

## Historical Perspectives

### Robert (Bob) Hofman, Ph.D.

(Born 25 January 1938)

Bob Hofman was born and raised in western Pennsylvania. After high school, he enlisted and spent 40 months as a sonar man in the U.S. Navy. He received his B.S. and M.S. degrees in Biology from the Indiana University of Pennsylvania (IUP) in Indiana, Pennsylvania. He taught biology, general science, and physics at Warren Harding High School in Warren, Ohio, from 1962 to 1967. In 1967, he received a National Science Foundation (NSF) Academic Year Grant to do advanced work at the University of Minnesota.

Dr. Hofman did his Ph.D. dissertation at the University of Minnesota on the *Population Dynamics of Antarctic Seals*. During the Austral summers of 1968 through 1974, he worked as part of a research group from the University of Minnesota that conducted studies of pupping colonies of Weddell seals near the U.S. research station in McMurdo Sound (southern Ross Sea); studied Adelie penguins and leopard, crabeater, and elephant seals near the U.S. Palmer Station on Anvers Island in the Antarctic Peninsula; and studied crabeater, Ross, and leopard seals aboard icebreakers and the NSF's *Research Vessel Hero* in the pack ice of the Weddell, Bellinghousen, and Ross Seas. In the summer of 1975, he was involved in the initiation of a sea otter research program in Prince William Sound, Alaska, the area affected by the *Exxon Valdez* oil spill in 1989. The Minnesota research group pioneered the development of radio-tagging, underwater television monitoring, and genetic and behavioral studies of Antarctic seals.

Dr. Hofman received his Ph.D. from the University of Minnesota in 1975. From September 1975 through June 2000, he was the Scientific Program Director for the Marine Mammal Commission, a U.S. government agency created by the 1972 U.S. Marine Mammal Protection Act. The Act was the first legislation in the world to mandate an ecosystem approach to the conservation of marine mammals—seals, whales, walruses, dolphins, porpoises, polar bears, sea otters, manatees, and dugongs. It provided for the establishment of a three-person Commission, appointed by the President, and a nine-person Committee of Scientific Advisors to advise the Commission on needed research and conservation measures. It charged the Commission with overseeing and



providing recommendations to other government agencies and Congress on measures needed to protect and conserve marine mammals and their habitats in U.S. waters and on the high seas. In addition to managing the Commission's research program, Dr. Hofman played a lead role in assessing threats to, and formulating and promoting implementation of, recovery and conservation plans for Florida manatees, California sea otters, Hawaiian monk seals, and other endangered and threatened marine mammal species and populations.

From 1979 until his retirement in 2000, Dr. Hofman was a special advisor to the U.S. Department of State on Antarctic matters. He was a member of the U.S. delegations to the Antarctic Treaty Consultative Meetings and was involved in development of U.S. positions and negotiations of the 1981 Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), the 1988 Convention for the Regulation of Antarctic Mineral Resource Activities, and the 1991 Protocol to the Antarctic Treaty on Protection of the Antarctic Environment. Dr. Hofman was the first U.S. representative on the Scientific Committee established by the Living Resources Convention, and on the Committee on Environmental Protection (CEP) established by the Environmental Protocol.

Since his retirement, Dr. Hofman has done contract work for the MMC and other organizations, and he has made several trips as a lecturer and observer aboard Antarctic cruise ships.

# The Continuing Legacies of the Marine Mammal Commission and Its Committee of Scientific Advisors on Marine Mammals

Robert J. Hofman

*Scientific Program Director, MMC, September 1975 to June 2000*

The Marine Mammal Commission (MMC) and its Committee of Scientific Advisors (CSA) on Marine Mammals were established by the U.S. Marine Mammal Protection Act of 1972. The Commission, Committee, and the Act itself have played lead roles in promoting the conservation of marine mammals and marine ecosystems worldwide. In this paper, I review the background and some of the key provisions of the Marine Mammal Protection Act (hereafter referred to as the MMPA or the Act) and describe some of the Commission's initiatives regarding six particularly important topics: (1) the "optimum concept" and the "ecosystem approach" to resource conservation; (2) marine mammal-fishery interactions; (3) the Florida manatee, an example of a species of special concern; (4) the marine debris problem; (5) marine mammal strandings and unusual mortality events; and (6) the controversy concerning the effects of anthropogenic sound on marine mammals and other biota. Details concerning these and other Commission efforts to give effect to the intent and provisions of the MMPA can be found in the Commission's Annual Reports to Congress.

## Background

The MMPA was one of a series of landmark U.S. environmental laws enacted in the late 1960s and early 1970s in response to the then growing awareness that expanding human populations, unsustainable exploitation of natural resources, and burgeoning environmental pollution were jeopardizing the planet and the welfare of future human generations. In addition to the MMPA, the laws included the Wild and Scenic Rivers Act of 1968, the National Environmental Policy Act of 1969, the Clean Air and Coastal Zone Management Acts of 1972, the Endangered Species Act of 1973, and the Fisheries Conservation and Management Act of 1976.

Before the MMPA, conserving and regulating the "taking" (i.e., hunting, capturing, and killing) of marine mammals in U.S. coastal waters were the responsibility of the adjacent coastal states. The Department of State, in cooperation with the Departments of Commerce and the Interior, was responsible for conserving and regulating the taking of marine mammals on the high seas

through international agreements such as the International Whaling and the North Pacific Fur Seal Conventions. The MMPA established a general moratorium on the taking of marine mammals in U.S. waters and on the importation of marine mammals and marine mammal products into the U.S. It assigned responsibility to the Department of Commerce for implementing its provisions with regard to whales, dolphins, porpoises, seals, and sea lions, and to the Department of the Interior with regard to walrus, polar bears, manatees, dugongs, sea otters, and marine otters. Most of those responsibilities were delegated to subsidiary agencies—the National Marine Fisheries Service (NMFS) in the Department of Commerce and the Fish & Wildlife Service (FWS) in the Department of the Interior. In addition, the Act directed the Department of State to seek new international agreements and the revision of existing agreements to further the purposes and policies of the Act. It also provided that management authority could be returned to states if certain conditions were met.

Several features of the Act were unique:

- It established the concept of "optimum sustainable populations" (OSPs).
- It was the first legislation in the U.S. and, to my knowledge, anywhere in the world to mandate an ecosystem approach to the conservation of marine living resources.
- It mandated application of the "precautionary" principle—that is, except for taking by Alaska natives for subsistence and handicraft purposes, the Act established a moratorium on the taking of all marine mammals in U.S. waters and the importation of marine mammals and marine mammal products into the U.S., while providing that the moratorium can be waived and that permits can be issued to authorize taking for scientific research and public display when the taking would not "disadvantage" the affected species or population (e.g., cause it to be reduced or maintained below its OSP level).

Three issues were of particular concern in 1972 when the MMPA was enacted:

1. The killing of hundreds of thousands of dolphins each year in the Eastern Tropical Pacific

- Ocean (ETP) as a consequence of setting purse seines around dolphin schools to catch tuna that associate with the dolphins;
2. The failure of the International Whaling Commission (IWC) to prevent the overexploitation and near extinction of virtually all stocks of large whales throughout the world; and
  3. The clubbing and skinning of tens of thousands of newborn harp seals each year in the spring ice fields of the North Atlantic for the fur market.

Since passage of the MMPA, many additional issues have drawn attention such as unprecedented declines of numerous species and populations in U.S., international, and foreign waters—for example, West Indian (Florida), Amazonian, and African manatees; Hawaiian and Mediterranean monk seals; California and Alaska sea otters; northern fur seals and sea lions; North Atlantic and North Pacific right whales; the Gulf of California harbor porpoise; and the Yangtze and Amazon river dolphins. Other, often related issues include the effects of unintentional taking incidental to offshore oil and gas development, commercial fisheries, whale-watching, and other human activities; increases in some marine mammal populations and corresponding calls by fishermen and fishery management agencies to cull the populations to reduce competition for salmon and other fishery resources; unusual mortality events such as the die-off of bottlenose dolphins that occurred along the U.S. mid-Atlantic coast in 1987 and 1988; and increasing threats posed by chemical and trace metal contaminants, lost and discarded fishing gear and other types of persistent marine debris, ship strikes, human sources of ocean noise, and ecosystem changes due to climate change.

In addition to promoting new research and regulatory programs, these and related issues have fostered conflict between different interest groups, leading to a number of changes in the MMPA (*cf.*, Hofman, 1989, 2003). In 1981, for example,



Northern right whale (Courtesy of NOAA/Department of Commerce)

the Act was amended to allow the Secretaries of Commerce and the Interior to authorize the taking of small numbers of marine mammals incidental to activities, such as offshore oil and gas development, without going through the complicated process of obtaining a waiver of the Act's moratorium on taking. The various amendments and their backgrounds and intent are described in the Commission's Annual Reports to Congress.

#### **The Establishment and Legislative Mandate of the Marine Mammal Commission and the Committee of Scientific Advisors**

Congress, the scientific community, and the general public of the U.S. were dissatisfied with the efforts of the responsible regulatory agencies to deal with the tuna-dolphin problem, regulation of commercial whaling, and other human activities affecting marine mammals worldwide. Consequently, Title II of the MMPA established the Marine Mammal Commission and its Committee of Scientific Advisors to provide an independent overview of all federal activities affecting marine mammals and to advise Congress and the responsible regulatory agencies of actions judged necessary to meet the intent and provisions of the Act. The Commission was given no regulatory authority. However, the Act mandated that recommendations made by the Commission to federal officials must be responded to within 120 days and, if the recommendation is not followed, that the officials must provide a detailed, written explanation to the Commission indicating why.

The MMPA specified that the Commission is to be composed of three members knowledgeable in the fields of marine ecology and resource management—not an employee of the federal government nor someone in a position to profit from the taking of marine mammals—appointed by the President of the United States from a list of qualified individuals submitted by the Chairman of the Council on Environmental Quality and approved unanimously by that individual, the Secretary of the Smithsonian Institution, the Director of the National Science Foundation, and the Chairman of the National Academy of Sciences. In 1981, the Act was amended to require Senate confirmation of individuals nominated by the President for appointment to the Commission, which is the same requirement for Senate confirmation of individuals nominated by the President to be federal judges, heads of Executive Branch agencies, etc.

The Act directed the Commission to establish a nine-member Committee of Scientific Advisors composed of scientists knowledgeable in marine ecology and marine mammal affairs. It directed further that the members of the Committee be

appointed by the Chairman of the Commission after consultation with the other Commissioners and with the heads of the previously noted agencies and organizations to confirm the scientific qualifications of the nominees. It specified that (1) the Commission must consult with the Committee on all studies it proposes to undertake, on proposed recommendations to other agencies concerning research programs being conducted or proposed to be conducted under the authority of the Act, and on all applications for permits for marine mammal research; and (2) any Committee recommendations not accepted by the Commission must be forwarded to the relevant federal agency and Congressional oversight committee with a detailed written explanation of why the recommendation was not followed.

The Commission and Committee members work in those positions part time. They either are retired or have full-time jobs in academic institutions, state and federal government agencies, public display facilities, etc. (see Appendices 1 & 2 for a listing of the past and current members of the Commission and the CSA). The Commission has a full-time staff headquartered in the Washington, DC area. The members of the Commission, Committee, and staff are listed in the Commission's Annual Reports to Congress. Collectively, the Commission's Annual Reports provide the most comprehensive description available of the issues bearing on the conservation of marine mammals over the last 35 years. Both the Annual Reports and reports of Commission-funded research and studies are publicly available and can be requested from the Commission at 4340 East-West Highway, Bethesda, Maryland 20814, or accessed through the Commission's website: [MMC.gov](http://MMC.gov).

### **Start-up of the Commission**

President Nixon signed the MMPA into law in October 1972. The first three Commissioners were appointed early in 1973. They were Drs. Victor Scheffer (then retired from the Fish & Wildlife Service as the Director of what later became the National Marine Mammal Laboratory in Seattle, Washington), A. Starker Leopold (University of California at Berkeley), and John Ryther (Woods Hole Oceanographic Institution). Dr. Scheffer, who wrote the first essay in this Historical Perspectives feature, was named Chairman. Following their appointment, the Commissioners made a series of decisions that have proven to be of long-lasting importance. They selected John R. Twiss, Jr., to be the Executive Director of the Commission, established an office in Washington, DC, and found and appointed nine highly qualified marine mammal scientists to be the first members of the Committee of Scientific Advisors.

Before becoming the Commission's Executive Director, John Twiss worked for the National Science Foundation's Office of Antarctic Programs (now the Office of Polar Programs). When he interviewed me for the job as the Commission's Scientific Program Director in August 1975, John told me that he had been interested in and accepted the job as the Commission's Executive Director because of the importance that the MMPA placed on obtaining and basing research and management decisions on the advice of knowledgeable scientists (i.e., the establishment and legislative mandate of the Committee of Scientific Advisors). Until he retired in September 2000, John was responsible for the day-to-day operation of the Commission. He spent much of his time on the telephone making sure that the members of the MMC and CSA were "up-to-speed" on matters requiring their attention and that virtually all of the Commission's decisions regarding permit applications, research funding, recommendations to other agencies, etc., were based on consultation with the Committee. It is fair to say that John fostered the development of the Commission's reputation for providing objective, apolitical, science-based advice for meeting the intent and provisions of the MMPA.

The initial nine members of the CSA were George Bartholomew (University of California at Los Angeles), John Burns (Alaska Department of Fish & Game), Douglas Chapman (University of Washington), Jack Lentfer (U.S. Fish & Wildlife Service, Anchorage, Alaska), Kenneth Norris (University of California at Santa Cruz), G. Carleton Ray (Johns Hopkins University), William Schevill (Harvard University and Woods Hole Oceanographic Institution), Donald Siniff (University of Minnesota), and Jessie White (Miami Sea Aquarium). The selection of these individuals set an important precedent. Namely, they represented all geographic areas in the U.S. with associated marine mammals, and each had background and expertise in a topic area that the Commission anticipated it would be required to address. As examples, Dr. Bartholomew, Mr. Burns, and Dr. Siniff were recognized authorities, respectively, on west coast seals and sea lions, Arctic seals, and Antarctic seals; Drs. Chapman and Schevill were recognized authorities on whales, whaling, and the IWC; Dr. Norris was a recognized authority on small cetaceans and the tuna-dolphin problem; Mr. Lentfer was an authority on polar bears; Dr. Ray was an authority on walrus and the developing field of ecosystem management; Dr. White was a veterinarian with firsthand expertise in marine mammal health and husbandry; and Drs. Chapman and Siniff were knowledgeable biostatisticians. Subsequent



John R. Twiss, Jr., the Executive Director of the Marine Mammal Commission from 1974 to 2000

members of the Committee have been similarly selected to provide geographic diversity and expertise regarding the issues the Commission anticipates being required to address. Aware of the importance of marine mammals to many Alaska natives, since 1986, the Commission has asked knowledgeable representatives of the Alaska Native community to serve as Special Advisors on Native Affairs.

The need for a full-time support staff was apparent immediately. One of the first tasks of the Executive Director and the Commissioners was to determine what staff was needed and where they should be located. Initially, consideration was given to locating the staff in the Seattle area where Dr. Scheffer lived or to opening and staffing offices in both Seattle and in the Washington, DC area. It was agreed that two offices would require redundant staff and that, to be optimally effective, the staff would have to interact regularly with Congressional staff and the staffs of the various federal agencies with related responsibilities and interests, all with headquarters in the Washington, DC area. Thus, in February 1974, the Commission opened and staffed an office at 1625 Eye Street, NW, in Washington, DC. Before the Commission, that office had been occupied by the Committee to Reelect the President. The room that the Commission's General Counsel occupied was soundproofed, leading to speculation that it was where the Watergate "break-in" was planned that led to the resignation of President Nixon.

During the first two start-up years (1974 & 1975), the Commissioners, Committee, and staff met quarterly for three days in different geographic areas around the U.S. Essentially all of the Commission's business was done during

those meetings. Before the meetings, the staff would compile and send to the Commission and Committee members background information and documents requiring their consideration—for example, applications for research and public display permits that had been submitted to the NMFS and FWS and forwarded in the intervening periods for Commission review and comment, proposals that had been submitted to the Commission seeking funding for research or other activities, and reports from subcommittees and Committee members that had been tasked with providing background papers and recommendations on matters under consideration. During the first two days, the Committee, with the Commissioners and staff in attendance, would review, discuss, and prepare its recommendations to the Commission on research proposals, permit applications, and other science-related matters. On the third day, the Commissioners would meet with the senior staff to make decisions on follow-up actions. In the evenings, the staff would draft letters of recommendation, etc., for consideration by the Commissioners and Committee.

In recent years, the Commission and Committee have met only once each year and have used the meetings principally to obtain information and views on regional issues regarding marine mammal conservation problems and policies (*cf.*, the MMC's Annual Report to Congress for calendar year 2007). Most of the day-to-day consultations with the Committee and Commissioners regarding permit applications, etc., are handled by telephone and e-mail. Except for consideration of personnel and budget matters, the meetings of the Commission and Committee are open to the public.

Many of those who read this article may not be old enough to remember what life was like before the personal computer, e-mail, and the Internet. When I started working for the Commission in 1975, each of the senior staff had a full-time secretary who typed memos, letters of recommendation, policy papers, etc., on an electric typewriter. If an error was made or the staff member wanted a change, the document often had to be retyped from the beginning. There were no copying or fax machines. Draft letters, position papers, meeting agendas, and other materials sent to Commission and Committee members in advance of meetings were typed and mimeographed. It was not unusual to have weekly mailings of six or more inches of paper sent to each member. Between meetings, they responded in-kind or by telephone. Although the process was streamlined with the advent of photocopiers and fax machines, even more paper and time-investment were required as the Commission and Committee began to consider a broader range of issues affecting marine

mammals and marine ecosystems. Although the Commission's staff is not substantially larger now than it was in the 1970s and 1980s, there are fewer support staff. Each staff member now has a personal computer; communicates with the Commission and Committee members and others mostly by e-mail; and generates his or her own memos, draft letters, etc., using the latest word-processing software.

There similarly have been substantial advances in research techniques and technology that many of those who have become involved in marine mammal research in the last 10 to 20 years may take for granted. They include photo-identification, satellite-linked radio-tracking, passive acoustic tracking, and use of nuclear and mitochondrial DNA for species and sex identification and assessment of population discreteness and structure. In this regard, it is useful to keep in mind that technological developments sometimes are controversial, often require fine-tuning and validation, and allow lines of research that were not previously possible. As an example, in the late 1970s, many members of the scientific community, including several members of the CSA, questioned whether photo-identification of individual humpback whales was sufficiently reliable for mark-resighting studies to estimate population size. Consequently, in 1977, the MMC funded a study in which a series of humpback whale fluke photographs were sent to different investigators to assess accuracy and consistency in identifying photographs of individual whales. The results (Katona & Kraus, 1979) demonstrated that if the photographs were good enough, experienced researchers could repeatedly identify individual animals over many years. Since then, photo-identification has become a reliable tool for assessing the distributions, abundance, and other demographic patterns of several species of both large and small cetaceans.

### **The OSP Concept and the Ecosystem Approach to Marine Mammal Conservation**

As indicated earlier, the optimum sustainable population concept and the ecosystem approach to marine mammal conservation were two of the unique features of the MMPA. Section 2 (6) of the Act states that

Marine mammals have proven themselves to be resources of great international significance . . . and it is the sense of Congress that they should be protected and encouraged to develop to the greatest extent feasible commensurate with sound policies of resource management and that *the primary objective*

*of their management should be to maintain the health and stability of the marine ecosystem. Whenever consistent with this primary objective, it should be the goal to obtain an optimum sustainable population keeping in mind the optimum carrying capacity of the habitat* [emphasis added].

The term *optimum sustainable population* was defined as

the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the optimum carrying capacity of the habitat and the health of the ecosystem of which they form a constituent element.

When the Act was passed, there were differing, often conflicting, views regarding the meanings of the terms *maximum productivity*, *optimum carrying capacity*, and *health of the ecosystem*. Most fishery managers and many marine mammal biologists viewed the term *maximum productivity* to be analogous to the then generally accepted management goal of maximum sustainable yield (MSY). Consequently, they interpreted the terms *optimum carrying capacity* and *ecosystem health* to mean the habitat conditions necessary to maintain marine mammal populations at their MSY levels. On the other hand, environmental groups generally viewed the terms to mean the largest populations that can be supported by their historic habitat in pristine conditions.

I became aware of this situation in 1975 when I represented the Commission at an interagency meeting to develop U.S. positions regarding possible renegotiation of the North Pacific Fur Seal Convention. As noted earlier, the MMPA directed the Department of State to seek revision of international agreements, such as the North Pacific Fur Seal Convention, to incorporate the objectives of the Act. During the meeting, an NMFS biologist expressed the view that there was no need to seek any changes as the Convention was consistent with the intent and provisions of the MMPA. His statement suggested that he and I did not have a common understanding of the terms maximum productivity, optimum carrying capacity, etc. When I asked what he understood the terms to mean, he indicated that maximum productivity meant MSY, which was in fact the management goal of the Convention. Although the U.S. subsequently did propose changes to incorporate in the Convention some of the language in the MMPA, the proposed changes were not acceptable to the other signatories of the Convention—Canada, Japan, and the USSR.

In the U.S., an agreed definition of OSP was one of the products of the “tuna-dolphin” lawsuit and workshop described below.

*The Richey Decision and the La Jolla Workshop*

As required by the MMPA, the NMFS issued regulations in September 1974 to govern the taking of dolphins by U.S. vessels engaged in the tuna purse-seine fishery in the ETP. The NMFS then issued a permit to the American Tuna Boat Association authorizing the encircling and incidental mortality of an unspecified number of dolphins during the 1975 fishing season. Subsequently, several environmental groups filed a lawsuit in the Federal District Court of Washington, DC claiming that the regulations and permit violated the MMPA because the NMFS had not established a limit on the species and numbers of dolphins that could be encircled and killed, nor determined the size and status of the affected dolphin stocks relative to their OSP levels (for details, see MMC, 1974, 1975, 1976b; Gosliner, 1999).

On 11 May 1976, Judge Charles Richey issued his findings regarding the suit (*Committee for Humane Legislation et al. v. Richardson et al.* [C.A. No. 74-1465]). Among other things, he found that the NMFS had violated the intent and provisions of the MMPA by not providing estimates of the sizes and OSP levels of the affected stocks and by not establishing limits on the species and numbers of dolphins that could be killed. In partial response, the NMFS convened a workshop at its Southwest Fisheries Science Center in La Jolla, California, to review available information and provide assessments of the sizes and status of the affected dolphin stocks in the ETP.

The workshop participants, one of whom was the Chairman of the MMC’s Committee of Scientific Advisors, identified 11 species and 21 stocks of dolphins subject to encirclement and mortality in the fishery. They estimated the sizes of the stocks using the results of a pilot aerial survey carried out by the NMFS in 1974 (Smith, 1974). They estimated the sizes of the stocks before the beginning of the purse-seine fishery in the late 1950s by back-calculating from the current size estimates using estimates of the annual fishery-related mortality and of the maximum annual replacement rates. They developed and used the following interpretive definitions to make judgments concerning the status of the various dolphin stocks:

Optimum sustainable population is a population size which falls within a range from the population level of a given species or stock which is the largest supportable within the ecosystem to the population level that results in maximum net productivity.

Maximum net productivity is the greatest net annual increment in population numbers or biomass resulting from additions to the population due to reproduction and/or growth less losses due to natural mortality.

They concluded that the maximum net productivity levels (MNPLs) of the affected dolphin stocks likely were between 50 and 70% of their carrying capacity and that 60% of the estimated carrying capacity would be a prudent approximation when available information is insufficient to determine the MNPL (Southwest Fisheries Center, 1976).

The findings of the La Jolla Workshop had three long-lasting effects on implementation of the MMPA: (1) the interpretive definitions of OSP and MNPL were adopted by both the NMFS and the FWS for regulatory purposes (50 CFR 216.3); (2) 60% of estimated carrying capacity was adopted as the lower limit of the OSP range when available information is insufficient to make an actual determination of the MNPL; and (3) back-calculations using estimates of current population size, annual mortality, and replacement rates were accepted as a reasonable means for estimating pre-exploitation population sizes and carrying capacity for given species.

Since the survey data used to calculate stock sizes were insufficient to calculate meaningful confidence limits, the MMC subsequently provided funding for a review of marine mammal census methods (Chapman et al., 1977; Eberhardt et al., 1979).

*Ecosystem Considerations*

The La Jolla Workshop did not consider the ecosystem aspects of the tuna-dolphin problem. Therefore, in May 1976, the MMC held a workshop in Seattle, Washington, to consider ways to identify and characterize marine mammal responses to ecosystem variables. The results were described in an unpublished Commission report entitled *The Concept of Optimum Sustainable Populations* (MMC, 1976a). Among other things, the report pointed out that “[t]he term optimum sustainable population suggests an attempt [requirement] to ‘optimize’ the value of marine mammals in the ecosystem in some manner to give the ‘best’ return in terms of values considered important by man” (p. 4). It also pointed out that optimization requires establishing management priorities and assigning weights to selected variables. Twelve criteria were identified for use as empirical indicators of the ecological relationships between marine mammals and their environments, assuming that regulation of marine mammal populations is density dependent—that is, populations are regulated by intraspecific competition for food, space, and other resources in limited supply (p. 5).

The criteria were grouped into four categories as follows:

*Behavioral Responses*

1. Antagonistic displacement behavior or schooling behavior
2. Time spent searching for food or tending and feeding young
3. Shifts in dietary components observed in food habit studies

*Effects Evident in Individuals*

4. Physical condition, including growth rates
5. Incidence of disease and parasitism

*Reproductive Effects*

6. Age at first reproduction
7. Annual reproductive rates of mature females

*Population Aspects*

8. Age structure
9. Survival rates, particularly of young age classes
10. Occupancy of marginal range
11. Rate of change of population size
12. Changes in abundance of preferred foods or other indicators of habitat effects

The report was provided as a Working Paper to the International Consultations on Mammals in the Seas held in Bergen, Norway, in September 1976 under the sponsorship of the Food and Agriculture Organization of the United Nations (FAO, 1978). An expanded version was published later in the *Journal of the Fisheries Research Board of Canada* (Eberhardt & Siniff, 1977).

A number of investigators have used time spent feeding and changes in food items consumed to assess possible density-dependent effects on the sizes of sea otter and other marine mammal populations (*cf.*, Estes et al., 1982; Garshelis et al., 1986; Ralls & Siniff, 1990). Others have used observations of changes in movement and distribution patterns to make judgments concerning the nature and significance of impacts resulting from anthropogenic sound and other sources of disturbance (*cf.*, Jones & Swartz, 1986; Jones et al., 1994; Estes et al., 1996). However, there has not been a concerted effort to date to develop and use a broader suite of criteria to assess and monitor the status of marine mammal populations relative to their environments. Both the difficulty and potential value of doing so are reflected in the National Research Council's 2005 report titled *Marine Mammal Populations and Ocean Noise:*

*Determining When Noise Causes Biologically Significant Effects.*

*MSY: An Outdated Management Concept*

In 1974 and 1975, the President's Council on Environmental Quality, in cooperation with the World Wildlife Fund-U.S., the Ecological Society of America, the Smithsonian Institution, and the International Union for Conservation of Nature and Natural Resources, sponsored a series of workshops and consultations to examine the basis for conserving and managing the use of wild living resources. The resulting findings were reported in *Wildlife Monographs* in 1978 (Holt & Talbot, 1978). Among other things, the monograph indicates that the concept of *maximum sustainable yield* (MSY) is problematic in that it focuses assessments and management actions on single target species without regard to interactions with nontarget and associated species. The monograph states the following on pages 14-15:

The consequences of resource utilization and the implementation of principles of resource conservation are the responsibilities of the parties having jurisdiction over the resource or, in the absence of clear jurisdiction, with those having jurisdiction over the users of the resource. The privilege of utilizing a resource carries with it the obligation to adhere to the following four general principles:

1. The ecosystem should be maintained in a desirable state such that
  - a. consumptive and non-consumptive values could [can] be maximized [optimized] on a continuing basis,
  - b. present and future options are ensured, and
  - c. the risk of irreversible change or long-term adverse effects as a result of use is minimized.
2. Management decisions should include a safety factor to allow for the facts that knowledge is limited and institutions are imperfect.
3. Measures to conserve a wild living resource should be formulated and applied so as to avoid wasteful use of other resources.
4. Survey or monitoring, analysis, and assessment should precede planned use and accompany actual use of wild living resources. The results should be made publically available promptly for critical public review.

Several of the first and subsequent members of the MMC and its Committee of Scientific Advisors participated in the workshops. As illustrated in the next section, the referenced principles have guided the Commission's and Committee's efforts to foster implementation of the ecosystem approach.

*The Antarctic Marine Living Resources Convention*

In the 1960s, trawlers from Japan and the USSR began exploratory fishing for krill (*Euphasia superba*) in the Southern Ocean—the seas around Antarctica (Sahrhage, 1985). *E. superba* is a keystone species in the Southern Ocean, the primary food of fin, blue, humpback, and minke whales; crabeater and Antarctic fur seals; Adelie, chinstrap, macaroni, and rock hopper penguins; several species of flying birds; and several species of fish and squid. Some of these species are eaten in turn by sperm whales, killer whales, leopard seals, and other higher order predators. Consequently, if not properly regulated, the krill fishery could prevent or impede recovery of overexploited Antarctic whale stocks and alter the structure and dynamics of the Antarctic marine ecosystem (cf., Beddington & May, 1982; Bengtson, 1985a; Hofman, 1985).

Aware of the possible impacts of the fishery, the NSF's Office of Antarctic Programs funded a study in the early 1970s to compile and analyze available information on the biology, ecology, and harvesting of Antarctic krill. A draft of the subsequent study report (McWhinnie, 1978) was provided to the MMC for comment in 1975. In its response (see MMC, 1976a), the Commission noted that the biology and ecology of both krill and krill-dependent species were poorly known and that it therefore was not possible to assess the catch levels that might be sustained without adversely affecting either the target krill stocks or other species. The Commission advised that priority should be afforded to establishing an ecosystem-oriented research program and an ecosystem-oriented management regime while the fishery was still small.

Subsequently, the NSF provided funding to the National Academy of Sciences for an International Conference on the Living Resources of the Southern Ocean. The conference, held in August 1976 at the Academy's Summer Study Center in Woods Hole, Massachusetts, was attended by scientists from 14 countries who had an interest in the Antarctic. The conference reports (BIOMASS, 1977) summarized available information concerning the Southern Ocean Ecosystem and outlined a proposed international research program entitled Biological Investigations of Marine Antarctic Systems and Stocks or BIOMASS. The research proposal called on the Parties to the Antarctic Treaty to undertake the proposed research program cooperatively.

At the IXth Antarctic Treaty Consultative Meeting held in London in 1977, the participants recommended to their governments that a definitive regime for the conservation of Antarctic marine living resources should be concluded before the end of 1978 and that a Special Consultative Meeting should be convened for that purpose (Recommendation IX-2). Australia offered to host the Special Consultative Meeting, the first session of which was held in Canberra from 27 February to 16 March 1978. Prior to that negotiating session, several of the Antarctic Treaty Parties circulated draft fisheries regimes for consideration. Each had as its central tenant the goal of maximum sustainable yield (MSY). During interagency meetings convened by the Department of State to prepare for the negotiations, John Twiss, the MMC representative, called attention to the problem with the MSY concept. He advocated an ecosystem approach (as recommended in Holt & Talbot, 1978) and the incorporation of the MMPA's OSP concept. Although the NMFS representative thought that such a proposal would be "non-negotiable," the State Department representative, who was to head the U.S. delegation to the Canberra negotiating session, indicated that he would be willing to table an alternative, ecosystem-oriented regime if the Commission would draft it. The Commission, in consultation with the Committee, then prepared a draft conservation regime incorporating the ecosystem approach and OSP concept. The draft was tabled for consideration at the Canberra negotiating session.

At the beginning of the Canberra negotiations, Dr. Richard Laws, who at the time was the Director of the British Antarctic Survey, made a slide presentation describing and illustrating the relationships among the components of the Antarctic marine ecosystem, emphasizing the keystone role of *E. superba*. The presentation made clear the need for an ecosystem approach to fishery management in the Antarctic. It led to two agreements in principle: (1) the conservation regime should incorporate the ecosystem and OSP concepts set forth in the draft regime tabled by the U.S. and (2) the regime should apply north of the Antarctic Treaty Area to the Antarctic Convergence, the northern boundary of the Antarctic marine ecosystem. Both concepts were incorporated in the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), which was adopted by the Treaty Parties at a diplomatic conference in May 1980 and entered into force in April 1982. In particular, Articles I and II of the Convention read as follows:

*Article I [Scope and Definitions]*

1. This Convention applies to the Antarctic marine living resources of the area south

of 60 degrees South latitude and to the Antarctic marine living resources of the area between that latitude and the Antarctic Convergence which form part of the Antarctic marine ecosystem.

2. Antarctic marine living resources means the populations of finfish, mollusks, crustaceans [e.g., krill] and all other species of living resources, including birds, found south of the Antarctic Convergence.
3. The Antarctic marine ecosystem means the complex of relationships of Antarctic marine living resources with each other and with their physical environment.

#### *Article II [Objectives]*

1. The objective of this Convention is the conservation of Antarctic marine living resources.
2. For the purposes of this Convention, the term "conservation" includes rational use [i.e., commercial fisheries].
3. Any harvesting and associated activities in the area to which this Convention applies shall be conducted in accordance with the provisions of this Convention and with the following principles of conservation:
  - a. prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment. For this purpose its size should not be allowed to fall below a level close to that which ensures the greatest net annual increment;
  - b. maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to the levels defined in sub-paragraph (a) above; and
  - c. prevention of changes or minimization of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades [approximately a human generation], taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources.

Similar principles have since been incorporated in other international agreements, including the FAO's 1995 Code of Conduct for Responsible Fisheries and the United Nation's 1995 Agreement on Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. The critical importance of, and need for, further ecosystem-based fishery management is pointed out in a paper published in the Policy Forum of the 16 July 2004 issue of the AAAS journal, *Science* (Pikitch et al., 2004).

On a related matter, in 1979, the MMC sought cooperative funding from NOAA and the NSF for a National Academy of Sciences study to identify ecosystem research that the U.S. should be supporting to facilitate implementation of the BIOMASS program and the Living Resources Convention. Both the NOAA and NSF contributed funding. In spring 1980, a joint committee of the Academy's Polar Research Board and Ocean Sciences Board was established to carry out the study. The Committee's report (NRC, 1981) noted the range of U.S. interests in the Antarctic and recommended research that should be targeted to best meet those interests. The study results were used in the formulation of the U.S. CCAMLR implementing legislation—the Antarctic Marine Living Resources Convention Act of 1984—and in the subsequent development of the NMFS's Antarctic Marine Living Resources (AMLR) Research Program. Also, the MMC funded several studies, the products of which were submitted to the CCAMLR's Commission and Scientific Committee to facilitate implementation of the ecosystem approach to conservation in the Convention Area (Green-Hammond et al., 1983; Bengtson, 1985a, 1985b).

Additional information regarding negotiation of CCAMLR and its implementation is provided in the MMC's Annual Reports to Congress for calendar years 1978 through 1999.

#### **Marine Mammal-Fishery Interactions and Conflicts**

Virtually all marine mammal species interact in some way with commercial fisheries. Many are caught and killed or injured incidentally in a variety of gillnet, trawl, and hook-and-line fisheries; some take or damage bait and fish caught on lines, in traps, and in nets; some damage or destroy fishing gear when caught accidentally or when they are entangled attempting to scavenge bait or caught fish; some compete with both commercial and recreational fishermen for the same food species; and some benefit fishermen by helping them to find and catch associated fish as in the ETP tuna purse-seine fishery.



Purse seine being closed prior to harvesting the tuna; the small boat is used to make noise and keep the tuna within the net prior to closing. (Courtesy of NOAA/Department of Commerce)

### *The Tuna-Dolphin Conflict*

In 1972, the year the MMPA entered into law, an estimated 423,678 dolphins were killed in the ETP tuna purse-seine fishery—368,600 by U.S. purse seiners and 55,078 by purse seiners from other countries. Since then, this issue has fostered more research, public concern, lawsuits, regulations, Congressional attention, and MMPA amendments than almost all other marine mammal issues combined. The MMC's Annual Reports to Congress describe the related actions and reactions as well as the Commission's efforts to find a practical solution to the problem.

Gosliner (1999) described the fishery and provides a comprehensive review of the evolution of research, regulations, litigation, and industry and Congressional actions through 1999. Among other things, he flagged two related and particularly important points:

1. During a 1971 Congressional hearing seeking views on a variety of marine mammal-related issues, a U.S. tuna boat captain asserted that most of the dolphin mortality could be avoided by application of two recent dolphin-saving innovations—backing-down the fishing vessel to pull the apex of the pursued net underwater and thus provide an escape route for the encircled dolphins, and insertion of a small mesh panel at the top of the net in the release area to prevent dolphins from being entangled in the net during “back down.”
2. Although it took two decades, the assertion eventually proved accurate when in 1992 the members of the Inter American Tropical Tuna Commission (IATTC) agreed to an International Dolphin Conservation Program (IDCP) that, among other things, (1) required placement of independent observers on all their nation's tuna purse seiners fishing in the ETP capable of encircling dolphin schools, and (2) instituted

individual boat quotas authorizing the killing of no more than 5,000 dolphins annually.

These two actions effectively ensured that the small mesh “dolphin safety panels” were inserted in all nets used in the ETP tuna purse-seine fishery and that, to avoid exceeding their individual boat quotas, vessel captains will continue back-down until all encircled dolphins are released. Further, they provide hard evidence that 100% observer coverage on boats, combined with individual boat quotas rather than fleet or country quotas, provide effective means for ensuring compliance with fishery regulations.

Although the required 100% observer program and individual boat quotas led to a dramatic reduction in dolphin mortality, there is uncertainty whether all mortality is being observed and reported, and whether separation of mothers and calves and stress caused by multiple chases and captures may be cryptic sources of mortality sufficient to prevent or delay recovery of the affected dolphin stocks. Due to this uncertainty, the U.S. implementing legislation for the IDCP—the 1997 International Dolphin Conservation Program Act—directed the NMFS, in consultation with the MMC and the IATTC, to conduct a series of abundance surveys and stress studies to determine whether repeated chases and captures are having a significant adverse impact on any depleted dolphin stock in the ETP. The legislation specified that abundance surveys were to be conducted in 1998, 1999, and 2000, and that the stress studies were to include (1) a review of relevant stress-related research; (2) collection of, and assessment of possible stress-related indicators in, biological samples from dolphins killed in the fishery in 1998, 1999, and 2000; (3) a review of available demographic and biological data concerning the status of the affected ETP dolphin stocks; and (4) an experiment involving the repeated chase and encirclement of representative dolphin schools. Although not conclusive, the resulting studies suggest that (1) at least two of the ETP dolphin stocks have not increased as expected in response to the dramatic decline in fishery-related mortality, and (2) the apparent lack of recovery could be due to separation of mothers and calves and stress-related mortality and morbidity caused by repeated chases and captures (*cf.*, Curry, 1999; Archer et al., 2001, 2004; Forney et al., 2002; Romano et al., 2002; Reilly et al., 2005; Gerrodette & Forcada, 2005; MMC, 2005, 2006; Edwards, 2006, 2007).

Both the Congressional directive and the subsequent studies conducted and funded by the NMFS are particularly significant in that they represent the first legislative recognition of, and directed effort



John R. Twiss, Jr., the former Executive Director of the Marine Mammal Commission

to assess, the physical, physiological, and psychological effects of stress on marine mammals.

#### *Other Marine Mammal-Fishery Interactions*

In the late 1970s, the MMC initiated a series of workshops and provided “seed money” for studies to identify and assess the biological-ecological and socioeconomic significance of marine mammal-fishery interactions in different regions of the U.S. In December 1977, for example, the Commission sponsored a workshop to determine what was known about the nature and significance of marine mammal-fisheries interactions in Alaska, British Columbia, Washington, Oregon, California, and Hawaii. Among other things, the workshop report (Mate, 1980) indicated that the most acute conflicts in these areas were those associated with the interactions between seals, sea lions, and the salmon gillnet fisheries in the Copper River Delta of Alaska and in the Columbia River and adjacent areas of Washington and Oregon. The report concluded that identification of the biological and socioeconomic significance and possible means for resolving the conflicts were being hampered by (1) the absence of a comprehensive, goal-oriented research program; (2) funding limitations; (3) the apparent failure of many fishermen to obtain incidental take permits and to report interactions with marine mammals as required by the MMPA; and (4) the failure of the NMFS to develop and implement an effective permit system and research program.

Following the workshop, the Commission, in consultation with the NMFS, funded studies to better document the biological and socioeconomic significance of the interactions in the Copper River Delta (*cf.*, Matkin & Fay, 1980), and in the Columbia River and adjacent areas (*cf.*, MMC, 1980; Everett & Beach, 1982; Brown & Mate, 1983; Beach et al., 1985; Jeffries, 1986). In addition, the Commission funded a study to identify ongoing and planned fisheries that could

interact with marine mammals in the northwestern Hawaiian Islands (Foster, 1981). Subsequently, the Commission funded workshops to (1) identify research needs regarding East and Gulf Coast marine mammals (Prescott et al., 1980), (2) review and determine how to coordinate and improve ongoing research programs regarding marine mammal-fishery interactions throughout the U.S. (Contos, 1982), and (3) assess measures necessary to address marine mammal-fishery interactions in California (Montgomery, 1986).

#### *The Bering Sea Initiative*

In addition to establishing a 200 nmi Fishery Conservation Zone (FCZ), the U.S. Fishery Conservation and Management Act of 1976 (FCMA) established national standards for the development and regulation of fisheries in the FCZ, and created eight fishery management councils to draft and oversee implementation of regional fishery management plans.

In September 1978, the MMC funded a study to determine whether possible impacts on marine mammals were being factored into the draft fishery management plans being developed by the regional councils. The contractor’s report (Green-Hammond, 1980) concluded that the plans being developed failed to consider possible impacts on either marine mammals or other nontarget ecosystem components. It recommended that the Commission take steps to encourage development of more ecosystem-oriented management plans.

Late in 1978, the Commission received for comment both the contractor’s preliminary report and a draft *Fishery Management Plan and Environmental Impact Statement for the Groundfish Fishery in the Bering Sea / Aleutians Islands Area* prepared by the North Pacific Fishery Management Council. In its comments on the draft FMP, sent to the Council on 18 January 1979, the Commission noted that the draft failed to identify or take into account uncertainties concerning the possible effects of the fishery on marine mammals or other nontarget ecosystem components. It recommended that available data and theory concerning possible interactions with marine mammals and other nontarget species be assessed and that the proposed groundfish catch levels be adjusted as necessary to reflect any uncertainties concerning possible impacts on other ecosystem components and processes.

The Executive Director of the Council acknowledged that the draft plan did not provide a meaningful assessment of possible ecosystem effects. Following discussions with the MMC’s Executive Director, the two agreed that a steering group, comprised of representatives of the Commission, the Council, and the NMFS, would be established to develop a plan for approaching the problem.

At a meeting in August 1979, the steering group concluded that

- the ultimate goal is to develop standard models and procedures for assessing the interrelationships among target and nontarget fish populations, marine mammals, birds, and other possibly interacting ecosystem components;
- effort should be focused initially on the Bering Sea ecosystem, keeping in mind that models and procedures applicable there would be applicable at least conceptually in other ocean areas;
- a request for proposals should be developed and published seeking available information on the species composition, status, food habits, and food requirements of marine mammals and birds occurring in the Bering Sea; and
- a workshop should be held to assess the adequacy of the existing data, models, and procedures for predicting the effects of fisheries on nontarget species, with particular emphasis on the Bering Sea.

The NMFS offered to organize and host the recommended "modeling" workshop. To assist compilation of background information, the MMC funded a study of the interactions between fur seals and fisheries in the Bering Sea (Swartzman & Harr, 1980, 1983). The workshop was held at the NMFS' Northwest and Alaska Fisheries Center in Seattle on 29 April-1 May 1980. Participants included representatives of the Alaska Department of Fish & Game, the U.S. Fish & Wildlife Service, and the academic community as well as representatives of the NMFS, the North Pacific Fishery Management Council, and the Commission. The objectives were to (1) review the related management provisions of the FCMA, the MMPA, and other relevant legislation; (2) assess the availability of and means for applying ecosystem simulation models to fishery management; and (3) identify steps that could be taken to improve existing models or otherwise facilitate the development of fishery management plans that take into account the dynamics and interactions among the target fish stocks and nontarget species of marine mammals, birds, etc.

Following consideration of existing data and models, including a model that had been developed and used by an NWAFRC staff member to assess how marine mammal predation could be affecting commercial fish stocks in the Bering Sea, the workshop participants concluded that

- both population and ecosystem simulation models can and should be used to assist in the development and evaluation of fishery management plans;

- models can and should be used to help identify critical gaps in knowledge concerning interactions among target and nontarget species;
- no single model is likely to be applicable to all areas and problems;
- no existing model is fully adequate for assessing the implication of alternative management actions;
- models used to help develop and evaluate fishery management plans should be constructed for explicitly stated objectives, and research and monitoring programs should be designed and implemented as part of fishery management plans to validate the models; and
- persons knowledgeable about the biology and ecology of nontarget as well as target species should be included in the teams constituted to draft fishery management plans.

Although a workshop report titled *Ecosystem Simulation Models and Their Application to Fishery Management* was drafted and sent by the convener to the participants for comment, it was never finalized or made publicly available. When I asked when the report was expected to be finalized and published, the convener indicated that, while he concurred with the workshop findings, he believed that available data and computer technology were inadequate to develop and run the kinds of computer models conceptualized by the workshop participants and would remain so for the foreseeable future. Consequently, he never finalized or made the report publicly available. However, by the late 1980s, computer technology had developed to the point that the kinds of calculations envisioned could be done effectively and at reasonable cost. Thus, the principal problem was and remains the paucity of reliable information on the distributions, abundance, life histories, and interactions among the target and nontarget species.

#### *The Follow-up Bering Sea Workshop*

During the previously noted discussions between the Executive Directors of the Commission and the North Pacific Management Council, it was agreed that the Council would contract an appropriately qualified individual or organization to compile and evaluate information on the presence, status, feeding habits, and food requirements of marine mammals in the Bering Sea, and that the Commission would transfer funds to the Council to help pay the contract costs. In July 1981, following consultation with the MMC and NMFS, the Council contracted the Alaska Department of Fish & Game to do the compilation and evaluation. Among other things, the contract report (Lowry et al., 1982) recommended that a workshop be held to address

a number of issues raised in the report (see also Lowry & Frost, 1985). It subsequently was agreed that the Council would assume responsibility for organizing the recommended workshop and that its principal objective would be to determine and formulate a plan for obtaining the array of information needed by the responsible agencies to effectively manage fisheries and conserve marine mammal populations in the eastern Bering Sea. Again, the MMC provided funds to the Council to help pay for the workshop.

The Alaska Sea Grant Program was contracted to organize and report the results of the workshop. The workshop was held in Anchorage on 18-21 October 1983. Participants included scientists with relevant expertise and representatives of the MMC, the NMFS, the Council, Alaska state agencies, and fishery and environmental groups with related interests and responsibilities. Background papers were solicited and presented to help focus discussions on the existing database and research programs concerning fisheries in the Bering Sea; the relevance of oceanographic studies to marine mammal conservation and fishery management in the area; and potential models for assessing the indirect ecosystem effects of fisheries. Working groups were established to consider and identify research needs regarding interactions between marine mammals and the four principal fisheries in the eastern Bering Sea: (1) groundfish, (2) herring, (3) salmon, and (4) shellfish. The findings set forth in the workshop report (Melteff & Rosenberg, 1984) have been used by the Council, the NMFS, the MMC, and others to improve formulation and assessment of the possible environmental impacts of fishery management plans developed in accordance with the FCMA.

#### **Regulation of Marine Mammal-Fishery Interactions: The Kokechik Decision and the 1988 and 1994 MMPA Amendments**

Establishment of 200-nmi Fishery Conservation Zones as provided for in the 1982 Law of the Sea Convention, combined with the development of lightweight, durable, and inexpensive synthetic fishing nets and the depletion of fishery resources in many traditional fishing grounds, led in the mid-1970s to the development of large-scale pelagic, driftnet fisheries. Three of the fisheries targeting salmon, squid, and tuna occurred in and near the U.S. FCZ in the Northeast Pacific and Bering Sea. Together, these three fisheries involved approximately 1,000 vessels from Japan, Taiwan, and South Korea. Each vessel set from 15 km (the salmon fishery) to more than 50 km (the squid fishery) of net each day of the fishing season. The nets were 8 to 9 m deep with a cork-line at the surface and a

lead-line at the bottom to hold them vertically in the water. At their maximums, the squid driftnet fleets were estimated to set as much as 32,000 km of net daily during the May to December fishing season. Although large numbers of marine mammals, seabirds, and other nontarget species were being caught and killed in these fisheries, the fishing nations made no effort to document the incidental take or to assess its impacts on the affected species, populations, or ecosystems (*cf.*, Northridge, 1991, 1995; Northridge & Hofman, 1999).

When the U.S. Fishery Conservation and Management Act was enacted in 1976, the provisions of the MMPA became applicable to foreign fisheries throughout the 200-nmi FCZ it established. In 1977, the NMFS received applications for incidental taking authorizations from representatives of several foreign fisheries operating in the U.S. FCZ. One was from the Federation of Japan Salmon Fisheries Cooperative Association (the Federation) seeking authorization for its members to take Dall's porpoises incidental to their driftnet fishing in those parts of the North Pacific and Bering Sea within the U.S. FCZ. The information submitted with the application was insufficient to conclude that the taking would not "disadvantage" the affected porpoise population(s). As noted in the MMC's Annual Report to Congress for calendar year 1978, the Department of State subsequently negotiated a Protocol to the International Convention for the High Seas Fisheries of the North Pacific, which, among other things, exempted Japan's salmon driftnet fleet from the MMPA's incidental take permit requirement until 9 June 1981, subject to the development of a cooperative research program to resolve uncertainties concerning the numbers of Dall's porpoises and other marine mammals being killed in the fishery, and the sizes and discreteness of the affected populations. The Protocol and an associated Memorandum of Understanding concerning the research program were signed in Tokyo on 25 April 1978.

Based on the results of the cooperative research program, the NMFS issued a permit on 15 May 1981 authorizing the taking of up to 5,500 Dall's porpoises, 450 northern fur seals, and 25 Steller sea lions each year through the 1983 fishing season. There remained substantial uncertainties concerning the impacts of the incidental take, and the efforts to develop fishing gear and techniques to minimize the take were still underway. Consequently, in the Fisheries Amendments of 1982, Congress mandated continued efforts to reduce the marine mammal mortality to insignificant levels and extended the permit issued to the Federation until June 1987. In July 1986, the Federation submitted an application for a

five-year permit to take up to 5,500 Dall's porpoises, 450 northern fur seals, and 25 Steller sea lions annually following the expiration of the legislatively extended permit in June 1987. After much deliberation, the NMFS issued a three-year permit on 22 May 1987 authorizing the taking of a total of 789 Dall's porpoises from the Bering Sea stock and 5,250 from the North Pacific stock. The request to take fur seals and sea lions was denied on the grounds that the Federation had failed to provide adequate evidence that the affected stocks were at or above their maximum net productivity levels—that is, were within their OSP range—and would not be “disadvantaged” by the projected level of take (see the MMC's Annual Reports for 1978 through 1987 for details).

After the permit was issued, the Federation, the Kokechik Fishermen's Association representing Alaskan subsistence fishermen, and the Center for Environmental Education (now the Ocean Conservancy), representing several environmental organizations, all filed related lawsuits in the Federal Court for the District of Columbia. The Federation argued that the quota levels and the denial of the request to take fur seals were not justified and that it was unlawful to require the placement of observers on vessels fishing outside the U.S. FCZ. The Kokechik Fishermen's Association and the Center for Environmental Education argued, in part, that the permit violated the MMPA because it applied to Dall's porpoises only when it was certain that fur seals and other marine mammals also would be caught and killed.

On 15 June 1987, the Court ruled in favor of the Fishermen's Association and the Center (*Federation of Japan Salmon Fisheries Cooperative Association v. Baldrige*). Although both the Federation and the Department of Commerce appealed the ruling, the Federal Court of Appeals upheld the ruling (*Kokechik Fishermen's Association v. Secretary of Commerce*, 839 F. 2d 795, D.C. Cir. 1988). In its ruling, the Appeals Court stated that the Secretary does not have authority, when issuing a permit authorizing the incidental taking of one marine mammal species, to disregard the taking of other species, even if the impact on the other species would be negligible. The ruling raised questions as to whether the NMFS would be able to renew incidental take permits issued to U.S. fishermen if (1) the permits did not apply to all marine mammals that might be caught and killed, and (2) the available data were insufficient to determine that all of the potentially affected stocks were within their OSP range and would not be “disadvantaged” by the incidental taking.

The environmental community, fishing industry, NMFS, MMC, state fishery regulatory agencies,

and Congress all recognized that a total prohibition on the taking of marine mammals incidental to commercial fisheries would have severe economic consequences. In response, Congress amended the MMPA in 1988 to provide a five-year exemption to the Act's permit and “small-take” requirements for U.S. and certain foreign fisheries, other than the ETP tuna purse-seine fishery addressed by other provisions of the Act. The intent was to provide time to (1) compile the data necessary to document the types, levels, and biological-ecological and socioeconomic consequences of marine mammal-fishery interactions in the U.S. FCZ, and (2) formulate a regime to govern future interactions that both avoid significant adverse effects on marine mammals and minimize impacts on commercial fisheries. The amendments directed that the MMC develop and provide to the NMFS recommended guidelines to govern the taking of marine mammals incidental to commercial fisheries in U.S. waters after 1 October 1993 when the interim five-year exemption was to expire. They specified that the guidelines should

- A. be designed to provide a scientific rationale for determining how many marine mammals may be taken incidentally under a new regime to be adopted to govern such taking after October 1, 1993;
- B. be based on sound principles of wildlife management, and be consistent with and in furtherance of the purposes and policies set forth in the Act; and
- C. to the maximum extent practicable, include as factors to be considered and utilized in determining permissible levels of such taking
  1. the status and trends of the affected marine mammal population stocks;
  2. the abundance and annual recruitment of such stocks;
  3. the level of confidence in the knowledge of the affected stocks; and
  4. the extent to which the incidental taking will likely cause or contribute to their decline or prevent their recovery to optimum sustainable population levels.

The Commission's recommended guidelines, developed in consultation with the CSA and others with relevant expertise, were sent to the NMFS on 12 July 1990 (MMC, 1990). Among other things, the Commission recommended that the new regime (1) reinstate the substantive requirements of the general permit and small-take provisions of the MMPA for populations known or reasonably thought to be within their optimum sustainable levels, and (2) allow the incidental

taking of marine mammals listed as endangered or threatened under the ESA or depleted under the MMPA, when

- a. a recovery plan or conservation plan, including an implementation plan, has been developed, adopted, and implemented;
- b. the authorized level of take, by itself and in combination with other sources of mortality, is not likely to cause or contribute to a further population decline or cause more than a 10% increase in the estimated time it will take for the affected species or population to recover to its maximum net productivity level;
- c. ongoing and planned monitoring and enforcement programs are adequate to ensure that the authorized take levels are not exceeded and to detect any unforeseen effects on the size or productivity of the affected species or population; and
- d. there is reason to believe that the incidental take has been or will be reduced to as near zero as practical.

The NMFS subsequently developed and in December 1992 transmitted to Congress its *Proposed Regime to Govern Interactions between Marine Mammals and Commercial Fishing Operations*. The proposal included an innovative approach to determining catch levels that can be sustained without causing the affected species or stocks to be reduced or maintained below their MNPL—the lower limit of the OSP range. The approach took account of, and was fully consistent with, the guidelines provided by the MMC. It assumed that regulation of marine mammal populations is density-dependent and that the number of animals that can be removed without “disadvantaging” the affected species or stock—the potential biological removal level or PBR—can be calculated using a minimum population estimate and an estimate of the species’ or stock’s intrinsic or maximum rate of growth.

Although other aspects of the NMFS’s proposal generated substantial controversy and were not accepted (see MMC, 1994, 1995), the PBR concept was accepted and incorporated in the new regime to govern marine mammal-fishery interactions set forth in the 1994 MMPA amendments. That is, the 1994 amendments directed the Secretary of Commerce [NMFS] to prepare status reports for all marine mammal stocks in U.S. waters and specified that the assessments are to include (1) descriptions of the geographic ranges of the stocks; (2) minimum abundance estimates and estimates of the current trend and the current

and maximum net productivity levels of each stock as well as a description of the data used to make those determinations; (3) estimates of the annual human-caused mortality and serious injury by source and, for stocks that are endangered, threatened, depleted, or declining, identification of other factors that may be causing the decline or impeding recovery; (4) descriptions of the fisheries that interact with the stocks, including the number of vessels in each fishery, and fishery-specific estimates of the associated marine mammal mortality and serious injury, and an assessment of whether the incidental take levels are approaching a zero rate; (5) an estimate of the stock’s PBR level; and (6) an assessment of the likelihood that the level of human-caused mortality and injury is exceeding the estimated PBR level and causing the stock to be reduced or maintained below its MNPL. The amendments also directed the NMFS to establish regional scientific review groups to assist in determining information needs and the reliability of the “status-of-stocks” determinations.

Like some of the previously noted MMPA definitions of terms, some of the terms in the amendment’s definition of PBR were not commonly understood. As an example, the term *minimum population estimate* could be interpreted to mean the smallest number of individuals counted in a population survey, or the average of the minimum counts from a series of surveys. The NMFS, therefore, has held a series of workshops to develop standard criteria for making PBR determinations (*cf.*, Wade, 1994; Barlow et al., 1995; Wade & Angliss, 1997). Also, both the NMFS and FWS have developed and periodically updated status reports for marine mammal stocks in U.S. waters under their jurisdictions (*cf.*, Waring et al., 2008, and the NMFS’s Office of Protected Resources website: [nmfs.noaa.gov/pr](http://nmfs.noaa.gov/pr)). Although the PBR concept fails to explicitly account for possible indirect ecosystem effects, it requires minimal data and avoids the pitfalls of the “back-calculation” method developed and used in the 1976 La Jolla Workshop.

#### *Other MMC Fishery-Related Initiatives*

The by-catch in commercial fisheries of marine mammals, sea turtles, seabirds, and nontarget fish species can have serious economic as well as biological and ecological effects. Well aware of this, the MMC contributed funding in 1993 for a FAO global assessment of fisheries’ by-catch and discards. The report of that study (Alverson et al., 1994) estimated that between 17.9 and 39.5 million metric tons (mt) of fish and other marine living resources were being caught and discarded each year in commercial fisheries worldwide. Total landings of marine living resources at the time were approximately 90 million mt. Thus,



The sea otter population was harmed by the Exxon Valdez oil spill. (Photo provided by J. A. Thomas)

approximately 30% of the total catches were being discarded. That study effectively initiated worldwide efforts to develop fishing gear and practices that minimize the by-catch of nontarget species.

Cognizant of the need to find cost-effective solutions to the by-catch problem, the Commission funded a follow-up study in 1994 to identify deficiencies in existing international fishery agreements and measures that could be taken to overcome them. The report of that study (Weber & Spivy-Weber, 1995) evaluated 15 existing and pending international marine conservation regimes and recommended the following seven basic principles for more effectively conserving both target and nontarget species:

1. *Maintain an Ecosystem Perspective:* The exploitation of marine living resources should be structured to ensure that it does not reduce target, dependent, or associated species below the lower limit of their natural equilibrium range or alter the basic structure and resilience of the ecosystems of which they are a part.
2. *Consider All Variables:* Management measures should consider and, as appropriate, factor in ecological, economic, social, demographic, and behavioral consequences of fishery development and regulation.
3. *Obtain Independent Scientific Advice:* Fishery management regimes should provide means for obtaining independent, peer-reviewed scientific advice that includes majority and minority views and clear statements of uncertainty and the possible consequences of authorizing different forms and levels of exploitation without resolving the uncertainties.
4. *Management Should Be Responsive [Adaptive]:* The exploitation of living

marine resources should be structured to ensure that monitoring and reporting are sufficient to develop the information base necessary to meet the management objectives and to change in response to unanticipated consequences.

5. *Management Should Be Anticipatory:* The needs of managers for information and control of exploitation rates should take precedence over expansion of fisheries or economic development.
6. *Management Should Be Conservative [Precautionary]:* When faced with uncertainty, managers should favor the long-term over the short-term and place the burden of proof on proponents for increasing resource exploitation or for delaying institution of measures to rebuild depleted stocks.
7. *Management Should Be Accountable [Transparent]:* Fishery management/conservation regimes should include means for analyzing the effectiveness of management measures, for ensuring the accountability of both managers and fishermen, and for addressing any failures to meet responsibilities.

Also in 1994, the MMC funded a study (Talbot, 1996) to identify changes that had occurred in approaches to marine resource conservation since publication of the Holt & Talbot monograph in 1978, and an international workshop to review and update guiding principles for marine resource conservation (Mangle et al., 1996). Although the need for precautionary and adaptive ecosystem-oriented marine resource management is well-documented, efforts to date to develop sustainable fisheries and maintain stable and healthy marine ecosystems have been marginal at best. The basic problem is that fisheries are developed faster than the information base necessary to determine, *a priori*, the catch levels that can be sustained without adversely affecting either the target or dependent and associated species.

#### **Marine Mammal Species and Populations of Special Concern**

One of the Congressionally mandated functions of the MMC is to identify and undertake, or cause to be undertaken, research and other measures necessary to meet the intent and provisions of the MMPA. As one of its first actions, the Commission, in consultation with the CSA, initiated a continuing review to identify marine mammal species and populations being adversely affected by human activities, and to determine

and promote measures necessary to eliminate or mitigate the threats. As indicated in the MMC's Annual Reports to Congress, species and populations identified as meriting and therefore receiving such special attention have included the Western Arctic population of bowhead whales; the Eastern Pacific population of gray whales; the Western North Atlantic and Eastern North Pacific populations of right whales; the Cook Inlet population of beluga whales; the Prince William Sound and Puget Sound populations of killer whales; the Gulf of Maine population of harbor porpoises; the Gulf of California harbor porpoises or vaquitas; the U.S. East and Gulf Coast populations of bottlenose dolphins; Steller sea lions; Alaska, Columbia River, and Gulf of Maine populations of harbor seals; Hawaiian monk seals; polar bears; Alaska and California populations of sea otters; and the Florida manatee.

For species and populations listed as endangered or threatened under the Endangered Species Act, the MMC, with the advice of the CSA, seeks to promote development and periodic updating of recovery plans and related implementation plans. Toward these ends, the Commission encourages the responsible regulatory agencies—the NMFS or FWS—to appoint recovery teams composed of appropriately qualified individuals, to assess the human-associated threats to the particular species or population and identify the actions needed to reliably document and eliminate or mitigate sources of injury, mortality, or habitat loss/degradation preventing or impeding recovery to its OSP level. Once the basic threats and recovery needs are set forth in a recovery plan, the Commission encourages the responsible regulatory agency to appoint an implementation team,

composed of knowledgeable scientists and representatives of environmental organizations, industry groups, and state and federal agencies with related interests and responsibilities, to develop and implement an action plan to meet the recovery objectives. For species and populations not listed as endangered or threatened but potentially subject to significant levels of human-caused mortality or habitat loss, the Commission encourages and often initiates development of conservation plans to avoid jeopardizing or adversely affecting habitat essential to their welfare (*cf.*, Lentfer, 1988, 1990). To illustrate the approach, I provide a brief summary of the Commission's actions to promote development, implementation, and regular updating of a recovery plan for the Florida manatee.

In the continental U.S., manatees occur principally in the coastal waterways of the State of Florida. Before the MMPA was enacted, local municipalities and the state were responsible for regulating activities that affected the animals and their habitats. As noted earlier, the MMPA made the Secretary of the Interior responsible for the conservation of manatees, polar bears, walrus, and sea otters, a responsibility that was delegated to the U.S. Fish & Wildlife Service. Recognizing that protection and recovery of the endangered Florida manatee population(s) would require cooperative efforts by the FWS and the State of Florida, the MMC recommended in 1976 that the FWS seek additional funding for its manatee research program and convene a workshop to better determine and describe research and management needs. Although delayed, the recommended workshop, cosponsored by the FWS, the Florida Audubon Society, the Florida Department



The members of the MMC, its Committee of Scientific Advisors, and some of the Commission staff taken at the 1985 annual meeting in San Diego. *Front Row (l to r):* Dr. Robert Brownell (CSA), Dr. Jane Packard (CSA), Dr. David Ainley (CSA), Dr. William Medway (CSA), Dr. Douglas Chapman (CSA Chair), David Laist (MMC staff). *Back Row (l to r):* Donald Baur (MMC General Counsel), Robert Hofman (MMC staff), John Twiss (MMC Executive Director), Dr. Robert Elsner (Commissioner), Dr. William Evans (Commission Chair), Ms. Karen Pryor (Commissioner), Mr. Forest Wood (CSA), and Dr. William Fox (CSA).

of Natural Resources, and Sea World of Florida, was held in Orlando on 27-29 March 1978.

The workshop participants noted that significant numbers of manatees were being killed and injured by collisions with boats and barges, entrapment in flood control structures, entanglement in fishing nets and traps, vandalism, thermal shock during unusual winter cold-spells, and possible environmental contamination. They identified research needs and recommended six management actions: (1) that the responsible state and federal agencies prepare, publish, and implement regulations to control boat speeds, behavior of divers, and public access to manatee concentration areas; (2) that winter manatee refugia be provided special protection through land acquisition; (3) that artificial refugia not be developed until the advantages and disadvantages of possible manatee use of such areas are better understood; (4) that consideration be given to mandatory adoption of possible technological solutions to mortality reduction, including mechanical guards around boat propellers, modification of flood control structures to prevent entrapment, use of biodegradable rope for hanging crab traps, and development of alternatives to the use of herbicides for weed control in areas where ingestion of herbicide-treated food plants is likely; (5) that contingency plans be developed for containing and cleaning up oil spills in manatee habitats; and (6) that increased efforts be devoted to educating the public concerning the plight of manatees and what they can do to help.

In March 1978, after discussions with both State of Florida and FWS representatives, the Commission advised the FWS that (1) within the Department of the Interior there appeared to be no centralized authority for directing efforts to protect and promote recovery of the species; (2) questions relating to state vs federal jurisdiction, legal authority, and exercise of that authority appeared to be unresolved; and (3) the recovery team established by the FWS in July 1976 appeared to be inactive. The Commission recommended that a senior member of the FWS be assigned responsibility for developing and overseeing implementation of a recovery plan. The Commission also contracted an independent assessment of the administrative and other problems affecting the protection of manatees and their habitats in Florida. The assessment (Reynolds & Gluckman, 1978) included a critique of state and federal actions concerning law enforcement, public education, and efforts to formulate a recovery plan.

In January 1979, the FWS sent the MMC a preliminary draft recovery plan for review and comment. In its comments, the Commission noted that the draft stressed research and contained little in terms of actions needed to address the previously

noted sources of mortality, injury, and possible habitat degradation. A technical review draft, reflecting some of the Commission's comments on the preliminary draft, was circulated for agency review and comment in April 1979. The Commission, in consultation with the CSA, reviewed the revision and provided comments to the FWS in July 1979. The Commission pointed out that the draft lacked specificity and recommended that it be expanded to describe and explain the rationale for each task required to (1) address causes of mortality, injury, behavioral disturbance, and habitat degradation; (2) identify and protect habitats of special biological importance; and (3) assess and monitor population and habitat status. The Commission also recommended addition of appendices indicating (1) the FWS's statutory responsibilities and the names, addresses, and duties of personnel involved in recovery-related activities; (2) the names, institutional affiliations, and areas of expertise of the recovery team members; and (3) the agencies or organizations with lead responsibility for implementing the various research, regulatory, and monitoring tasks, the target dates for initiating and completing each task, and the funding, special equipment, or other resources required to accomplish each task.

In Fiscal Year 1980, the MMC received a special \$100,000 Congressional appropriation to facilitate development of a more effective manatee research and recovery program. To determine how to best invest this money, the Commission's Executive Director traveled to Florida and met with officials of state and federal agencies with related responsibilities, and with representatives of the scientific community, industry, and environmental groups with related interests and expertise. The Commission, in consultation with the CSA, subsequently developed work statements and transferred funds to the FWS to (1) hire and support the first year's work of a Manatee Recovery Activities Coordinator, (2) initiate development of a site-specific research and management plan for the Crystal River Area, and (3) assess and characterize manatee feeding areas and food preferences in different parts of the state. Further, the Commission provided funds to the Florida Department of Natural Resources to (1) conduct a series of training workshops for enforcement personnel, (2) develop and publish a field manual for the Florida Marine Patrol, and (3) help support the travel and other expenses of its Manatee Technical Advisory Council.

In April 1980, the FWS completed and adopted a recovery plan. In February 1982, the FWS completed and adopted a comprehensive implementation plan. These documents incorporated the MMC's recommendations and were combined and updated in 1989, 1996, and 2001 (*cf.*, U.S. Fish



(A) The Florida manatee in its natural habitat; and (B) on land, injured by motorboat propellers (Courtesy of the National Fish & Wildlife Laboratory, Gainesville, Florida)

& Wildlife Service, 2001). As recommended by the Commission, the development, implementation, and periodic updating of the recovery plan have involved representatives of environmental organizations, industry groups, and state and federal agencies with related interests and responsibilities. The involvement of all parties with related interests and responsibilities in the development, implementation, and updating of the manatee recovery plan set a precedent for formulating and implementing recovery plans for other endangered and threatened marine mammals, including the Hawaiian monk seal, the California sea otter, and the North Atlantic right whale population.

The Commission conducted two additional studies and supported a third in the 1980s that established precedents regarding the identification and protection of essential marine mammal habitats. In 1982, the Commission tasked David Laist, a member of the Commission's staff, and a working group of the CSA to identify habitat protection needs for the manatee subpopulations in the Crystal River area on the west coast of Florida and along the east coast of Florida and Georgia. The results of those assessments and related recommendations for acquiring and protecting the essential habitats identified were transmitted to the FWS in 1984 and 1988, respectively (MMC, 1984, 1989). In addition, the Commission provided funding for a workshop, held in March 1989, to determine how technological developments regarding geographic information systems (GISs) could be used to integrate, display, and make better use of manatee demographic and mortality data, and related data regarding human activities in and near manatee concentration areas. The results of that workshop (Reynolds & Haddad, 1990) were used by the Florida Department of Natural Resources' Marine Research Institute to develop a centralized database accessible to agencies and research centers throughout Florida and Georgia.

### Marine Mammal Strandings and Unusual Mortality Events

Marine mammals that strand alive or wash up dead on coastal beaches provide important sources of information on the distributions, regional abundance, seasonal occurrences, anatomy, diseases, contaminant loads, general health, and body condition of many marine mammal species. In the early 1970s, Dr. James Mead, Curator of Marine Mammals at the Smithsonian Institution's Museum of Natural History in Washington, DC, began investigating, collecting, and archiving data and specimen material from stranded marine mammals. Recognizing that such efforts could help identify mortality factors and monitor the health of both coastal marine mammal populations and coastal ecosystems, the MMC provided financial support in 1977 for a workshop to (1) assess available stranding data and theories concerning mass strandings; and (2) determine how both rescue and rehabilitation of live-stranded animals and necropsy and collection of tissues, stomach contents, etc., from dead-stranded animals could be improved to derive greater scientific benefit from the occurrences. The workshop report (Geraci & St. Aubin, 1979) identified classes of data that should be collected in the course of all stranding investigations. In addition, it recommended the establishment of regional networks of volunteers to facilitate investigation and standardized collection, archiving, and reporting of data from both live- and dead-stranded animals.

Following the workshop, the NMFS encouraged development of volunteer stranding networks, helped train volunteers, and promoted the establishment of newsletters to publicize and make known the results of regional stranding investigations. Later, the NMFS took steps to regulate and archive data collected by the regional networks (*cf.*, Wilkinson & Worthy, 1999). These networks have produced a large and growing

database on such things as the locations, species, numbers, and causes of marine mammal strandings in various U.S. coastal regions (*cf.*, Reynolds & Odell, 1987; St. Aubin et al., 1996; Geraci et al., 1999). They also have served as a model for development of similar stranding response programs in other countries (*cf.*, Geraci & Lounsbury, 1993, 2005).

Although there are records of mass strandings of live animals and unusual mortality events prior to the enactment of the MMPA, there appears to have been an increase in both since then. Whether the apparent increase is real, a product of more routine investigation and reporting, or some combination of these is not clear. It is clear, however, that the establishment of the regional networks, combined with the NMFS's and private sector responses to the directives in the Marine Mammal Health and Stranding Response Act of 1992 (described later), have led to greater efforts to document the occurrence and cause(s) of unusual mass strandings and mortality events.

Much of the current effort to investigate and determine the causes and biological significance of unusual mortality events is the product of public and Congressional concern regarding the "die-off" of more than 700 bottlenose dolphins along the U.S. mid-Atlantic coast from June 1987 to January 1988. The MMC learned of the event in late July 1987 when unusually high numbers of dead dolphins began washing up on beaches in Virginia. After consulting the NMFS and individuals familiar with the biology and diseases of bottlenose dolphins, the Commission asked Dr. Joseph Geraci, a knowledgeable marine mammal veterinarian and member of the CSA, to organize and lead an investigation to determine the cause or causes of the die-off. To facilitate the investigation, the Commission made arrangements with the Department of Agriculture's Animal and Plant Health Inspection Service to conduct bacterial, viral, and contaminant isolation studies to determine whether pathogens, pollutants, or biological toxins were causing or contributing to the dolphin deaths. The Commission also made arrangements with the Navy to provide facilities at the Little Creek Virginia Amphibious Base for conducting necropsies of dead dolphins recovered in the Virginia Beach area. Similarly, the Commission made arrangements with Dr. Mead at the Smithsonian Institution to continue collecting basic data concerning the locations, age, sex, etc., of the dead dolphins. In addition, the Commission, in consultation with the NMFS, arranged for toxicological analyses to be done by the NMFS's laboratory in Charleston, South Carolina. Subsequently, selected tissue samples were sent to the diagnostic Virology Laboratory of the Eastern Virginia Medical School and to the National Institutes of

Health's National Cancer Institute for isolation and identification of human viruses and *Vibrio* sp. that might be causing or contributing to the die-off. Further, the Commission sought the assistance of the Environmental Protection Agency to obtain information on offshore dumpsites, possible illegal dumping of medical wastes, etc., that might provide a clue to the cause of the deaths.

Funding and administrative support for the response team assembled by Dr. Geraci was provided by the NMFS. Details of the investigation are provided in Dr. Geraci's 1989 report to the MMC, Navy, and NMFS. Based on the information available at the time, Dr. Geraci concluded that the most likely cause of the die-off was brevetoxin poisoning resulting from the dolphins eating fish that had accumulated the toxin by consuming phytoplankton that produce the toxin that causes *red tides*. Subsequent analyses of tissue samples collected during the die-off suggested that the die-off more likely was caused by a previously unknown *Morbillivirus*, similar to the one that caused the deaths of more than 17,000 harbor seals in the North Sea in 1988 (Lipscomb et al., 1994). Both red tides and *Morbilliviruses* have been implicated in subsequent unusual mortality events (*cf.*, Aguilar & Raga, 1993; Bossart et al., 1998; Gulland, 2000).

#### *The Marine Mammal Health and Stranding Response Act*

Public and Congressional concerns regarding the 1987-1988 dolphin die-off led to the Marine Mammal Health and Stranding Response Act of 1992. Among other things, the legislation directed the Secretary of Commerce to (1) establish a Marine Mammal Unusual Mortality Event Working Group to provide advice on measures necessary to be better prepared to detect and respond to future unusual mortality events, (2) develop a Contingency Plan for responding to such events, (3) establish a fund to compensate persons and groups for certain costs incurred in responding to unusual events, (4) develop objective criteria for deciding when rehabilitated marine mammals can be returned to the wild, (5) continue development of the National Marine Mammal Tissue Bank established during the 1987-1988 dolphin die-off, and (6) establish and maintain a central database for tracking and accessing data concerning marine mammal strandings. Responsibility for meeting these directives was delegated to the NMFS's Office of Protected Resources.

In 1993, the NMFS, in consultation with the MMC and the FWS, established the mandated working group. The group met for the first time in April 1993 and, since then, has met as necessary to provide advice on responses to and determining

the causes of unusual mortality events. Members include veterinarians, biologists, toxicologists, and others with relevant expertise, and generally they are appointed for three-year terms. Representatives of state and federal agencies with related interests and responsibilities serve as *ex officio* members. In addition to advising on responses to unusual mortality events, the group has provided advice on the development of a National Contingency Plan for responding to unusual mortality events (Wilkinson, 1996), development of the National Marine Mammal Tissue Bank, and criteria that should be used to determine when an unusual event is occurring and for deciding when rehabilitated sick and injured marine mammals can be returned to the wild.

For more information concerning these and related activities see the MMC's Annual Reports to Congress and the section of the NMFS's Office of Protected Species website regarding marine mammal health and stranding response: [nmfs.noaa.gov/pr/health](http://nmfs.noaa.gov/pr/health).

### Ocean Pollution

As noted earlier, a number of threats to marine mammals and marine ecosystems were not apparent or widely recognized when the MMPA was enacted in 1972. These include entanglement in lost and discarded fishing gear and other types of persistent marine debris; ingestion of plastic bags, balloons, Styrofoam particles, and other indigestible materials discarded, washed, or blown into the sea; introduction of increasing amounts and varieties of fertilizers, pesticides, herbicides, pharmaceuticals, and other chemical compounds and trace metals into the world's oceans; and disturbance and possible injury and mortality caused by sounds of human origin. Although all pose significant threats to marine mammals and other marine organisms, it would require a book to address them all in a meaningful way. Thus, I provide brief descriptions of the Commission's efforts to address issues related to only two of the problems—(1) marine debris and (2) anthropogenic sound.

#### *The Marine Debris Problem*

In 1975, the North Pacific Fur Seal Commission's Standing Scientific Committee advised the Commission that, since 1967, there had been a decline in the numbers of fur seals hauling out to pup and breed on the Pribilof Islands, and a corresponding four-fold increase in the incidence of seals on the Islands entangled in pieces of fishing nets, rope, plastic strapping bands, and other materials lost or discarded at sea. In response, the four parties to the North Pacific Fur Seal Convention—Canada, Japan, the U.S., and the



Entangled fur seal (Courtesy of NOAA/Department of Commerce)

USSR—attempted to address the problem through education—that is, by developing posters and brochures illustrating the nature and causes of the entanglement problem and providing them to individuals, vessels, and organizations involved in North Pacific fisheries. Beaches in selected areas also were surveyed to help assess the scale and sources of the problem by monitoring the types and quantities of netting and other potentially hazardous debris washing ashore (*cf.*, Sanger, 1974; Lander, 1979; Merrell, 1980).

By 1982, it was clear that the efforts of the parties to the Fur Seal Convention were having little effect on the rate of entanglement. Further, it was estimated that as many as 50,000 fur seals were being entangled and drowned each year in pieces of netting and other debris larger than that seen on entangled animals onshore (*cf.*, Swartzman & Harr, 1980; Fowler, 1982). Also, at a Marine Mammal Program Review held at the NMFS's Southwest Fisheries Science Center in August 1982, it was reported that monk seals entangled in netting and other debris were being seen on beaches in the northwestern Hawaiian Islands and that related at-sea mortality could be causing or contributing to the ongoing decline of that species, as well as the decline in northern fur seals. It was agreed that an international workshop should be held as soon as possible to assess and determine what should be done to resolve the entanglement problem.

Following the program review, the MMC offered to provide funding to the NMFS to help pay for the workshop. The NMFS took no action, and on 13 April 1983, the Commission sent a follow-up letter emphasizing the need for immediate action, proposing that the workshop be held in Hawaii in August and that invitations be provided to representatives of the governments, fishing industries, and scientific communities of Japan, Taiwan, South Korea, and the USSR, as well as to relevant U.S. environmental groups, fishery organizations, and state and federal agencies. The Commission



(A) Brown boobies on marine debris; and (B) marine debris on the reef (Courtesy of NOAA/Department of Commerce)

provided a draft scope-of-work suggesting that the ultimate objectives of the workshop should be (1) to determine the sources and actions that could be taken to prevent the accidental at-sea loss and intentional discarding of fishing gear and other materials in which fur seals, monk seals, and other wildlife were being entangled and killed; and (2) to ascertain actions necessary to identify and remove potentially harmful debris being accumulated in areas where it may be hazardous to marine mammals and other biota. The Commission offered to provide funding for a steering group to immediately begin organizing the workshop.

The NMFS agreed that prompt action was required but made no effort to convene the workshop. However, on 27 September 1983, a member of the NMFS's staff provided a briefing on the entanglement problem to invited representatives of the Washington, DC embassies of Canada, Japan, the Republic of Korea, Taiwan, and the USSR. The Commission's Executive Director attended the briefing and outlined the Commission's views regarding the need and its suggested Terms of Reference for an international workshop to determine how best to resolve the problem. The embassy representatives requested and the Commission sent them the suggested Terms of Reference for the workshop. After several additional exchanges of correspondence with the NMFS, the NMFS advised the MMC in February 1984 that, as the Commission had recommended, it had established a steering group to guide the structuring of the workshop. Also, as the MMC had recommended, the NMFS advised that the Office of NOAA's General Counsel was assembling a list of domestic and international authorities with a possible bearing on the entanglement problem; the Department of State had been asked to request information from the aforementioned countries concerning their efforts and authorities for dealing with the problem; and a research and management plan was being developed and would be finalized following the workshop.

The workshop was held at the Ala Moana Americana Hotel in Honolulu, Hawaii, on 27-29 November 1984. Funding and support services were provided by the MMC, the NMFS, the FWS, the North and Western Pacific Fishery Management Councils, and the Hawaii Sea Grant Program. Participants included scientists, technical experts, and representatives of fishery and environmental interest groups from the U.S., Canada, Japan, New Zealand, Taiwan, South Korea, West Germany, and the United Kingdom. The workshop proceedings and related recommendations for better documenting and addressing the sources of the problem were published in July 1985 (Shomura & Yoshida, 1985). Aware of the problem, Congress provided the NMFS with a special \$1,000,000 appropriation in FY 1985 to develop and begin implementing a comprehensive research and regulatory program to resolve the problem. Congress directed that the program be developed in consultation with and the concurrence of the MMC.

As indicated in the MMC's 1986 Annual Report to Congress, the NMFS began allocating the \$1,000,000 appropriation without the Commission's concurrence. After learning that \$250,000 of the special appropriation was to be used for purposes unrelated to the debris problem, the Commission advised the NMFS that it did not concur with that decision. The Commission recommended that a senior NMFS scientist or administrator be assigned responsibility for managing the entanglement program and that an advisory body, composed of knowledgeable scientists and representatives of relevant interest groups, be established to help develop a plan for allocating the funding. In response to a subsequent MMC initiative, a meeting was held on 18-19 March 1985 at the NMFS's Southwest Fisheries Science Center to review the results of the November 1984 workshop and identify priorities for follow-up. After the meeting, the Commission developed and provided the NMFS with an annotated outline

of the priority research and management actions identified by the meeting participants, and detailed scopes-of-work and cost estimates for each of the priority projects listed in the outline.

In April 1985, the NMFS assigned a staff member at its Northwest and Alaska Fisheries Center responsibility for managing the entanglement program. The program was continued through FY 1995 with funding averaging \$600,000 to \$650,000 per year. The program was guided by a steering group as recommended by the MMC, taking into account the results of the 1984 workshop and follow-up workshops held in April 1989 and May 1994 (*cf.*, Shomura & Godfrey, 1990; Clary, 1995; Faris & Hart, 1995; NOAA, 2000).

Laist et al. (1999) provided a comprehensive review of the entanglement program and its antecedents. Additional details can be found in the MMC's Annual Reports to Congress for calendar years 1984 to 1996. Information concerning related and ongoing beach clean-up programs can be found on the Ocean Conservancy's website: [oceanconservancy.org](http://oceanconservancy.org).

#### *The Anthropogenic Sound Controversy*

The effects of human-generated sounds on marine mammals and other biota have become a subject of much controversy. When the MMPA was enacted in 1972, there were few indications that such sounds could pose a threat to marine mammals. However, studies in Alaska and Canada in the late 1970s and early 1980s found that the distribution patterns and behavior of ringed seals, beluga whales, and bowhead whales could be affected by sounds associated with offshore oil and gas development (Fraker, 1977, 1978; Fraker & Fraker, 1979, 1981; Burns et al., 1982; Awbrey et al., 1983). Although the observed distributional and behavioral changes seemed insignificant, they indicated that the sound-producing activities were resulting in the "taking" of marine mammals as defined in the MMPA (*cf.*, Swartz & Hofman, 1991). Representatives of the Alaskan oil industry lobbied Congress to revise the MMPA, arguing that it was unnecessarily burdensome to have to obtain a waiver of the Act's moratorium on

taking for unintentional taking that would have inconsequential effects. Congress agreed, and in 1981 added to the MMPA section 101(a)(5)(A) directing the Secretaries of Commerce and the Interior to authorize the unintentional taking of small numbers of marine mammals incidental to activities other than commercial fisheries (covered by other provisions of the Act) when the taking would have negligible impacts on the affected species or stock, and the responsible regulatory agency (the NMFS or FWS) promulgates reporting requirements and regulations specifying when, where, how, and how many marine mammals can be taken incidental to the activity.

Except for purposes of scientific research, the MMPA prohibited authorizing the taking of marine mammals listed as endangered, threatened, or depleted. Likewise, the 1981 addition of section 101(a)(5)(A) prohibited authorizing the incidental taking of listed species and stocks, even when the taking was unlikely to have any biologically significant effects. This posed a conundrum for the Alaskan oil and gas industry because authorization could not be obtained to take endangered bowhead whales incidental to their offshore exploration and development activities. Also, Alaskan Native subsistence hunters believed that exploration and development activities were causing bowheads to migrate further offshore, making it more difficult and dangerous to hunt and retrieve the whales. In response to lobbying by both groups, Congress amended section 101(a)(5)(A) in 1986 to allow authorizing the incidental taking of small numbers of listed as well as non-listed marine mammals (e.g., bowhead whales) when the population effects would be negligible and there would be no unmitigable effect on the availability of the affected species for taking by Alaska Natives for subsistence purposes.

Actions taken subsequently by the MMC, the NMFS, the FWS, and the Minerals Management Service to implement and ensure compliance with these additions to the Act are described in the Commission's Annual Reports to Congress. Although the initial focus was on sounds associated with oil and gas activities, much of the concern in recent years has focused on the effects of low- and mid-frequency Navy sonars, particularly on beaked whales. I described the evolution of this concern and related activities in a paper published in 2003 in the *Marine Technological Society Journal* (Hofman, 2003). Among other things, the paper points out the uncertainties and concerns raised in turn by (1) an experiment known as the Heard Island Feasibility Study, which was carried out in January 1991 to determine whether transmission of low-frequency sounds across ocean basins could be used to detect changes in deep ocean temperature



Photo by Chris Richter, Texas A&M

indicative of global warming (*cf.*, Bowles et al., 1994); (2) a subsequent proof-of-concept study known as the Acoustic Thermometry of Ocean Climate or ATOC Program, which was funded by the Defense Department's Advanced Research Projects Agency (*cf.*, Advanced Research Projects Agency et al., 1995a, 1995b; ATOC Consortium, 1998; NRC, 1994, 2000; ONR et al., 2001); (3) Congressionally mandated shock trials of new classes of Navy ships and submarines (Department of the Navy, 1998, 2001a); and (4) the Navy's development and proposed operational use of a new, low-frequency active sonar system titled the Surveillance Towed Array Sonar System: Low Frequency Active or SURTASS LFA sonar (*cf.*, Department of the Navy, 2001b).

#### *The Smoking Gun*

On 15 and 16 March 2000, 17 cetaceans, including 14 beaked whales, two minke whales, and one spotted dolphin, were found stranded on beaches in the northern Bahamas Islands (Abaca, Grand Bahama, and Eleuthra). Most of the animals were alive when they stranded and were presumed to have beached themselves. Eight of the beaked whales and the spotted dolphin subsequently died. Six of the beaked whales and both minke whales were pushed to sea and swam away—whether they survived is unknown.

Six days later, on 22 March, an article was published in the *Washington Post* indicating that these and two previous strandings had coincided with Navy training exercises. The day before, two environmental groups, the Natural Resources Defense Fund and the Humane Society of the U.S., had written to the Navy expressing concern that the Bahamas strandings may have been caused by acoustic systems being tested as part of the Navy's Littoral Warfare Advanced Development (LWAD) Program. Subsequently, the Bahamian government asked the NMFS for assistance in determining the cause of the strandings. Due to the reported concurrence with the LWAD tests, the Navy, as well as the NMFS, responded with funding and personnel to facilitate the investigation. Necropsies of the animals that died found indications of hemorrhaging in the internal ears and surrounding tissues consistent with the kinds of trauma that could be expected if the animals had been exposed to high intensity sounds. The timing of the strandings and the LWAD tests did not coincide, ruling out the possibility that the LWAD tests caused or contributed to the strandings. However, a U.S. Navy anti-submarine training exercise, involving multiple ships using standard mid-frequency tactical sonars was being conducted at the time near where the strandings occurred. Although similar exercises had been carried out previously

in many ocean areas with no apparent ill effects on marine mammals, the investigation focused on the possible cause-effect relationship of the training exercise and the strandings.

On 20 December 2001, the Navy and the NMFS issued a Joint Interim Report on the Bahamas Marine Mammal Stranding Event of 14-16 March 2000. The report indicated that most parts of the investigation had been completed and that

Based on the way in which the strandings coincided with ongoing naval activity involving tactical mid-frequency range sonar use in terms of both time and geography, the nature of the physiological effects experienced by the dead animals, and the absence of any other acoustic sources, the investigation team concluded that tactical mid-range frequency sonars aboard the U.S. Navy ships that were in use during the sonar exercise in question were the most plausible source of this acoustic or impulse trauma.

The report also indicated that a combination of unusual factors appeared to have contributed to the event. Particularly, the presence of a strong, warm-water surface duct and underwater bathymetry that allowed the sonar transmissions to propagate over greater distances than would occur normally, use of multiple active sonars over an extended period of time, and the presence of beaked whales that appear particularly sensitive to sonar transmissions in a constricted channel with limited escape routes.

There have been reports of strandings of beaked whales and other cetaceans coincident with naval sonar exercises in other parts of the world before and since the Bahamas strandings (Simmonds & Lopez-Jurado, 1991; D'Amico & Verboom, 1998; Frantzis, 1998; Brownell et al., 2004; Freitas, 2004; Martin et al., 2004; Taylor et al., 2004). There also are indications that behavioral or physiological responses to certain sounds may induce formation of nitrogen bubbles in the circulatory systems of deep-diving marine mammals, such as the beaked whales, which can cause tissue and organ damage similar to that caused by the "bends" in human divers (*cf.*, Houser et al., 2001; NOAA, 2002; Jepson et al., 2003; Fernandez et al., 2004; Cox et al., 2006).

#### *Congressional Directive to the MMC*

Due to the uncertainty and controversy concerning the effects of anthropogenic sound on marine mammals, Congress, in the Omnibus Appropriations Act of 2003 (Public Law 108-7), provided funding and directed the MMC to "fund an international conference or series of

conferences to share findings, survey acoustic 'threats' to marine mammals, and develop means of reducing those threats while maintaining the oceans as a global highway of international commerce." In response, the Commission established a 28-member Advisory Committee to identify and seek agreement on the scope, significance, and possible solutions to the problem. Due to the apparent vulnerability of beaked whales to mid-frequency tactical sonar transmissions, the Commission also held a workshop to assess the characteristics of beaked whales possibly contributing to that apparent vulnerability (Cox et al., 2006). In addition, the Commission, in cooperation with the United Kingdom's Joint Nature Conservation Committee, held a workshop in London to obtain the views of other countries and international organizations on the need and means for assessing, avoiding, and mitigating the impacts of anthropogenic sound on marine mammals and other marine biota (Vos & Reeves, 2006).

The members of the Advisory Committee were selected to provide relevant scientific expertise and balanced representation of the environmental organizations, industry groups, and state and federal agencies with related responsibilities or interests. The Committee met six times between February 2004 and September 2005. The members generally agreed that available information was insufficient to reliably determine the biological significance of the array of possible effects of anthropogenic sounds on marine mammals. However, there were substantially differing views on the significance of the apparent and perceived threats, the research and monitoring needs and priorities, and the regulatory measures that should be instituted to eliminate or mitigate the threats given the current state of knowledge concerning them. Consequently, groups of members with similar views were asked to prepare and provide the Commission a *précis* and explanation of the basis of their views concerning research needs, etc.

In March 2007, the Commission reported to Congress the results of its consultations. The report (MMC, 2007a) identified and factored in the views of the various interest groups and the results of the beaked whale and London workshops. It pointed out (1) uncertainties regarding the impacts of anthropogenic sound on marine mammals and other marine biota, (2) inadequacies in the existing monitoring and mitigation measures, (3) inconsistencies in the application and enforcement of marine mammal taking regulations, and (4) difficulties associated with obtaining incidental-taking authorizations and permits for certain types of marine mammal research. Among other things, it recommended the following:

- The establishment and funding of a national research program, guided and coordinated by a steering committee composed of representatives of agencies with related responsibilities, to document and determine how best to avoid or mitigate the biologically significant effects of various sources of anthropogenic sound on marine mammals and other marine organisms;
- An amendment of the MMPA to (1) provide uniform standards for governing all sources of anthropogenic sound having biologically significant effects on marine mammals, (2) require incidental-taking authorizations for all producers of anthropogenic sound potentially having biologically significant effects on marine mammals, and (3) provide the NMFS and the FWS the means and authority to monitor and ensure compliance with incidental-taking authorizations; and
- The development by the NMFS and the FWS of a regulatory system, incorporating the PBR concept set forth in the 1994 MMPA amendments, to account for the possible cumulative adverse effects of anthropogenic sound and other human activities on marine mammals and marine ecosystems.

To ensure that laypeople understand the issues addressed in the report, the Commission also contracted and published a booklet titled *Underwater Sound and the Marine Mammal Acoustic Environment: A Guide to Fundamental Principles* (Bradley & Stern, 2008).

#### **Recent Initiatives and Responses to Congressional Directives**

Most of the preceding descriptions relate to Commission initiatives and activities before I retired in June 2000. It is clear from the MMC's recent Annual Reports to Congress that the Commission, in consultation with the CSA, continues to play a lead role in identifying, calling attention to, and recommending practical approaches to human activities affecting marine mammals and marine ecosystems worldwide. It also is apparent from its continuing directives to the MMC that Congress relies on the Commission for objective, apolitical, science-based advice on controversial issues. One example of each follows.

##### *Effects of Climate Change on Coastal Alaska Native Communities*

In the late 1990s, the Commission's Special Advisor on Alaska Native Affairs called the Commission's attention to Native concerns that climate change was adversely affecting communities and traditional lifestyles in coastal Alaska



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through changes in sea ice and other environmental conditions. In response, the Commission organized and, in February 2000, held a workshop, *Impacts of Changes in Sea Ice and Other Environmental Parameters in the Arctic*, in Girdwood, Alaska. Participants included scientists with relevant expertise, representatives of affected Native communities, and state and federal agencies with related interests and responsibilities. Among other things, the workshop report (Huntington, 2000) noted ways that changes in sea ice and other environmental conditions may be affecting marine mammals and the indigenous people who depend on them. It pointed out uncertainties and recommended measures to resolve them and to minimize and mitigate impacts. To follow up on some of the workshop recommendations, the Commission solicited and provided funding to publish a series of papers on *Arctic Marine Mammals and Climate Change* (Huntington & Moore, 2008). Also, the Commission, with support from the FWS and members of the Arctic Council, held an international workshop in March 2007 at the Oceanographic Institute (L'Oceanografic) in Valencia, Spain, to review and formulate plans for coordinating regional research and monitoring programs for two Arctic marine mammals—ringed seals and beluga whales—likely to be sensitive indicators of climate change in the Arctic (see the Commission's Annual Report to Congress for calendar year 2007 for details).

#### *Controversy Concerning the Cost-Effectiveness of the ESA*

In recent years, there has been growing controversy concerning the cost-effectiveness of actions, or lack thereof, being taken in accordance with the U.S. Endangered Species Act to identify, protect, and promote recovery of endangered and threatened plants and animals. Congress in the Omnibus Appropriations Act of 2004 directed

the MMC to “. . . review the biological viability of the most endangered marine mammal populations and make recommendations regarding the cost-effectiveness of current protection programs.” In response, the Commission (1) undertook an assessment of the applicable provisions of the ESA and the MMPA, as well as the criteria and procedures used by the International Union for the Conservation of Nature and Natural Resources (IUCN), to classify the conservation status of marine mammal species and populations worldwide (Lowry et al., 2007); (2) reviewed the status of, threats to, and recovery programs for the 22 endangered, threatened, or depleted species and populations of marine mammals that occur in U.S. waters (Weber & Laist, 2007); (3) held a workshop on population viability assessments (PVAs) of endangered marine mammals in U.S. waters (MMC, 2007b); (4) in cooperation with the NMFS, did an assessment of the North Atlantic Right Whale Recovery Program (Reeves et al., 2007); and (5) in February 2008, conveyed to Congress the results of the assessments (MMC, 2008).

Among other things, the report to Congress notes that, while commercial, subsistence, and bounty hunting were the principal threats to marine mammals historically, the principal threats now are environmental pollution; habitat loss; and taking incidental to commercial fisheries, offshore oil and gas development, Navy training exercises, commercial shipping, etc. It also notes that, while the most high-risk species receive appropriate attention, assessment and development of recovery programs for other listed species and populations tend to be more problematic, largely because of funding limitations. It recommended that Congress require the agencies with related responsibilities to develop and implement a coordinated strategy for determining (1) the annual funding requirements for research, monitoring, and recovery actions for endangered, threatened, and depleted marine mammals in U.S. waters; and (2) how those funds should be allocated to ensure that recovery efforts are optimally cost-effective.

#### **Summary Comments and Lessons Learned**

The preceding provides a general overview of the nature and scope of the Marine Mammal Commission's efforts, in consultation with the Committee of Scientific Advisors, to identify and find practical solutions to human activities having adverse effects on marine mammals and ecosystems. Although far from comprehensive, it hopefully illustrates three things: (1) the unique features of the MMPA and later revisions to make it more flexible and responsive to unforeseen issues;

(2) the Commission's and Committee's ongoing role in identifying, calling attention to, and seeking practical solutions to human-related threats to marine mammals and marine ecosystems; and (3) the influence that both the Act and the Commission have had on conservation of marine mammals and marine ecosystems worldwide.

Although inherent in the descriptions of the various issues, the following "lessons learned" merit explicit mention:

- Funding limitations and competing needs often place constraints on what can be done to identify and respond promptly to both real and perceived conservation problems.
- It is easier to find solutions to conservation problems if the problems are identified and addressed before the most cost-effective solution is likely to have substantial socioeconomic consequences and generate controversy—that is, whenever possible, it is important to avoid crisis management. The MMC's proactive approach to identifying and attempting to find practical solutions to marine mammal conservation problems before they reach crisis levels exemplifies the value of this approach.
- Although the MMPA incorporates the precautionary principle—that is, places the burden on those "taking" marine mammals to show that the taking will not "disadvantage" the affected species or stock before it can be authorized—some taking occurs without meeting the evidentiary burden. If the intent of the Act is to be met fully, standard criteria must be developed for deciding the kinds and levels of taking likely to have biologically significant effects, and the provisions of the Act applied to all such taking.
- Available information often is insufficient to accurately predict the biological-ecological and socioeconomic impacts of alternative regulatory or management actions. In such cases, management policies and decisions must be based on the best available information, meaning that simulation models and a variety of assumptions are likely to be used to make judgments concerning possible effects. If those doing the assessments do not clearly and explicitly identify the uncertainties and the possible consequences if the models or assumptions are not valid, those responsible for making the policy and management decisions cannot be held accountable for bad decisions. For example, if those preparing Environmental Impact Statements for proposed activities do not clearly identify limitations concerning the available data, assumptions made in determining possible impacts, and the potential consequences if the assumptions or analyses are not valid, those responsible for

deciding whether the activity should or should not proceed as planned cannot be held responsible if the activity has adverse unforeseen effects. In cases where there is substantial uncertainty, it is essential that the authorization to proceed requires monitoring capable of validating assumptions and detecting unforeseen impacts before they are irreversible and that the activity be suspended until adequate mitigation measures are implemented if significant unforeseen impacts are detected.

- Both government and academic scientists sometimes are asked or attempt to answer questions that cannot be answered given the available data. As an example, both government and academic scientists have been asked or attempted to determine the kinds, levels, and durations of exposure to anthropogenic sound that will have biologically significant effects on marine mammals and other marine organisms even though the available data are insufficient in most cases to do so with reasonable confidence. In such cases it would be more responsible to provide assessments of the exposures unlikely to have adverse effects given the available data. This approach is reflected in the 1994 MMPA amendment that provides a general authorization for types of marine mammal research judged likely, based on the available data, to have insignificant effects. Such an approach encourages research and adaptive management, while basing decisions on insufficient data and assumptions tends to favor the status quo and has a high likelihood of being wrong.
- Many if not most regulatory and management decisions regarding implementation of the MMPA, ESA, FCMA, and international agreements, such as the International Whaling Convention, are based on data and analyses provided in technical memoranda, environmental impact statements, and committee and contract reports. Although most of these documents are peer-reviewed, the data and analyses may never be published in peer-reviewed journals. Thus, students and others with interest in the antecedents of management policies and practices must be aware of and access these information sources.
- To minimize the potential for controversy, it is essential that all parties with related interests are given the opportunity to have input to the decisionmaking process—that is, to be part of the solution rather than part of the problem. The MMC's efforts to have all parties with related interests involved in developing and implementing fishery management plans and endangered species recovery plans provide good examples of the advantages of this approach.

### Acknowledgments

I thank John Reynolds and Tim Ragen for reviewing an early draft of this feature and suggesting additions and other changes to improve it. I also thank the staff of the Marine Mammal Commission, particularly Melissa Herman, Suzanne Montgomery, Darel Jordan, and Wilhelmina Innes, for their assistance in locating and obtaining documents and data essential to this endeavor. Finally, I thank the editors and staff of *Aquatic Mammals*, particularly Jeanette Thomas and Kathleen Dudzinski, for asking me to write a “history” of the Marine Mammal Commission and for the guidance they provided in bringing this paper to fruition. Any errors of omission or commission are mine alone.

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#### Appendix 1. Past and current members of the Marine Mammal Commission

Victor B. Scheffer, Ph.D. (1st Chairman)	Bureau of Sport & Commercial Fisheries, retired (now the NMFS), Seattle, Washington	May 1973 – May 1976
A. Starker Leopold, Ph.D.	University of California, Berkeley	May 1973 – September 1975
John H. Ryther, Ph.D.	Woods Hole Oceanographic Institution, Woods Hole, Massachusetts	May 1973 – November 1973
Richard A. Cooley, Ph.D.	University of California, Santa Cruz	October 1974 – November 1979
Donald B. Siniff, Ph.D.	University of Minnesota, Minneapolis	September 1975 – February 1981
Douglas G. Chapman, Ph.D.	University of Washington, Seattle	September 1976 – November 1981
Murray L. Johnson, M.D.	Burke Museum, University of Washington	November 1979 – November 1981
Robert B. Weeden, Ph.D.	University of Alaska, Fairbanks	November 1981 – December 1984
James C. Nofziger, Ph.D.	Canoga Park, California	November 1981 – April 1984
Donald K. MacCallum, Ph.D.	University of Michigan, Ann Arbor	November 1981 – December 1984
William E. Evans, Ph.D.	Sea World Research Institute, San Diego, California	April 1984 – September 1986
Karen W. Pryor	North Bend, Washington	December 1984 – November 1987
Robert Elsner, Ph.D.	University of Alaska, Fairbanks	December 1984 – May 1991
Francis H. Fay, Ph.D.	University of Alaska, Fairbanks	November 1987 – May 1991
William W. Fox, Jr., Ph.D.	University of Miami, Miami, Florida	May 1987 – January 1990
Paul K. Dayton, Ph.D.	Scripps Institution of Oceanography, San Diego, California	October 1990 – Present
John E. Reynolds III, Ph.D.	Eckerd College; Mote Marine Lab, St. Petersburg, Florida	May 1991 – Present
Jack W. Lentfer	U.S. Fish & Wildlife Service, Anchorage, Alaska	May 1991 – August 1995
Vera Alexander, Ph.D.	University of Alaska, Fairbanks	August 1995 – Present

**Note:** The members of the Commission are listed chronologically; those of the CSA in Appendix 2 are listed alphabetically. As can be seen, a number of individuals served on both the Committee and Commission. The institutional affiliations indicated were those at the time the individuals served (some may be at different places now). Note that when the word “retired” is used, it means that the individual was retired from the organization shown when he was appointed to the Commission or CSA.

**Appendix 2.** Past and current members of the Committee of Scientific Advisors on Marine Mammals

Name	Institutional affiliation	Dates of service
David G. Ainley, Ph.D.	Point Reyes Bird Observatory	March 1982 – December 1985
Richard H. Backus, Ph.D.	Woods Hole Oceanographic Institution, Woods Hole, Massachusetts	January 1976 – November 1976
George A. Bartholomew, Ph.D.	University of California, Los Angeles	August 1973 – June 1975
Daryl J. Boness, Ph.D.	National Zoological Park, Washington, DC	December 1993 – Present
Daniel B. Botkin, Ph.D.	University of California, Santa Barbara	December 1979 – December 1982
Robert L. Brownell, Jr., Ph.D.	U.S. Fish & Wildlife Service, Washington, DC & National Marine Fisheries Service, La Jolla, California	August 1975 – September 1978 May 1985 – December 1990
John J. Burns	Alaska Department of Fish & Game, Anchorage	March 1994 – September 1999
Douglas G. Chapman, Ph.D.	University of Washington, Seattle	August 1973 – June 1976
Paul K. Dayton, Ph.D.	Scripps Institution of Oceanography, La Jolla, California	August 1973 – September 1976 December 1981 – January 1986 April 1987 – December 1993
Douglas P. De Master, Ph.D.	National Marine Fisheries Service, La Jolla, California	November 1976 – March 1982 May 1983 – December 1985
Daryl P. Domning, Ph.D.	Howard University, Washington, DC	December 1982 – February 1985 March 1982 – May 1985
L. Lee Eberhardt, Ph.D.	Pacific Northwest Laboratory, Battelle Memorial Institute	December 1993 – February 1998
Francis H. Fay, Ph.D.	University of Alaska, Fairbanks	January 1976 – January 1984
William W. Fox, Jr., Ph.D.	University of Miami, Miami, Florida	July 1975 – July 1977
Joseph R. Geraci, D.V.M, Ph.D.	University of Guelph, Ontario, Canada; National Aquarium, Baltimore, Maryland	January 1984 – April 1987
Tim Gerrodette, Ph.D.	National Marine Fisheries Service, La Jolla, California	September 1978 – October 1982 November 1985 – August 1988 October 1995 – January 2000
Daniel Goodman, Ph.D.	University of Montana, Bozeman	March 2009 – Present
Frances M. D. Gulland, MRCVS, Vet. M.B., Ph.D.	The Marine Mammal Center, Sausalito, California	December 1985 – February 1989
John A. Hildebrand, Ph.D.	Scripps Institution of Oceanography, La Jolla, California	January 2000 – Present
Ancel M. Johnson	Alaska Department of Fish & Game, Anchorage	April 2003 – January 2008
Murray L. Johnson, M.D.	Burke Museum, University of Washington, Seattle	January 1976 – August 1977
Steven K. Katona, Ph.D.	College of the Atlantic, Bar Harbor, Maine	December 1985 – December 1993
Karl W. Kenyon	Bureau of Sport & Commercial Fisheries, retired (now NMFS), Seattle, Washington	April 1995 – December 2004
Gerald L. Kooyman, Ph.D.	Scripps Institution of Oceanography, La Jolla, California	December 1976 – December 1979
Burney J. Le Boeuf, Ph.D.	University of California, Santa Cruz	January 1978 – December 1981
Jack W. Lentfer	U.S. Fish & Wildlife Service, Anchorage, Alaska	February 1989 – February 1993 August 1973 – January 1976 November 1985 – April 1991
George A. Llano, Ph.D.	Naples, Florida (National Science Foundation, retired)	December 1985 – February 1989
Lloyd F. Lowry	Alaska Department of Fish & Game, Fairbanks	April 1991 – January 2008

Name	Institutional affiliation	Dates of service
Marc Mangel, Ph.D.	University of California, Davis	February 1989 – April 1995
Bruce R. Mate, Ph.D.	University of Oregon, Newport	October 1981 – October 1984 June 1994 – January 2000
James G. Mead, Ph.D.	National Museum of Natural History, Washington, DC	October 1982 – November 1985
William Medway, D.V.M., Ph.D.	University of Pennsylvania, Philadelphia	October 1982 – November 1985 August 1988 – October 1995
Sue Moore, Ph.D.	National Marine Fisheries Service, Seattle, Washington	April 2005 – Present
Kenneth S. Norris, Ph.D.	University of California, Santa Cruz	August 1973 – January 1976
Daniel K. Odell, Ph.D.	University of Miami, Miami, Florida	September 1978 – March 1982
Thomas O'Shea, Ph.D.	U.S. Fish & Wildlife Service, Gainesville, Florida & Fort Collins, Colorado	June 1991 – June 1994
James E. Overland, Ph.D.	Pacific Marine Environmental Laboratory, Seattle, Washington	February 2008 – Present
Jane M. Packard, Ph.D.	Texas A&M University, College Station	February 1985 – January 1989
William F. Perrin, Ph.D.	National Marine Fisheries Service, La Jolla, California	September 1980 – May 1983 December 1990 – March 1994
John H. Prescott	New England Aquarium, Boston, Massachusetts	July 1977 – September 1980
Katherine Ralls, Ph.D.	National Zoological Park, Washington, DC	September 1979 – October 1982
Galen B. Rathbun, Ph.D.	U.S. Fish & Wildlife Service, Cambria, California	January 2000 – April 2003
Clayton E. Ray, Ph.D.	National Museum of Natural History, Washington, DC	October 1975 – December 1977
G. Carleton Ray, Ph.D.	Johns Hopkins University, Baltimore, Maryland	August 1973 – January 1976
Andrew Read, Ph.D.	Duke University Marine Laboratory, Beaufort, North Carolina	April 2003 – January 2008
Randall R. Reeves, Ph.D.	Okapi Wildlife Associates, Hudson, Quebec, Canada	February 2006 – Present
Stephen B. Reilly, Ph.D.	National Marine Fisheries Service, La Jolla, California	September 1999 – April 2003
John E. Reynolds III, Ph.D.	Eckerd College, St. Petersburg, Florida	January 1989 – April 1991
Sam H. Ridgway, D.V.M., Ph.D.	Naval Undersea Center, San Diego, California	September 1975 – September 1978
William E. Schevill, Ph.D.	Harvard University & Woods Hole Oceanographic Institution	August 1973 – August 1975
Donald B. Smiff, Ph.D.	University of Minnesota, Minneapolis	August 1973 – September 1975
Robert S. Suydam	North Slope Borough, Barrow, Alaska	February 2008 – Present
Tim D. Smith, Ph.D.	University of Hawaii, Manoa; National Marine Fisheries Service, La Jolla, California, and Woods Hole, Massachusetts	July 1976 – July 1979 March 1989 – April 1995
Ian Stirling, Ph.D.	Canadian Wildlife Service, Edmonton, Alberta, Canada	April 2003 – Present
Barbara L. Taylor, Ph.D.	National Marine Fisheries Service, La Jolla, California	January 1998 – April 2005
Jeanette A. Thomas, Ph.D.	Western Illinois University, Moline, Illinois	February 1993 – January 2000
Peter L. Tyack, Ph.D.	Woods Hole Oceanographic Institution, Woods Hole, Massachusetts	January 2000 – January 2002
Douglas C. Wartzok, Ph.D.	University of Missouri, St. Louis; Florida International University, Miami, Florida	January 1998 – Present
Robert B. Weeden, Ph.D.	University of Alaska, Fairbanks	September 1977 – January 1981
Jesse R. White, D.V.M.	Miami Sea Aquarium, Miami, Florida	August 1973 – August 1975
Forrest G. Wood, Jr.	Naval Oceans Systems Center, San Diego, California (retired)	October 1984 – March 1989
Judith E. Zeh, Ph.D.	University of Washington, Seattle	April 1995 – January 1998