean behavior;
- boat-based behavioral observations;
- tagging and tracking studies;
- laboratory or field experiments dealing with factors specific to OCS development;
- continuation and elaboration of stranding network activities;
- feeding biology studies, particularly of *Tursiops*; and
- development of a standard sighting form.

With the exception of extensive NMFS aerial surveys for *Tursiops, Tursiops* stomach contents analysis, limited *Tursiops*--marking studies in the Mississippi Sound, and continued studies on *Tursiops* in the Sarasota (Florida) area, these recommendations have not been met.

The 1989 Workshop has made many similar (identical) recommendations and expanded them because the scope of the 1989 meeting was not limited to OCS activities.

References Cited

Geraci, J. R. 1989. Clinical investigation of the 1987-88 mass mortality of the bottlenose dolphins along the U.S. central to south Atlantic Coast. Wildlife Disease Section, Department of Pathology, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada. 63 pp.

Keller, C. E. and J. K. Adams (eds.) 1983. Proceedings of a workshop on cetaceans and sea turtles in the Gulf of Mexico: study planning for effects of Outer Continental Shelf development. Prepared by the U.S. Fish and Wildlife Service for Minerals Management Service, Metairie, Louisiana. FWS/OBS-83/03. 42 pp.

Odell, D. K. A review of the southeastern United States Marine Mammal Stranding Network: 1978-1987. Reynolds III, J. E., and D. K. Odell (eds.). Proceedings of the Marine Mammal stranding workshop. Miami, Florida. December 1987. National Marine Fisheries Service Technical Report. In press.

O'Shea, T. J. and G.B. Rathbun. 1983. Summary report on a dieoff of the West Indian manatee (*Trichechus manatus*) in Lee County, Florida, spring 1982. Unpublished Report. Sirenia Project. U.S. Fish and Wildlife Service, Gainesville, Florida.

Schmidly, D. J. 1981. Marine Mammals of the southeastern United States coast and the Gulf of Mexico. U.S. Fish and Wildlife Service FWS/OBS-80/41. U.S. Department of the Interior, Washington, D.C. 165 pp.

Scott, G.P., D. M. Burn, L. J. Hansen, and R. E. Owen. 1989. Estimates of bottlenose dolphin abundance in the Gulf of Mexico from regional aerial surveys. National Oceanic & Atmospheric Administration/National Marine Fisheries Service, Southeast Fisheries Council, Miami Laboratory, Coastal Resources Division. Contribution No. CRD-99/89-07. 70 pp.

Klima, E. F., G. R. Gitschlag, and M. L. Renaud. 1988. Impacts of the explosive removal of offshore petroleum platforms on sea turtles and dolphins. Marine Fisheries Review. 50(3):33-42.

ECOLOGY, BEHAVIOR AND PHYSIOLOGY OF MARINE MAMMALS IN THE GULF OF MEXICO

Chairs:
Dr. Randall S. Wells, University of California, Santa Cruz
Mr. Hans Neuhauser, Georgia Conservancy
Dr. Bernd Wursig, Texas A&M University at Galveston

Co-chairs:
Ms. Carol P. Fairfield, Minerals Managment Service
Mr. Kenneth Graham, Minerals Management Service
Dr. Ren Lohoefener, National Marine Fisheries Service

The ranking of research priorities on the ecology, behavior, and physiology of marine mammals was determined by consensus of the participants. The process used to arrive at this consensus started with the identification of species of concern and human activities that may impact those species. These were presented in matrix form and participants were asked to rank the activity categories of concern.

For the top priority categories, specific habitats of concern and data and research needs were identified. The data and research needs were then ranked by consensus. Each participant was given a final opportunity to make additional recommendations (for pertinent extracts, see Attachment A immediately following this section.

Species of Concern

Both individual species and groups of species were identified. These were, with relative rankings in parentheses, *Tursiops truncatus* (62), *Physeter macrocephalus catodon* (1), *Stenella* spp. (2), odontocetes minus *Tursiops* (43), all odontocetes (no rank), and all cetaceans (42).

Human Activities

The categories of human activities that may impact some or all Gulf of Mexico cetaceans were, in descending order of concern, (1) coastal development; (2) offshore industrial activities including oil and natural gas exploration, development and closure; (3) pollution including oil, toxics, point and nonpoint discharge sources, plastics, and noise; (4-tie) direct interactions with fisheries including incidental take; (4-tie) indirect impacts associated with fisheries including competition for prey, (5-tie) vessel traffic; (5-tie) military activities; (6) live-capture; (7) hunting or directed take; and (8) dolphin feeding, watching and swimming-with-dolphin programs.

The Matrix Results

The combination of species and activities resulted in the identification of topics for further discussion, with the greatest attention being paid to those topics of greatest concern. The top five were, with relative numerical ranking in brackets, (1) coastal development and *Tursiops* {38}, (2) offshore industrial development and all cetaceans {33}, (3) pollution and all cetaceans {21}, (4-tie) direct fisheries interactions with all odontocetes {20}, and (4-tie) indirect fisheries interactions with all odontocetes {20}.

From these discussions were derived, first, the specific habitats of concern, and then the data and research needs. When all of this information had been assembled, the participants ranked the data and research needs. Because there was some overlap and redundancy involved, both within the categories discussed during this session on ecology, behavior, and physiology and with other workshop sessions, discussion group chairs Wells and Wursig combined some of the results and separated out some topics more appropriately dealt with elsewhere; their synthesis makes up the body of this report.

Research Priorities

Our research recommendations are presented below as (1) the five most highly recommended efforts ranked in order of decreasing priority, (2) a listing of the lower-ranked research recommendations, and (3) an attachment containing individual, unranked recommendations of the session participants (See Attachment A immediately following this section). We recommend that the high priority research be integrated as much as possible with turtle research with similar logistical needs. We further recommend that a long-term commitment be made to research, and that an ecosystem approach be used wherever applicable.

Distribution and abundance. The primary research objective was to ascertain distribution and abundance of cetaceans in the Gulf, including both *Tursiops* nearshore and offshore and other marine mammals offshore. It was stated that the most likely marine mammals to be encountered offshore are of the genera *Tursiops, Physeter, Kogia, Stenella, Globicephala*, and *Ziphius*. It is also possible that several of the baleen whales may be seen in offshore waters often enough for us to gain some idea of occurrence patterns.

Habitats. While distribution and abundance patterns are covered in a different session, we feel that it is imperative that information on where and how many cetaceans there are will be integrated with knowledge of how they use their habitat. This research priority has two integrated parts: (1) a determination of habitat type and (2) a consideration of the behavior of animals found in those habitats.

We therefore recommend that, while surveys for cetacean distribution and abundance are carried out, an assessment of environmental parameters be made as well. This assessment consists of knowledge of physiographic, oceanographic, and biological features that may impact cetacean occurrence patterns. In other words, we recommend

the monitoring of water depth, temperature, salinity, and currents; and an assessment of primary productivity, prey availability patterns, and patterns of recruitment of larval fishes and squid.

Some of the needed data can be obtained from existing databases and surveys; others may need to be obtained with surveys of distribution and abundance patterns. The NMFS environmental monitoring program, which is carried out Gulf-wide three times per year nearshore, and twice per year offshore, should be used. As well, there are other university and agency monitoring programs whose utility should be assessed. We also recommend that where appropriate physical and biological data are not being assessed concurrently with survey information, these data be gathered so that correlations between the presence of animals and environmental variables may be obtained. If aerial surveys are being made to assess distribution of cetaceans, colorimetry data obtained concurrently with surveys can supply water temperature as well as some measure of primary productivity. If boat-based surveys are used, temperature, salinity, primary productivity, and some prey data can be gathered. As a second need, concurrent with the gathering of environmental data, we need to assess the use of habitats by the cetaceans in question. This involves a description and monitoring of behavior concurrent with survey efforts. We therefore recommend that when animals are seen on all surveys, whether boat- or airplane-based, the survey be temporarily halted long enough to ascertain whether the cetaceans are primarily resting, socializing, travelling, or feeding. These determinations should be made by observers experienced in methods of ascertaining behavioral patterns, and the results of behavioral observations should be quantified and correlated with environmental (or ecological) parameters. In other words, we need to assess, in an ecosystems approach, not only where cetaceans occur, but also what are the ecological qualities of the environment that may affect this distribution and–by assessment of behavior patterns–how these habitats are used.

The integrated approach of obtaining information on distribution and abundance along with information on habitat use allows an assessment of several of the major topics of concern. By knowledge of the importance of coastal habitat, *Tursiops* abundance and distribution characteristics can be assessed relative to coastal development. Offshore development impacts can be described relative to habitat types and the importance of habitats for the cetaceans in question, and fisheries-cetacean interactions can also be assessed relative to habitat.

An integrated approach to describing where and when cetaceans occur, along with what environmental parameters may lead to this distribution, allows a more informed evaluation of the potential effects of human disturbance. For example, if the distribution of a certain species changes from year to year, this may be due to some measured change in human activity, but it may also be due to a measured inter year difference in current or temperature pattern or in overall distribution of prey.

Furthermore, an ecosystems approach to assessing the occurrence and behavior patterns of cetaceans may have predictive value. If a certain species, such as offshore *Tursiops*, shifts north or south by some distance between years, we may be able to describe the major reasons for this shift relative to environmental change, natural, as well as human-induced, if enough information exists on the habitat preferences and needs of the species.

Data on incidental take. Our understanding of the kind and level of cetacean take in Gulf of Mexico fisheries suffers from a lack of data. It was recommended that incidental take be better defined through identification of the fisheries and species involved and through improved quantification of the numbers taken. Stranded and beach-cast cetaceans provide some information, but decomposition in the warm waters of the Gulf often precludes recognition of indications of incidental take. The

implementation of observer programs on vessels involved in suspected fisheries as a means of assessing the ecological significance of the take was considered to be a relatively high research need.

Correlates of pollutants–in the environment and cetaceans. The true effects of chemical pollutants are extremely difficult to identify or quantify, but the collection of information on these effects was considered to be a priority. It was suggested that several stages of research would be required to begin to assess the effects of pollutants and to evaluate the utility of cetaceans as biological indicators of pollution.

The first step should be a measure of ambient and input levels of pollutants such as heavy metals, polychlorinated biphenyls, and other toxins in the habitat of the subject cetacean species. Background data may be available from some sites and should be incorporated as possible. These environmental levels can then be compared with the body burdens of pollutants in the cetaceans. In time, it may be possible to link pollutant levels, body burdens, and physiological aberrations into cause-effect relationships.

Such an approach might be facilitated by sampling members of resident dolphin populations in regions where environmental pollutant levels have been monitored over years. A refinement of this approach would be a comparative analysis of body burdens of known-age dolphins to determine rates of accumulation, along with a monitoring of health parameters.

Potential disturbance. The behavioral responses of cetaceans to potential disturbances from human activities were considered to be the fifth-ranked research need. Potential disturbance sources include, but are not limited to, vessel traffic, including commercial and recreational; seismic activity; platform construction; drilling operations; channel dredging; air traffic; and removal of structures. No systematic research on the potential impacts of these noise-producing activities on the cetaceans of the Gulf of

Mexico has been completed to date. Previous Minerals Management Service-sponsored research in other areas has found significant responses by certain cetacean species to some of these activities, strongly suggesting that study of the cetaceans inhabiting Gulf of Mexico waters where extensive human activities occur is warranted.

Research by MMS on the behavioral responses of bowhead and gray whales can serve as a model for experiments to be conducted with Gulf of Mexico cetaceans. In these studies, the effects of real human activities or playbacks of recorded sounds have been measured on the basis of short-term changes in behavioral variables as well as longer term abandonment of previously used areas. For whales, for example, short-term behavioral variables include surfacing, respiration, and dive variables, and variations in swimming speed, orientation, and social interactions, to name a few.

Disturbance responses can take a variety of forms. Long-term or cumulative effects should be assessed in addition to the potentially more obvious short-term behavioral effects described above. Habitat abandonment may be one important response, but the confounding influences of other environmental factors must be carefully controlled. Telemetry can provide information on shifts in movement patterns as well as subtle physiological responses, such as changes in heart rate. Long-term observations of recognizable individuals may provide data on reproductive success, but cause-effect relationships would be difficult to define.

Other Research Needs

In addition to the priority research needs described above, a number of additional needs are identified. Some of these were incorporated by the session chairs into the recommendations on priority research. Others more appropriately belonged in the recommendations of other workshop sessions. Rankings should be regarded as relative,

and in comparison only to other recommendations of this session. They do not necesarily reflect overall importance, or lack thereof, to Gulf of Mexico cetacean research needs. These are (with relative rankings in parentheses) the following:

- correlation of vessel traffic with the distribution, movements, and behavior of cetaceans (7)
- correlation of the distribution of cetaceans with oceanographic features (5)
- conducting of surveys in deep-water areas for *Tursiops*, paying special attention to oceanographic features, numbers of animals, social interactions, and other behavior (4)
- determination of appropriate numbers for quotas and allowable take (4)
- study of competition between odontocetes and fisheries for prey (including by-catch) (3)
- monitoring cetacean behavior in relation to offshore industrial development (3)
- increasing the frequency with which data on cetaceans, oceanographic factors and biological factors, are collected (3)
- identification of the metabolic needs of odontocetes as they affect behavior and as they relate to fisheries (3)
- identification of odontocete prey species and description of their distribution and abundance (3)

- identification of cetacean food preferences using both direct and indirect data (2)

- correlation of cetacean distribution with existing and new biological data (new data needed especially on squid and myctophids) (2)

- identification of criteria for site selection for sampling and for intense research, taking into consideration such factors as present distribution and abundance, relatively "pristine" sites, and the variability of the Gulf of Mexico (2)

- description of the extent and nature of effects (including mortality) on cetaceans associated with (1) live capture, including temporary and long-term, (2) military activities, (3) hunting, and (4) dolphin feeding, watching, and swimming-with-dolphin programs (1)

- replication of the Fritts *et al.* surveys of 1980-1981 (1)

- correlation of coastal development activity with data on *Tursiops*, and from those correlations, conducting trend analyses and constructing models, using both existing and new data (0)

- identification important deep-water habitats for *Tursiops* (0)

- identification of stress indicators for cetaceans and description of the methodologies appropriate for measuring changes in stress (0)

- identification of the causes of vessel interactions with cetaceans and description of the results of those interactions (0)

- use of pollutant load variations to discriminate between stocks of cetaceans (0)

- description of the impacts of cetaceans on fisheries (0)

- correlation of data on cetacean distribution, abundance, movements, etc., with fisheries data and identification of trends (0)

Attachment A. Extracts from participant submittals– Working group session on the ecology, behavior, and physiology of marine mammals in the Gulf of Mexico

We should proceed very slowly in new development. We should complete distribution and abundance studies before new development is allowed.

New platform areas (small ones) should be monitored very closely for changes in cetacean diversity and abundance. Only in the face of positive results (for the cetaceans) should more development continue. (Another solution may be to rotate oil fields allowing for clear area where cetaceans may seek refuge).

Keith Mullin

* * *

[We need] assessment of the indirect effects of . . . "artificial reef" development.

Unidentified author

* * *

The effects of commercial fisheries on marine mammals must also be more fully understood. It is quite possibly the largest manmade impact on marine mammals.

Jeff Brown

* * *

I recommend [that] distribution and abundance of cetaceans (especially seasonally) are key to all other aspects of offshore research needs. Until this basic information is available, [we] will have nothing on which to build.

Attachment A. Extracts from participant submittals– Working group session on the ecology, behavior, and physiology of marine mammals in the Gulf of Mexico *continued*

Knowledge of distributional "hotspots" is needed to assess impacts of oil and gas development (need to know where the animals are, and when, before any meaningful impact assessment is practicable).

Let us not forget, however, that the animals of most species don't stay in one place all that long. They go where there's food. This fact should not be overlooked.

Unidentified author

* * *

I would recommend that more attention be given to quantifying the levels of take of marine mammals in association with military weapons testing in the Gulf of Mexico. Because of the large amounts of explosives involved in these activities, they have a much greater chance of causing incidents and behavioral alterations than offshore industrial activities.

Another impact that was not discussed in this session was the sensitivity of marine mammals to spilled oil. Data about the distribution and abundance of marine mammals in combination with knowledge of impacts of spilled oil could impact requirements for oil-spill response (which are directed primarily at protecting land-based resources).

Unidentified author

* * *

I recommend that live-capture people (those financially benefiting from removing animals) be required to collect data from the captured and released animals and be required to fund, for example, stock differentiation studies.

Unidentified author

Attachment A. **Extracts from participant submittals– Working group session on the ecology, behavior, and physiology of marine mammals in the Gulf of Mexico *continued***

Since these are, for the most part, endangered species found in low numbers, we should be taking more advantage of "platforms-of-opportunity." If not, actual surveys may prove to be very frustrating.

Unidentified author

* * *

I recommend that an interagency meeting be convened to allocate responsibilities for supplementary surveys and data collection, including genetic data analysis for stock identity.

Unidentified author

* * *

I would recommend direct monitoring of body condition (total body fat) in a sample (10 to 20) of animals at all study sites being monitored on a regular basis by surveys (see R. Wells for details on techniques). In addition, I suggest the monitoring of energy content of major prey species in the same areas. These data will quantify the cumulative effect of fisheries, pollution, and development (should include deep-water sites).

In conjunction with radio-tracking, the simultaneous documentation of preferred feeding depths with time/depth recorders is advisable. These units also document temperature at depth.

Attachment A. **Extracts from participant submittals– Working group session on the ecology, behavior, and physiology of marine mammals in the Gulf of Mexico *continued***

An attempt should be made at using animals killed as incidental catch for use in determining the reproductive status, body burden of pollutants, body condition, and food preference (stomach contents).

We also need further elaboration of metabolic capabilities from the perspective of insulative needs and energy intake requirements. This will elucidate the impact on a local population of overexploitation of fish stocks.

Graham Worthy

* * *

Some of the cetaceans [other than *Tursiops*] are at present thought to be endangered. Some not recognized as endangered are probably more endangered than those so recognized, and some not endangered might quickly become so.

Therefore, I believe research funds should be directed to distribution, abundance, and behavior of cetaceans other than *Tursiops* in the Gulf of Mexico. *Ren Lohoefener*

* * *

I would recommend studying other species present in the Gulf of Mexico. We have a lot of *Stenella* and *Delphinus delphi* and maybe other dolphin species. Some of these species are seen more than *Tursiops* (I think) down in Mexico. I think all the *Stenella* species are important.

Adela Nieto Vallejo

* * *

SECTION V
APPENDIX A

Gulf of Mexico Sea Turtles and Marine Mammals Workshop

OPENING PLENARY SESSION

Tuesday, August 1, 1989

Session I

International Ballroom (16th floor)

Chair: Mr. Patrick Mangan — Gulf of Mexico OCS Region, Minerals Management Service

8:30 - 8:35 a.m.	Welcome, Announcements, and Workshop Objectives	Mr. J. Kenneth Adams Minerals Management Service
8:35 - 9:05 a.m.	Marine Mammals Protection Act of 1972 and Endangered Species Act of 1973 Responsibilities	Dr. Robert Hofman Marine Mammal Commission
9:05 - 9:15 a.m.	Protected Species Concerns in the Gulf of Mexico	Dr. Tyrrell A. Henwood National Marine Fisheries Service
9:15 - 9:45 a.m.	Human Activities and Conservation of Sea Turtles in the Gulf of Mexico	Mr. Michael Weber Center for Marine Conservation
9:45 - 10:15 a.m.	Present Day Human Impacts on Cetaceans	Dr. Bernd Wursig Texas A&M University
10:15 - 10:30 a.m.	Break	
10:30 - 11:00 a.m.	Current Status and Future Goals for Sea Turtle Research	Dr. Karen Bjorndal Center for Sea Turtle Research
11:00 - 11:30 a.m.	Marine Mammals of the Gulf of Mexico: Past, Present, and Future	Dr. David Schmidly Texas A&M University

Gulf of Mexico Sea Turtles and Marine Mammals Workshop

DISTRIBUTION, ABUNDANCE, AND SURVEY TECHNIQUES FOR SEA TURTLES N THE GULF OF MEXICO

Tuesday, August 1, 1989

Session II

1:00 p.m. - 4:15 p.m.
(Mid-afternoon break scheduled for 2:30 p.m. - 2:45 p.m.)

Discussion Group II.A. Madewood A (2nd floor)

Chair:	Dr. Alan Bolten Center for Sea Turtle Research
Co-chair:	Dr. Nancy Thompson National Marine Fisheries Service

Discussion Group II.B. Nottoway B (2nd floor)

Chair:	Mr. Larry Ogren National Marine Fisheries Service
Co-chair:	Dr. Robert W. Middleton Minerals Management Service

DISTRIBUTION, ABUNDANCE, AND SURVEY TECHNIQUES FOR MARINE MAMMALS IN THE GULF OF MEXICO

Tuesday, August 1, 1989

Session III

1:00 p.m. - 4:15 p.m.
(Mid-afternoon break scheduled for 2:30 p.m. - 2:45 p.m.)

Discussion Group III. Madewood B (2nd floor)

Chair:	Dr. Douglas G. Chapman III University of Washington
Co-chair:	Dr. Joseph Powers National Marine Fisheries Service

Gulf of Mexico Sea Turtles and Marine Mammals Workshop

POPULATION DYNAMICS AND LIFE HISTORY OF MARINE MAMMALS IN THE GULF OF MEXICO

Wednesday, August 2, 1989

Session IV

8:00 a.m. - 11:15 a.m.
(Mid-morning break scheduled for 9:30 a.m. - 9:45 a.m)

Discussion Group IV.A. Nottoway A (second floor)

Chair: Dr. John E. Reynolds III
Eckerd College

Co-chair: Dr. Charles Karnella
National Marine Fisheries Service

Discussion Group IV.B. Shadows (2nd floor)

Chair: Dr. Robert L. Brownell, Jr.
Chairman, Scientific Committee, International Whaling Commission

Co-chair: Dr. William H. Lang
Minerals Management Service

Discussion Group IV.C. Madewood A (2nd floor)

Chair: Dr. Daniel K. Odell
Sea World of Florida

Co-chair: Mr. Larry J. Hansen
National Marine Fisheries Service

Gulf of Mexico Sea Turtles and Marine Mammals Workshop

POPULATION DYNAMICS AND LIFE HISTORY OF SEA TURTLES IN THE GULF OF MEXICO

Wednesday, August 2, 1989

Session V

8:00 a.m. - 11:15 a.m.
(Mid-morning break scheduled for 9:30 a.m. - 9:45 a.m)

Discussion Group V.A. Crescent A (16th floor)

Chair: Dr. Nat B. Frazer
Mercer University

Co-chairs: Dr. Debby Crouse
North Carolina State University

Mr. Earl Possardt
U.S. Fish and Wildlife Service

Discussion Group V.B. Crescent B (16th floor)

Chair: Dr. James I. Richardson
University of Georgia

Co-chair: Mr. Jack Woody
U.S. Fish and Wildlife Service

Gulf of Mexico Sea Turtles and Marine Mammals Workshop

PHYSIOLOGY OF SEA TURTLES IN THE GULF OF MEXICO

Wednesday, August 2, 1989

Session VI

8:00 a.m. - 11:15 a.m
(Mid-morning break scheduled for 9:30 a.m. - 9:45 a.m.)

Discussion Group VI. Madewood B (2nd floor)

Chair: Dr. Molly Lutcavage
University of British Columbia

Co-chair: Dr. James R. Spotila
Drexel University

Gulf of Mexico Sea Turtles and Marine Mammals Workshop

ECOLOGY, BEHAVIOR, AND PHYSIOLOGY OF MARINE MAMMALS IN THE GULF OF MEXICO

Wednesday, August 2, 1989

Session VII

1:00 p.m. - 4:15 p.m.
(Mid-afternoon break scheduled for 2:30 p.m. - 2:45 p.m.)

Discussion Group VII.A. Nottoway A (2nd floor)

Chair: Dr. Randall Wells
University of California, Santa Cruz

Co-chair: Ms. Carol P. Fairfield
Minerals Management Service

Discussion Group VII.B. Shadows (2nd floor)

Chair: Mr. Hans Neuhauser
Georgia Conservancy

Co-chair: Mr. Kenneth Graham
Minerals Management Service

Discussion Group VII.C. Madewood A (2nd floor)

Chair: Dr. Bernd Wursig
Texas A&M University

Co-chair: Dr. Ren Lohoefener
National Marine Fisheries Service

Gulf of Mexico Sea Turtles and Marine Mammals Workshop

ECOLOGY AND BEHAVIOR OF SEA TURTLES IN THE GULF OF MEXICO

Wednesday, August 2, 1989

Session VIII

1:00 p.m. - 4:15 p.m.
(Mid-afternoon break scheduled for 2:30 p.m. - 2:45 p.m.)

Discussion Group VIII.A. Madewood B (2nd floor)

Chair: Dr. L. M. Ehrhart
University of Central Florida

Co-chair: Dr. Edward F. Klima
National Marine Fisheries Service

Discussion Group VIII.B. Crescent A (16th floor)

Chair: Dr. Karen Bjorndal
Center for Sea Turtle Research

Co-chair: Dr. Tyrrell A. Henwood
National Marine Fisheries Service

Discussion Group VIII.C. Crescent B (16th floor)

Chair: Dr. Peter C. H. Pritchard
Florida Audubon Society

Co-chair: Dr. Richard Byles
U.S. Fish and Wildlife Service

Gulf of Mexico Sea Turtles and Marine Mammals Workshop

CLOSING PLENARY SESSION

Thursday, August 3, 1989

Session IX

Crescent Ballroom (16th floor)

Chair: Mr. Patrick Mangan — Gulf of Mexico OCS Region, Minerals Management Service

8:30 - 8:40 a.m.	Announcements	
8:40 - 9:00 a.m.	Summary of II.A.B. Distribution, Abundance, and Survey Techniques for Sea Turtles	Dr. Alan Bolten
9:00 - 9:20 a.m.	Summary of III Distribution, Abundance, and Survey Techniques for Marine Mammals	Dr. Douglas G. Chapman III
9:20 - 9:40 a.m.	Summary of IV.A.B.C. Population Dynamics and Life History of Marine Mammals	Dr. Daniel K. Odell
9:40 - 10:00 a.m.	Summary of V.A.B. Population Dynamics and Life History of Sea Turtles	Dr. Nat B. Frazer
10:00 - 10:20 a.m.	Summary of VI Physiology of Sea Turtles	Dr. Molly Lutcavage
10:20 - 10:40 a.m.	Break	
10:50 - 11:00 a.m.	Summary of VII.A.B.C. Ecology, Behavior, and Physiology of Marine Mammals	Dr. Randall Wells
11:00 - 11:20 a.m.	Summary of VIII.A.B.C. Ecology and Behavior of Sea Turtles	Dr. L. M. Ehrhart
11:20 - 12:20 p.m.	Open Discussion	

APPENDIX B

DISCUSSION OUTLINE

SESSION II

DISTRIBUTION, ABUNDANCE AND SURVEY TECHNIQUES FOR SEA TURTLES IN THE GULF OF MEXICO

OBJECTIVES

The objectives for this discussion group will be to:

1. Identify gaps in our knowledge of sea turtle distribution and abundance in the Gulf of Mexico;
2. Prioritize the research effort to obtain the needed data for all species and all life stages within species; and
3. Identify the appropriate research protocols necessary to obtain the needed data.

BACKGROUND FOR DISCUSSION

Topic I: Distribution and Abundance

The top research priority with respect to this workshop is mapping the distribution of sea turtles by species, size class within species, and season in the Gulf of Mexico. Our present knowledge is incomplete.

1. What regions in the Gulf are most important (by habitat type and geographic location)?
2. Are we in a position to measure abundance or only relative abundance? What data are needed to allow us to make population estimates? Or,is determining relative abundance satisfactory given our present knowledge?

Topic II: Survey Techniques

Our knowledge of sea turtle distribution is based on a combination of data from aerial surveys, vessel surveys, tag returns, historical records, netting, interviews, incidental capture, opportunistic sightings, telemetry, and strandings. No one method is satisfactory to answer all questions.

1. What are the advantages and disadvantages of the various survey techniques?
2. What method or combination of methods should be applied to the question of sea turtle distribution in the Gulf of Mexico?

Topic III: Movements of Sea Turtles Among Regions

Once we begin to understand the distribution of turtles within the Gulf, we need to establish patterns of movements. These movements would include those among sequential developmental habitats, seasonal movements, and migrations between foraging regions and nesting beaches.

1. What method or combination of methods (e.g., flipper tags, telemetry) should be applied to the question of sea turtle movements in the Gulf of Mexico?

Topic IV: Selection of Index In-Water Habitats

Appropriate index habitats (based on predictable populations representing critical life history stages and varied geographic regions) need to be identified. Baseline parameters (species composition, relative abundance, size class composition, sex ratio, and seasonal changes) can be established and monitored. Effects of industrial activity in the Gulf can then be detected.

1. Do we know enough about sea turtle distribution in the Gulf to begin to identify index in-water habitats?

2. What baseline parameters need to be monitored, and what methods should be used to monitor the populations?

DISCUSSION OUTLINE

SESSION III

DISTRIBUTION, ABUNDANCE AND SURVEY TECHNIQUES FOR MARINE MAMMALS IN THE GULF OF MEXICO

D. G. Chapman
University of Washington

I. Survey Techniques

   a. Platform - shipboard or aircraft

   b. Methodology - strip vs. line transect

   c. Calibration techniques

   d. Adjustments for missed animals (underwater)

   e. Estimation of group or school size

II. Other Estimation Procedures

III. Identification of Stocks

DISCUSSION OUTLINE

SESSION IV

POPULATION DYNAMICS AND LIFE HISTORY OF MARINE MAMMALS

(Chaired by Brownell, Odell, & Reynolds)

Start sessions with introductions of participants.
State goals of the sessions and explain how those goals fit into overall workshop goals.

I. Review distribution, abundance, and uncertainties regarding distribution and abundance of marine mammals in the Gulf of Mexico.
SOURCE: Chapman's Session (Session III, 1 August)

II. Indicate, if possible, the current status of species found in the Gulf of Mexico, based on topic I above.

III. What human-related threats exist that could impact species found in the Gulf? Are there critical: 1) activities; 2) species; or 3) locations.

A. Activities
1. Oil/gas exploration: see attached flow chart from Geraci & St. Aubin Cover direct/indirect & chronic/acute impacts
2. Fishing activities
3. Live capture
4. Toxicants besides oil/gas
5. Other

B. Critical species
1. Tursiops Truncatus
2. Pseudorca crassidens
3. Feresa attenuata
4. Kogia breviceps & K. simus
5. Stenella spp.
6. Ziphiids
7. Large endangered whales

C. Locations
1. Depend on activities defined above.

TIME USAGE SHOULD BE ABOUT 30 MINUTES TO THIS POINT

IV. Data needs or uncertainties: for all species except Tursiops truncatus virtually all data are needed. This topic should probably be broken into three parts as follows:

A. Tursiops truncatus
   1. Population size: problems with estimators
      a. Effective population size (genetics)
   2. Stock differentiation
   3. Factors affecting population size
      b. Natality
         1. Age-specific survival
         2. Causes: natural vs. human-related
      c. Emigration
      d. Immigration

   Goal: construction of life tables
   Requirements: Individual identification & follow-up

   4. Habitat requirements for "healthy" dolphin populations
      a. Food
      b. Ecosystem
      c. Water quality
      d. Etc.

B. Other species: all of the above, and more.

   1. Most important: distribution and abundance in areas being considered for offshore oil and gas exploration.

C. Physical oceanography: Given proposed sites of drilling and proposed avenues for transport of products where are those products likely to wind up in the event of a spill. In other words do not just describe what happens at the site, but create models of dispersal.

TOPIC IV SHOULD LAST ABOUT 1 HOUR. COFFEE BREAK TIME.

V. For each category of data need listed under Topic IV, identify the research that would be required to address that need. For many types of marine mammal studies, a minimum of three years of data is needed.

Identifications to be as follows:

1. Need: identified under Topic IV above.
2. Research: Identify exactly what questions may be answered given a particular research procedure. Identify any bias/uncertainty associated with the research.
3. Logistics: identify the time, money, or other resources necessary for each research program suggested. Identify lead agencies (???) to fund such research.

DISCUSSION OUTLINE

SESSION V

POPULATION DYNAMICS AND LIFE HISTORY OF SEA TURTLES IN THE GULF OF MEXICO

Preface: Survivorship, fecundity, and age at maturity are the three most important aspects to consider for assessing population dynamics and life history phenomena.

I. What are the important aspects and why?
   a. Survivorship
   b. Fecundity
   c. Age at Maturity

II. What do we know?
   a. Survivorship
   b. Fecundity
   c. Age at Maturity

III. What don't we know?
   a. Survivorship
   b. Fecundity
   c. Age at Maturity

IV. How do we find out?
   a. Survivorship
   b. Fecundity
   c. Age at Maturity

V. Use and Abuse of Population Models
   a. Recent MTN editorials
   b. Puerto Limon example

DISCUSSION OUTLINE

SESSION VI

PHYSIOLOGY OF SEA TURTLES

Chair: Dr. Molly Lutcavage
Co-Chair: Dr. Jim Spotila

Physiological Effects of Human Impacts on Sea Turtles

Species of concern:
L. kempi, C. mydas, D. coriacea, C. caretta, E. imbricata

I. Review of human activities with documented physiological impacts on sea turtles:
   1. ocean dumping/disposal of non-biodegradable refuse
   2. oil spills and containment operation
   3. toxic substance release
   4. fishing-related incidental mortalities: entanglement and asphyxiation
   5. Gulf oil and gas site deconstruction: explosion and compression
   6. harbor dredging operations

II. Prioritization of Research re. physiological effects of human activity on sea turtles in the Gulf of Mexico.
   1. Ranking of present and projected threats to Gulf sea turtle populations. Assessment of mortality.
   2. Oil spill response: prevention, containment methods, rehabilitation, long-term assessment.
   3. Non-biodegradable refuse: monitoring plastic ingestion and chronic pollution.
   4. Using the TED: predicting sea turtle survival in trawls.

III. Research Objectives, Organization, and Information Transfer
   1. Discussion of applied physiological research methods in relation to sea turtle survival and pollution biology.
   2. field and laboratory studies: state-of-the-art methods, or how can we best answer tough questions?
   3. Information transfer: research to management.
   4. Research priorities, permit requirements, and peer review.

SESSION VII

ECOLOGY, BEHAVIOR, AND PHYSIOLOGY OF MARINE MAMMALS IN THE GULF OF MEXICO

I. What are the specific species of concern?
   A. Mysticetes
   B. Odontocetes

II. What habitats are essential to the maintenance or recovery of marine mammal populations, and why are they essential?
   A. Kinds of habitats: coastal, estuarine, continental shelf, shelf-edge, pelagic.
   B. What habitats are of year-round importance?
   C. What habitats are of seasonal importance?
   D. How can these habitats be protected?

III. What human activities might have the greatest impacts on marine mammals, and what are the potential impacts, relative to ecology, behavior, and/or physiology?
   A. Coastal development and habitat degradation?
   B. Direct effects of fisheries through incidental mortality?
   C. Indirect effects of fisheries through competition for prey?
   D. Vessel traffic, commercial and recreational?
   E. Offshore industrial activities?
   F. Pollution, chronic vs. catastrophic?
   G. Live-capture operations?
   H. Others?

IV. What data are needed to reliably assess the direct and indirect effects of these human activities?

V. How can the needed information best be obtained?
   A. In general, what kinds of studies are needed to verify the predicted effects and detect the possible and unforeseen effects of human activities?
   B. How should these studies be prioritized with respect to their likely contribution to assessing and verifying the probable effects and detecting the possible unforeseen effects of human activities on marine mammals?
   C. What are the estimated time, money, logistics, personnel, and special equipment that would be required to carry out the needed research or monitoring?

DISCUSSION OUTLINE

SESSION VIII

ECOLOGY AND BEHAVIOR OF SEA TURTLES IN THE GULF OF MEXICO

Preface: A discussion of the research needs relevant to the behavior and ecology of sea turtles in the Gulf of Mexico could be organized in a number of ways. The primary organization could be broken out along the line of habitats, species, behavioral/ ecological subtopics or by life history stages. I am suggesting that it would be productive to organize around the latter category, life history stage, because there is some commonality in the threats and impacts of human activities in those stages that cross species lines.

I. ADULTS
A. For each of the following: Kemp's Ridley
Loggerhead
Green Turtle
Hawksbill
Leatherback

1. The State of Our Knowledge: Ecologic Geography (especially habitat selection and preference); Feeding Ecology; Activity Cycles.

a. Where are they, when, for how long? What constitutes good habitat? What habitats are essential for maintenance and recovery? What environmental factors cause change? What do we know; what needs to be learned?

b. What are the preferred foods; where does each fall on the euryphagy-stenophagy continuum; which food items are most susceptible to impact by human activities?

c. Do activity levels and diel activity patterns vary from season to season; is torpor (hibernation, brumation, etc.) a factor? Etc.

d. What human activities have the greatest impact at this stage (in the Gulf of Mexico)?

e. What research is needed (how can the needed information best be obtained) to detect, assess and/or verify the effects of those (above) humans activities?

f. What is required in terms of time, money, logistics, personnel and special equipment, to carry out the needed research/monitoring.

II. HATCHLINGS/POST-HATCHLINGS
A. For each of the following: Kemp's Ridley
Loggerhead

Hawksbill
Leatherback

1. The State of Our Knowledge: Ecologic Geography; Feeding Ecology; Activity Cycles.
   a. As above
   b. As above
   c. As above
   d. As above
   e. As above
   f. As above

III. JUVENILES (or "SMALL JUVENILES")
   A. For each of the following: Kemp's Ridley
   Loggerhead
   Green Turtle
   Hawksbill
   Leatherback

1. The State of Our Knowledge: Ecologic Geography; Feeding Ecology; Activity Cycles.
   a. As above
   b. As above
   c. As above
   d. As above
   e. As above
   f. As above

IV. SUBADULTS (or "LARGE JUVENILES")
   A. For each of the following: Kemp's Ridley
   Loggerhead
   Green Turtle
   Hawksbill
   Leatherback

1. The State of Our Knowledge: Ecologic Geography; Feeding Ecology; Activity Cycles.
   a. As above
   b. As above
   c. As above
   d. As above
   e. As above
   f. As above

APPENDIX C
WORKSHOP PARTICIPANTS

Dr. Bruce B. Ackerman
Dept. of Natural Resources
Florida Marine Research Institute
100 8th Ave., S.E.
St. Petersburg, FL 33701-5095

Ms. Suna Adam
Environmental Section
535 Main St.
Baton Rouge, LA 70810

Mr. J. Kenneth Adams
MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. Rita Alexander-Bloc
Greenpeace International
Sea Turtle Division
P.O. Box 2157
New Smyrna Beach, FL 32170

Mr. Dan Allen
Chevron Corporation
P.O. Box 7924
San Francisco, CA94120-7924

Ms. Stacie Arms
1878 E. Nine Mile Road, #708
Pensacola, FL 32514

Ms. Kit Armstrong
Chevron U.S.A.
P.O. Box 5050
San Ramon, CA94583-0905

Dr. Robert M. Avent
MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Ms. Barbara B. Bailey
Chevron USA, Inc.
Eastern Region
935 Gravier St.
New Orleans, LA 70112

Dr. James A. Barlow, Jr.
U.S. Army Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160

Dr. Nelio B. Barros
Rosenstiel School of Marine
& Atmospheric Science
Biology and Living Resources
4600 Rickenbacker Causeway
Miami, FL 33149-1098

Ms. Sherron Barrow
Help Endangered Animals Ridley Turtles
1611 Tucumcari
Houston, TX 70090

Ms. Mary R. Bartz
MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. Richard Bejarano
Louisiana Dept. of Wildlife & Fisheries
1400 Royal St., Room 129
New Orleans, LA 70130

Mr. Joe Benigno
NOAA, NMFS
P.O. Drawer 1207
Pascagoula, MS 39568-1207

Mr. Richard Bennett
MMS, Gulf of Mexico OCS
Region (LE-5-2)
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. Lester Bivens
Naval Ocean Systems Center
Biosciences Division, Code 5101
San Diego, CA 92152-5000

Dr. Karen Bjorndal
Center for Sea Turtle Research
University of Florida
223 Bartram Hall
Gainesville, FL 32611

Ms. Janice B. Blake
MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. R. A. Blaylock
NOAA, NMFS
Southeast Fisheries Center
75 Virginia Beach Dr.
Miami, FL 33149

Dr. Alan Bolten
University of Florida
Center for Sea Turtle Research
223 Bartram Hall
Gainesville, FL 32611

Mr. Ronald D. Boudreaux
Gulfway Travels
P.O. Box AF
Port Island, TX 78578

Mr. Jerry Brashier
MMS, Gulf of Mexico
Region (LE-5)
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. Jeff Brown
NOAA, NMFS
Protected Species Mgmt.
9450 Koger Blvd.
St. Petersburg, FL 33702

Dr. Robert L. Brownell, Jr.
U.S. Fish and Wildlife Service
Piedras Blancas Field Station
P.O. Box 70
San Simeon, CA 93452

Dr. Ann Scarborough-Bull
MMS, Gulf of Mexico OCS
Region (LE-2-2)
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. Robert L. Burnett
1828 E. Nine Mile Rd. #713
Pensacola, FL 32514

Dr. Richard Byles
U.S. Fish and Wildlife Service
Endangered Species Office
P. O. Box 1306
Albuquerque, NM 87203

Dr. Charles W. Caillouet
NOAA, NMFS
Galveston Laboratory
4700 Ave. U
Galveston, TX 77551-5997

Dr. Douglas Chapman
University of Washington
Center for Quantitative Science
HR-20
Seattle, WA 98195

Mr. Dennis Chew
MMS, Gulf of Mexico OCS
Region (LE-5-1)
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. Joe Christopher
MMS, Gulf of Mexico OCS
Region (LE-2-1)
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. Joseph M. Chromanski
Aquarium of the Americas
111 Iberville St., Ste 500
New Orleans, LA 70130

Mr. E. Scott Clark
U.S. Army Corps of Engineers
Environmental Division
P.O. Box 60267
New Orleans, LA 70160-0267

Dr. Sneed B. Collard
University of West Florida
Dept. of Biology
1100 University Parkway
Pensacola, FL 32514

Mr. Vincent F. Cottone
Texaco
Environmental & Regulatory Compliance
P.O. Box 60252
New Orleans, LA 70160

Dr. Deborah Crouse
North Carolina State University
526 Euclid St.
Raleigh, NC 27604

Mr. Les Dauterive
MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Dr. Richard E. Defenbaugh
MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. Donald R. Deis
Continental Shelf Associates, Inc.
759 Parkway St.
Jupiter, FL 33477

Mr. Steve Demuth
Demex International
7144 Dummyline Rd.
Picayune, Ms

Mr. Tommy Doran
Gulf Engineers & Consultants
535 Main St.
Baton Rouge, LA 70802

Dr. L. M. Ehrhart
University of Central Florida
Dept. of Biological Science
P.O. Box 25000
Orlando, FL 32816

Dr. Thomas J. Eley
Unversity of West Florida
Department of Geography
11000 University Pkwy.
Pensacola, FL 32514

Mr. Doug Elvers
MMS, Gulf of Mexico OCS Region (LE-2)
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Ms. Carol Fairfield
MMS, Branch of Environmental Studies
(MS 4310)
381 Elden St.
Herndon, VA 22070-4817

Mr. Reynaud Farve
MMS, Pacific OCS Region
1340 W. 6th St.
Los Angeles, CA 90017

Dr. Nat B. Frazer
Mercer University
Biology Dept.
1400 Coleman Ave.
Macon, GA 31207

Ms. Debbie Friedrichs
Consultant
1128 4th St.
New Orleans, LA 70130

Ms. Deborah Fuller
Louisiana State University
Center for Wetland Resources
Baton Rouge, LA 70803

Ms. Karen Furnweger
John G. Shedd Aquarium
1200 S. Lake Shore Dr.
Chicago, IL 60605

Mr. Paul D. Garangelo
Island Botanics E & EC
714 Don Patricio
Corpus Christi, TX 78418

Mr. Gregg Gitschlag
NOAA, NMFS
4700 Ave. U
Galveston, TX 77551

Ms. Cheryl Grafton
National Marine Fisheries Service
4700 Ave. U
Galveston, TX 77551

Mr. Kenneth Graham
Minerals Management Service
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. Larry J. Hansen
NOAA, NMFS
Miami Laboratory
75 Virginia Beach Dr.
Miami, FL 33149-1099

Mr. Gary L. Harper
Texaco, Inc.
Construction Dept.
P.O. Drawer 1219
Morgan City, LA 70381

Mr. Kenneth J. Havran
MMS, Branch of Environ. Evaluations
381 Elden St.
Herndon, VA 22070

Mr. Robert W. Heinly
Texas A&M University
Wildlife & Fisheries Sciences
P.O. Box 1675
Galveston, TX 77553

Mr. Larry R. Henry
Chevron USA, Inc.
Eastern Division
935 Gravier St.
New Orleans, LA 70112

Dr. Terry Henwood
NOAA, NMFS
9450 Koger Blvd.
St. Petersburg, FL 33702

Mr. Bryan Herczeg
NOAA, NMFS
4700 Ave. U
Galveston, TX 77551

Mr. H. Lew Herrin
Mobil Oil Corp.
Exploration & Production-U.S.
1250 Poydras St.
New Orleans, LA 70113

Ms. Nancy Hicks
Animal Protection Institute of America
Eastern Division
P.O. Box 57006
Washington, DC 20037

Dr. Henry H. Hildebrand
Marine Biological Consultant
413 Millbrook
Corpus Christi, TX 78418

Dr. Robert Hofman
Scientific Program Director
Marine Mammal Commission
1625 I St., N.W.
Washington, DC 20006

Ms. C. Rachael Howell
Corpus Christi State University
3140 Ocean Dr.
Corpus Christi, TX 78404

Mr. Bill Ibarra
Conoco, Inc.
New Orleans Div.
3500 General DeGaulle Dr.
New Orleans, LA 70114-6599

Mr. William B. Jackson
NOAA, NMFS
Southeast Regional Office
4700 Ave. U - Bldg. 308
Galveston, TX 77551-5997

Mr. Bruce Jaildagian
Greenpeace International
Sea Turtle Division
P.O. Box 2157
New Smyrna Beach, FL 32170

Mr. Art Jeffers
NOAA, NMFS
1335 East-West Hwy.
Silver Spring, MD 20910

Mr. Thomas Jefferson
Texas A&M University
Marine Mammal Research Program
P.O. Box 1675
Galveston, TX77553-1675

Ms. Jannine D. Johnson
Greenpeace USA
102 6th Ave. North
Jacksonville Beach, FL 32250

Mr. Jay Johnson
Conoco, Inc.
Environmental Affairs
3500 General De Gaulle Dr.
New Orleans, LA 70114-6599

Dr. Charles Karnella
NOAA, NMFS
Office of Protected Species & Habitat
Washington, DC 20235

Mr. Edward O. Keith
University Miami Medical School
Biochemistry Dept. (R629)
P.O. Box 016129
Miami, FL 33101

Dr. James J. Kendall
MMS. Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Dr. Robert D. Kenney
University of Rhode Island
Graduate School of Oceanography
Box 41 Bay Campus
Narragansett, RI 02882-1197

Mr. Timothy P. Killeen
La. Dept. of Natural Resources
Coastal Mgmt. Div.
400 Royal St.
New Orleans, LA 70130

Mr. John M. King
Texas A&M University
P.O. Box 1675 Fort Crockett
Galveston, TX 77553

Dr. Edward Klima
NOAA, NMFS
4700 Ave. U
Galveston, TX 77551

Mr. Lyle Kochinsky
Aqua-Med, Inc.
310 S E 3rd Terr
Dania, FL 33004

Ms. Connie Landry
MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Dr. Andre' M. Landry, Jr.
Texas A&M University
Dept. of Marine Biology
P.O. Box 1675
Galveston, TX 77553

Dr. William Lang
MMS, Branch of Environmental Studies
381 Elden St.
Herndon, VA 22070-4817

Ms. Joanne Langston
1554 Maplewood Dr.
Slidell, LA 70458-3136

Mr. Jackson E. Lewis
MMS, OEAD
381 Elden St. (MS 4300)
Herndon, VA 22070-4817

Ms. Dianne Lindstedt
Louisiana Geological Survey
Louisiana Coastlines
P.O. Box G
Baton Rouge, LA 70893

Dr. Ren Lohoefener
U.S. Fish and Wildlife Science
6578 Dogwood View Parkway
Jackson, MS 39213

Marcella Lowell
Bayou Wildlife Rescue &
Rehabilitation
2435 Wisteria St.
New Orleans, LA 70122

Dr.Molly Luctcavage
University of British Columbia
Dept. of Zoology
6720 University Blvd.
Vancouver, B.C. V6T2A9
CANADA

Mr. Richard V. Lynch III
Lockheed Missiles Space Co., Inc.
0/97-01 B/201
3251 Hanover St.
Palo Alto, CA 94304-1191

Dr. Ian Rosman MacDonald
Texas A&M Univ.
Dept. of Oceanography
College Station, TX 77843-3146

Mr. Patrick G. Mangan
MMS, Gulf of Mexico OCS Region
(LE 2-2)
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. Richard Martin
Louisiana Natural
Heritage Program
P.O. Box 9800
Baton Rouge, LA 70890

Mr. Robert Martinson
U.S. Army Corps of Engineers
Planning Division
P.O. Box 60267
New Orleans, LA 70160

Mr. Martin S. Mayer
U.S. Army Corps of Engineer
P.O. Box 60267
New Orleans, LA 70160

Dr. Thomas P. McIlwain
Gulf Coast Research Lab
P.O. Box 7000
Ocean Springs, MS 39564-7000

Mr. "Tee" John Mialjevich
President
Concerned Shrimpers
P.O. Box 637
Belle Chase, LA 70037-0637

Dr. Robert W. Middleton
MMS, Branch of Environmental Operations
381 Elden St.
Herndon, VA 22070-4817

Mr. Robert Morgan
U.S. Army Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160-0267

Dr. Keith D. Mullin
NOAA, NMFS
P.O. Drawer 1207
Pascagoula, MS 39568

Ms. Deborah Mundell
Chelonia Sea Turtle Project
P.O. Box 205
Edisto Island, SC 29438

Mr. Larry Narcisse
LA. Dept. of Natural Resources
P.O. Box 44487
Baton Rouge, LA 70808-4487

Dr. Walter R. Nelson
NOAA, NMFS
Miami Laboratory
75 Virginia Beach Dr.
Miami, FL 33149

Mr. R. Douglas Nester
U.S. Army Corps of Engineers
Coastal Environmental Section
109 St. Joseph St., CESAMPD-EC
Mobile, AL 36628-0001

Mr. Hans Neuhauser
Georgia Conservancy
711 Sandtown Rd.
Savannah, GA 31410

Dr. Daniel K. Odell
Staff Research Biologist
Sea World of Florida
7007 Sea World Dr.
Orlando, FL 32821

Mr. Larry Ogren
NOAA, NMFS
3500 Delwood Beach Rd.
Panama City, FL 32408

Dr. Dave Owens
Texas A&M University
Biology Department
College Station, TX 77843

Mr. Mike Park
U.S. Army Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160

Mr. Michael E. Parker
Exxon Company U.S.A.
P.O. Box 60626
New Orleans, LA 70160

Mr. Michael P. Payne
Manomet Bird Observatory
Marine Mammal & Seabird Studies
P.O. Box 936
Manomet, MA 02345

Mr. Earl Possardt
U.S. Fish and Wildlife Service
3100 University Blvd.
South Jacksonville, FL 32216

Ms. Dionne Powe
6803 Edgewater Ln.
Apt. #I
New Orleans, LA 70126

Dr. Joseph Powers
NOAA, NMFS
Miami Laboratory
75 Virginia Beach Dr.
Miami, FL 33149-1099

Dr. Peter C. H. Pritchard
Florida Audubon Society
1101 Audubon Way
Maitland, FL 32751

Mr. Darlene Reaves
Jefferson Parish School
504 Fife Ln.
Laplace, LA 70068

Mr. Maurice Renaud
NMFS, NOAA
4700 Ave. U
Galveston, TX 77551

Dr. John E. Reynolds, III
Eckerd College
Dept. of Marine Science and Biology
St. Petersburg, FL 33733

Mr. G. Ed Richardson
MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Ms. Leslie Richardson
2595 Lake Capri Dr.
Lithonia, GA 30058

Dr. James I. Richardson
University of Georgia
Institute of Ecology
Athens, GA 30602

Dr. Robert M. Rogers
MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Mr. David L. Scarborough
Texas A&M University
College Station, TX 77843

Ms. Lesley Scheele
Greenpeace
Ocean Ecology
1881 N.E. 26th St.
Ft. Lauderdale, FL 33305

Dr. David Schmidly
Texas A&M University
College Station, TX 77843

Mr. Pete Serio
U.S. Army Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160

Ms. Linda Shaw
NOAA, NMFS
Habitat Conservation Br.
1 Blackburn Dr.
Gloucester, ME 01930-2298

Mr. Jan Shea
NOAA, NMFS
4700 Ave. U
Galveston, TX 77551

Mr. Raymond F. Sis
Texas A&M University College
of Veterinary Medicine
College Station, TX 77843

Dr. Moby Solangi
Institute for Marine Mammal Studies
P.O. Box 4078
Gulfport, MS 39502-4078

Ms. Becky Souhlas
1704 Kings Row
Slidell, LA 70461

Mr. Joe Souhlas
MMS, Gulf of Mexico OCS Region
(LE-3-2)
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Dr. James R. Spotila
Drexel University
Dept. of Bioscience and Biotechnology
Philadelphia, PA 19104

Mr. Kerry M. Stanley
Texas A&M University
P.O. Box 1675
Galveston, TX 77551

Mr. Ted Stechmann
MMS, Gulf of Mexico OCS Region
1201 Elmwood Park Blvd.
New Orleans, LA 70123-2394

Ms. Karen O. Strawn
Chevron USA, Inc.
935 Gravier St.
New Orleans, LA 70112

Dr. Warren Stuntz
NOAA, NMFS
P.O. Drawer 1207
Pascagoula, MS 39567

Ms. Kim Terrell
Institute for Marine Mammal Studies
P.O. Box 4078
Gulfport, MS 39502

Dr. Nancy Thompson
NOAA, NMFS
Miami Laboratory
75 Virginia Beach Dr.
Miami, FL 33149-1099

Mr. Leryes J. Usie
NOAA, NMFS
World Trade Center, Suite 400-h
2 Canal St.
New Orleans, LA 70130

Mr. James A. Valade
Biologist
P.O. Box 11635
Jacksonville, FL 32239-1635

Dr. Adela Nieto Vallejo
University of Mexico
Institute De Investigaciones Biomedicas
Apto Postal 70228
Mexico, DF 04510
MEXICO

Ms. Margie Vicknair
Recycling of New Orleans
302 Midway Dr.
River Ridge, LA 70123

Dr. Michael Weber
1308 S. Carolina Ave. S.E.
Washington, DC 20003

Dr. Randall Wells
Conservation Biology Dept.
Chicago Zoological Society
Brookfield Zoo
Brookfield, IL 60513

Mr. Frederick T. Werner
U.S. Fish and Wildlife Service
17629 El Camino Real, Suite 211
Houston, TX 77058

Mr. Tony Williams
Texas A&M University
P.O. Box 1695
Galveston, TX 77553

Mr. Ross Witham
University of Miami
RSMAS
1457 N.W. Lake Pointe
Stuart, FL 34994

Ms. Barbara Wood
508 N.W. 10th St.
Gainesville, FL 32607

Ms. Cynthia Wood
U.S. Army Corps of Engineers
P.O. Box 1229
Galveston, TX 77553

Mr. Jack Woody
U.S. Fish and Wildlife Service
Endangered Species Office
P.O. Box 1306
Albuquerque, NM 87203

Dr. Graham A. J. Worthy
Texas A&M University
Marine Biology Dept., Marine Mammals
P.O. Box 1675
Galveston, TX 77553-1675

Dr. Bernd Wursig
Texas A&M University
Marine Mammal Research Program
P.O. Box 1675
Galveston, TX 77553

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. The includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. Administration.