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Marine Mammal Studies Supported by the Northeast Fisheries Science Center during 1980-89

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U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
Northeast Fisheries Science Center
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101. **Status of Fishery Resources off the Northeastern United States for 1993.** By Conservation and Utilization Division, Northeast Fisheries Science Center. October 1993. iv + 140 p., 62 figs., 70 tables. NTIS Access. No. PB94-142361.

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NOTE ON SPECIES NAMES

The NMFS Northeast Region's policy on the use of species names in technical publications and reports is to follow the American Fisheries Society's (AFS) lists of scientific and common names for fishes (Robins *et al.* 1991)[a], mollusks (Turgeon *et al.* 1988)[b], and decapod crustaceans (Williams *et al.* 1989)[c], and to follow the American Society of Mammalogists' list of scientific and common names for marine mammals (Wilson and Reeder 1993)[d]. This policy applies to all issues of the *NOAA Technical Memorandum NMFS-F/NEC* and *-F/NER* series.

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[a] Robins, C.R. (chair); Bailey, R.M.; Bond, C.E.; Brooker, J.R.; Lachner, E.A.; Lea, R.N.; Scott, W.B. 1991. Common and scientific names of fishes from the United States and Canada. 5th ed. *Amer. Fish. Soc. Spec. Publ.* 20; 183 p.

[b] Turgeon, D.D. (chair); Bogan, A.E.; Coan, E.V.; Emerson, W.K.; Lyons, W.G.; Pratt, W.L.; Roper, C.F.E.; Scheltema, A.; Thompson, F.G.; Williams, J.D. 1988. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks. *Amer. Fish. Soc. Spec. Publ.* 16; 277 p.

[c] Williams, A.B. (chair); Abele, L.G.; Felder, D.L.; Hobbs, H.H., Jr.; Manning, R.B.; McLaughlin, P.A.; Pérez Farfante, I. 1989. Common and scientific names of aquatic invertebrates from the United States and Canada: decapod crustaceans. *Amer. Fish. Soc. Spec. Publ.* 17; 77 p.

[d] Wilson, D.E.; Reeder, D.M. 1993. Mammal species of the world: a taxonomic and geographic reference. Washington, DC: Smithsonian Institution Press; 1206 p.

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List of Acronyms

CCS -- Center for Coastal Studies

CeTAP -- Cetacean and Turtle Assessment Program

COA -- College of the Atlantic

ICES -- International Council for the Exploration of the Sea

IWC -- International Whaling Commission

MBO -- Manomet Bird Observatory

MMPA -- Marine Mammal Protection Act

NEA -- New England Aquarium

NEFSC -- Northeast Fisheries Science Center

NMFS -- National Marine Fisheries Service

UMO -- University of Maine-Orono

URI -- University of Rhode Island

USMMC -- U.S. Marine Mammal Commission

WHOI -- Woods Hole Oceanographic Institution

ABSTRACT

Marine mammal research supported by the Northeast Fisheries Science Center from 1980 to 1989 is described in the context of four research areas defined retrospectively: (1) ecological roles and habitat requirements, (2) human interactions, (3) optimum sustainable population size, and (4) research planning and archiving. Within each area, contract and in-house projects are grouped into a number of research topics which are based on actual projects completed. Research activities and results, along with the total amount of money spent, are summarized for each topic. The relationship of the research supported over the decade to the recommendations of a research planning workshop held in 1979 is described. Finally, the implications for future research based on the progress made over the decade, as well as the implications of changing information needs, are discussed.

INTRODUCTION

Marine mammals have been important in the northeastern United States historically both as objects of commercial harvests and in ecological interactions with commercial fisheries. There was some scientific attention given to East Coast marine mammals as early as 1851 when Matthew Maury of the U.S. Navy's Depot of Charts and Instruments published his whale charts based upon whalers' logs and records of sightings. The U.S. Fish Commission gave more attention to marine mammals after its creation in 1871, including the commissioning of Starbuck's (1878) "History of the American Whale Fishery from Its Earliest Inception to the Year 1876." The omnibus series titled "The Fisheries and Fishery Industries of the United States" describes fisheries for both the great whales and smaller whales in the North Atlantic, the latter likely including pilot whales, bottlenose dolphin, and bottlenose whales (Goode and associates 1884).

In addition to these direct fisheries, there was also interest in indirect effects of marine mammals on other fisheries. Goode and associates (1884) described the destructiveness of marine mammals to fisheries, a theme that the U.S. Commissioner of Fisheries, Spencer Baird, used in 1889 in supporting a fish meal factory to be built in Woods Hole, Massachusetts. Baird (1889, p. 68) speculated that the 20 tons of predatory "fishes," *i.e.*, porpoises, skates, and dogfish, that the proposed factory would process annually "should present a marked influence upon the supply of edible fishes." The interest of the U.S. Fish Commission was primarily in terms of fisheries, and little biological study appears to have been done of marine mammals in this region beyond the taxonomic studies of Frederick True (1885) who, for example, provided written instructions to lighthouse keepers on "the best means of collecting and preserving specimens of whales and porpoises."

With the declining importance of U.S. harvests of East Coast species of marine mammals in the late 1800s and early 1900s, the incentive for systematic scientific study of species inhabiting waters off the northeastern United States declined. In the 1930s and 1940s, Remmington Kellogg at the Smithsonian Institution and William Schevill at Harvard University undertook taxonomic studies, but it wasn't until the late 1940s that cetacean biology began to be investigated more systematically. Then, Schevill began a series of investigations of cetacean acoustics at the Woods Hole Oceanographic Institution (WHOI) that continue. In the early 1970s, several other researchers began studying marine mammals in this region.

The results of this earlier work was addressed in 1979 when the U.S. Marine Mammal Commission (USMMC) sponsored a workshop to help define research needed for the study of marine mammals on the East and Gulf Coasts of the United States (Prescott *et al.* 1980). More than 50 participants from governmental agencies, scientific institutions, and independent research programs identified more than 28 scientific institutions with ongoing studies of marine mammals. These research efforts had resulted in substantial knowledge of the species inhabiting the region, and summaries of available information were presented for 22 cetacean and two pinniped species. These summaries revealed several information gaps, and the workshop participants developed five series of partially overlapping recommendations for future research. These have been reorganized into three general topics in paraphrased form in Table 1.

Shortly after the 1979 workshop, two major marine mammal research programs were begun, one a 3-yr program at the University of Rhode Island (URI) sponsored by the Minerals Management Service (*i.e.*, Cetacean and Turtle Assessment Program, or CeTAP), and the other a decade-long program of contract studies sponsored by the Northeast Fisheries Science Center (NEFSC). The two research programs are in marked contrast, with CeTAP being relatively short and tightly focused on determining distribution and abundance, and with the NEFSC program being much broader in scope and funded on a continuing basis. CeTAP resulted in an omnibus volume reporting a series of aerial sighting surveys covering the area from Cape Hatteras to Nova Scotia, giving seasonal distribution patterns and estimates of numbers of animals based on line transect methods (Cetacean and Turtle Assessment Program 1982). The NEFSC program has resulted in a long series of more modest research projects primarily in the form of small contract studies which, taken as a whole, document aspects of the distribution, ecological relationships, and human interactions for marine mammals in the region.

The direction and form of the National Marine Fisheries Service (NMFS) research program were adjusted over the decade in response to: (1) results of funded projects; (2) results of other projects on marine mammals and commercial fisheries; (3) additional planning workshops; and (4) to a considerable degree, personal interests of scientists who proposed interesting research topics. This program was markedly expanded in 1990

Table 1. Research recommendations from the 1979 "East Coast/Gulf Coast Cetacean and Pinniped Research Workshop" (Prescott *et al.* 1980), organized into three broad research areas

Species Group	Recommendation
	Ecological Roles and Habitat Requirements
All	Determine essential elements of marine mammal habitats by analyzing existing oceanographic, biological, fisheries, and marine mammal sighting data
All	Validate hypotheses generated from existing data using new oceanographic, biological, fisheries, and marine mammals sighting data to be collected
All	Study habitat alteration: oil & gas, noise, thermal effluents, environmental contaminants, reduction in carrying capacity, and habitat alteration (dumping, dredging, coastal zone development)
Harbor seal	Determine population discreteness, food habits, seasonal movements, and essential habitats through tagging and radiotelemetry
Large cetaceans	Determine habitat use and migration using sighting surveys, natural marks, Discovery tags, and radio tags
Harbor porpoise, bottlenose dolphin	Determine stock identity and movements using tagging studies; define essential habitat especially relative to coastal development and vessel traffic levels; assess contaminants through tissue analysis
	Human Interactions
All	Establish magnitude and nature of incidental take by fisheries using systematic surveys and interviews with fishermen
All	Integrate information on extent, nature, and proposed development of fisheries with marine mammal research plans
All	Modify permit process for incidental take to encourage recovery of specimens for scientific study; assess human activities that may threaten the population or species; and utilize specimens currently unavailable for research
Harbor porpoise, humpback	Assess the extent, nature, and effects of humpback subsistence fisheries
All	Examine the extent, nature, and effects of harassment on marine mammal populations and habitat
	Optimum Sustainable Population Levels
Large whales	Reanalyze existing population estimates and data
Large whales	Examine and analyze historical data, including whalers' logbooks
Harbor porpoise, bottlenose dolphin	Estimate population size and distribution using aerial and ship surveys
Harbor seal	Confirm and monitor the suspected increase in populations, at 3-yr intervals

in response to information needs mandated by the 1988 amendment of the Marine Mammal Protection Act (MMPA).

This paper describes the results of the NEFSC marine mammal research program, 1980 to 1989. Over this decade, research projects on many species of marine mammals and on many subjects were supported. To provide an overview of the program, we have organized the more than 100 contract and in-house projects into four different research areas and, within these, into 18 general topics. Summaries are provided of the research in each of the 18 topics based on the many published papers, contract reports, informal NEFSC staff reports, and abstracts of oral presentations at scientific meetings.

Table 2. Definition of four general areas into which NEFSC-funded contract projects were grouped retrospectively

Research Area	Definition
Ecological roles and habitat requirements	Focus is on seasonal & spatial distribution patterns, on feeding habits, and on basic population biology, including indirect interactions with human activities through the food chain
Human interactions	Focus is on those areas where human activities have direct impact on marine mammals, including bycatch, entanglement, and whale watching
Optimum sustainable population size	Focus is on abundance of marine mammals, addressing their historic levels especially relative to information needs under the MMPA and Endangered Species Act
Research planning and archiving	Focus is on identifying longer term research planning strategies, including identifying information gaps and new research methods, and on documenting and archiving results of previous research

RETROSPECTIVE ORGANIZATION OF RESEARCH PROJECTS

The more than 100 contracts and in-house projects supported over the decade were classified retrospectively into four research areas, depending on the primary focus of the study (Table 2). Projects that appeared to fall into more than one area were classified according to where the most important results were obtained. Within each of the four areas, research topics were defined to include several related projects. This resulted in two to six topics studied in each research area (Table 3).

When grouped into the topics defined in Table 3, the general thrusts of NEFSC's marine mammal research in the 1980s can be seen. Although this retrospective classification gives a greater sense of continuity and directedness than was the case, it provides a comprehensive method of understanding how the research direction varied over the decade. This is especially reflected in the amounts of money spent on the different studies each fiscal year (Table 4). Most research topics were supported for more than one year, and although gaps in support occurred, research in most of the topics was supported for several years.

SUMMARY OF RESEARCH RESULTS

The results of marine mammal research projects supported by the NEFSC between 1980 and 1989 are documented in the scientific literature (Appendix A) and in a series of contract reports and working papers (Appendix B), abstracts of oral presentations at scientific meetings (Appendix C), and brief cruise reports (Appendix D). This information has been used to prepare the following summaries of research results in each topic in the research areas defined in Tables 2 and 3. The references relevant to each topic are summarized in Table 5.

ECOLOGICAL ROLES AND HABITAT REQUIREMENTS

Topic 1. Harbor and Gray Seal Distribution and Biology

Studies conducted on harbor seal tissue samples collected from animals that had mass stranded on Cape Cod in 1980 indicated that the animals died from a pneumonia epidemic. Furthermore, size composition and autopsy data revealed that most of the dead animals were immature.

Researchers at Manomet Bird Observatory (MBO) conducted a study of harbor seal diel behavior and response to human disturbance at Stage Harbor, Massachusetts. In addition, individual behavioral studies were conducted by using phalange color patterns to recognize individual animals.

A small pilot study to determine ages of stranded harbor seals using radiographic techniques was funded. Results of this pilot study were inconclusive.

Researchers at MBO studied the movements of two, radio-tagged, rehabilitated harbor seals in Cape Cod Bay, and the population dynamics of harbor seals in Massachusetts coastal waters. The radiotelemetry study documented that rehabilitated seals can survive release back into the ocean after an extended period of captivity. The study also documented the number of seals using Massachusetts coastal haulout sites, and seal food habits based on scat analysis.

MBO researchers conducted aerial surveys during 1983-87 to document seasonal distribution and abundance of harbor seals on their Southern New England overwintering grounds. These surveys documented a steady increase in the number of overwinter seals, supporting other regional studies that suggest a doubling of the Gulf of Maine harbor seal population since enactment of the MMPA.

Table 3. Research topics defined retrospectively within each of the four research areas

Topic	Definition
Ecological Roles and Habitat Requirements	
1. Harbor and gray seal distribution and biology	Tissue samples from 1980 stranding; behavior; radiotelemetry; scat samples; Nantucket Sound population
2. Marine observer program	Sighting surveys for cetaceans, seabirds, and sea turtles (conducted by Manomet Bird Observatory aboard NOAA fishery research vessels)
3. Energetic requirements of East Coast cetaceans	Respiration characteristics; predator-prey relations; food habits; trophic interactions; marine mammal - fisheries interactions
4. Western Gulf of Maine humpback and fin whales	Seasonal distribution and abundance; photo-identification; habitat use; demographics
5. Humpback biopsy sampling	Karyotypic analyses for sex determination and chromosome variability; behavioral response to biopsy dart
6. Biological sampling of fishery bycatch	Incidental takes of nonendangered marine mammals from East Coast foreign fishing/processing vessels (analyzed by Smithsonian Institution)
7. Northern right whale habitat requirements	Detection of changes in populationdistribution and size
Human Interactions	
8. Marine mammal- fishery interactions	Documentation of marine mammals incidentally taken in New England groundfish gill nets (conducted by University of Maine - Orono)
9. Whale - vessel interactions	25 yr of observations of large cetaceans' reactions to human activities in Cape Cod Bay area (analyzed by WHOI)
Optimum Sustainable Population Size	
10. Harbor seal distribution and abundance	Aerial surveys along Maine coast to obtain population, recruitment, and distribution information in 1985-86
11. Harbor porpoise distribution and abundance	Shipboard surveys along Maine coast to study distribution patterns, population size, and seasonal movements (conducted by the New England Aquarium)
12. Harbor porpoise survey methodology	Experimental line-transect surveys in Gulf of Maine to test sighting methods and determine seaward and northern distribution (conducted by the NEFSC)
13. Humpback photo-identification catalog	Western North Atlantic humpback photo-identification catalog with over 3500 individual identifications (maintained by College of the Atlantic)
14. Northern right whale photo-identification catalog	Aerial and shipboard photo-identification; population catalog estimates; seasonal movement; tracking individuals to document calving intervals
15. Northern right whale distribution and abundance	Calving rates; population estimation and seasonal distribution; demographics; behavior; social groups
16. Bottlenose dolphin distribution and abundance along the Virginia capes	1980 aerial surveys in mouth of Chesapeake Bay
Research Planning and Archiving	
17. Workshop support	Workshop support in 1980, 1981, and 1986; staff time to plan and administer contracts and other studies
18. Documentation and archiving	Transfer of CeTAP data to NEFSC archiving fishery survey formats; creation of bibliographic system for cetacean literature; analysis of whaling logbooks

Table 4. Expenditures on marine mammal research (thousands of dollars) during fiscal years 1980-89 in 18 research topics organized into four research areas (as defined in Tables 2 and 3)

	Topic	Fiscal Year									
		80	81	82	83	84	85	86	87	88	89
	Ecological Roles and Habitat Requirements										
1.	Harbor and gray seal distribution and biology	42	3		15	1	2		4		
2.	Marine observer program	25	41	30	31	52	55	53	53	58	60
3.	Energetic requirements of East Coast cetaceans	5			13		6	1	7		30
4.	Western Gulf of Maine humpback and fin whales					12	10	20	31	38	31
5.	Humpback biopsy sampling		2		13		28	6			
6.	Biological sampling of fishery bycatch								4	5	5
7.	Northern right whale habitat requirements					10		20	32	20	30
	Human Interactions										
8.	Marine mammal- fishery interactions	37	46	20	15	15	60	6			
9.	Whale - vessel interactions						24				
	Optimum Sustainable Population Size										
10.	Harbor seal distribution and abundance		4	20	24	1		29			
11.	Harbor porpoise distribution and abundance	45		30	7						
12.	Harbor porpoise survey methodology								8	5	10
13.	Humpback photo-identification catalog	23	56	39	29	29	22	18	22	21	22
14.	Northern right whale photo-identification catalog							73	70	67	76
15.	Northern right whale distribution and abundance	23	28	25	45	49	33	290	140	120	114
16.	Bottlenose dolphin distribution and abundance along the Virginia capes	10									
	Research Planning and Archiving										
17.	Workshop support	16	2					1	2	3	5
18.	Documentation and archiving	.5						24	10		

Table 5. Publications, reports, and oral presentations germane to each of the 18 research topics in the four research areas. (Numbers refer to numbered items in the corresponding appendix.)

Topic	Appendix			
	A	B	C	D
Ecological Roles and Habitat Requirements				
1. Harbor and gray seal distribution and biology	26,28,40	7,40,55,56,68,72	5,10,26,38	
2. Marine observer program	22-24,33-38, 43,44,50	39,41-54,59-63,71,74,75,79	16,28	
3. Energetic requirements of East Coast cetaceans	20,21,25,27, 29,42	6,20,21,37,76	22,23,25,33,37	
4. Western Gulf of Maine humpback and fin whales	4-9,11,12,39,41	34,36	11,15,29,40	
5. Humpback biopsy sampling	16,17	28,29,80	19,27,41	
6. Biological sampling of fishery bycatch			18	
7. Northern right whale habitat requirements	2,15,18,45	38	14,36	
Human Interactions				
8. Marine mammal- fishery interactions	30,48	8-12	17,30,42	
9. Whale - vessel interactions	49	78		
Optimum Sustainable Population Size				
10. Harbor seal distribution and abundance	28	73	39	
11. Harbor porpoise distribution and abundance	30	23,25,57,58,65	8	1-3
12. Harbor porpoise survey methodology	32,43,44	38,65	3,34	1-3
13. Humpback photo-identification catalog	3,8,19,39, 47	1,3,13-16, 30-33,35	4,6,9,11,12, 21,24	
14. Northern right whale photo-identification catalog	14	5,35,38	2,7	
15. Northern right whale distribution and abundance	2,10,13,15, 45,46	17,18,22,24, 26,27,66,67,70	13,31,32,35	
16. Bottlenose dolphin distribution and abundance along the Virginia capes	1	2	1	
Research Planning and Archiving				
17. Workshop support	2	4,64,69		
18. Documentation and archiving		19,77	20	

Analyses of harbor seal scat samples collected on major haulout grounds indicated that sand lance (*Ammodytes* sp./spp.) was the preferred prey item. The abundance of sand lance coincided with the population explosion of this prey species in Northeast shelf waters during the 1980s.

Surveys of the Nantucket Sound gray seal population were conducted in 1982 and 1983 to document numbers, size composition, and reproductive success. The study revealed that 23-28 seals used Muskeget Island and that successful pupping had occurred. The presence of branding marks on some adult and subadult seals indicated that some of the animals were from the Sable Island population. This suggests that gray seal population growth in Nantucket Sound is partly due to recolonization of historical haulout sites by Sable Island animals.

Topic 2. Marine Observer Program

MBO researchers conducted systematic sighting surveys for cetaceans, seabirds, and sea turtles aboard NOAA fishery research vessels off the Northeast coast during 1980-87. These surveys provided substantial data on the spatial and seasonal distribution and abundance of cetaceans and seabirds. In addition, because these data were collected simultaneously with fisheries data, they can be used to assess trophic interactions among cetaceans, pelagic fishes, and squids. These data are archived in computer data files.

The decommissioning of the NOAA fishery research vessel *Albatross IV* from June 1989 to October 1991 shifted the emphasis of the MBO contract to compiling sea bird and cetacean atlases, trophic interaction studies, and evaluating historical sighting-survey data-collection procedures with the goal of improving survey design by incorporating recent line-transect methodology.

Topic 3. Energetic Requirements of East Coast Cetaceans

At the College of the Atlantic (COA), researchers analyzed 6 yr of undisturbed fin whale respiration rate data collected off Mount Desert Rock in the Gulf of Maine. This study compared five respiration characteristics (*i.e.*, dive length, surfacing length, blows per surfacing, blow interval, and percent of time at surface) when fin whales were undisturbed and when they were in the presence of whale watch vessels. This analysis indicated that there were no significant differences between the respiration characteristics of undisturbed whales and of whales in the presence of vessels.

URI researchers used CeTAP cetacean biomass density estimates, cetacean food habits literature, and published metabolic models to calculate the energetic requirements of the cetaceans of the Northeast outer continental shelf. Depending on the model used, annual prey consumption was approximately 365,000 or 545,000 metric tons (mt). The estimates of finfish (185,000 or 276,000 mt) and squid (154,000 or 224,000 mt) consumption totals exceed by about a third the commercial harvests. These estimates indicate that cetaceans are an important predator in the Northeast U.S. Shelf Ecosystem.

Researchers at the University of Massachusetts studied population dynamics of sand lances (*Ammodytes* spp.) off the Northeast coast. These species are principal prey for the endangered humpback and fin whale, and may be important competitors with the northern right whale for *Calanus* copepods. Collapse in 1986 of the sand lance population on Stellwagen Bank in the Gulf of Maine dramatically shifted the distribution of these three whales off the Massachusetts coast. Researchers analyzed 1968-87 sand lance abundance data collected during NEFSC spring and autumn bottom trawl surveys on the Northeast shelf between Cape Hatteras and Nova Scotia. In addition, age-and-growth studies provided information on growth rates, maturity, and age composition of the population. These data are being used in ecosystem models being developed at the NEFSC (Overholtz *et al.* 1987).

University of Massachusetts researchers conducted a sensitivity analysis of a multispecies virtual population analysis, with special emphasis on the impact of cetacean consumption of principal pelagic prey species (*i.e.*, sand lances, Atlantic herring, and Atlantic mackerel). Results of the analysis indicated the need to collect additional data on trophic interactions between cetaceans and prey resources on the Northeast shelf.

Researchers at the NEFSC processed stomach samples which had been collected by fishery observers aboard domestic and foreign fishing vessels. In addition, observers conducted qualitative examinations of marine mammal stomachs that could not be frozen. These food habits data provided new information on the trophic interactions of shelf and shelf-edge cetaceans, and will be incorporated into ecosystem models being developed at the NEFSC.

The spatial/temporal overlap between the Mid-Atlantic/Southern New England delphinid complex and potential pelagic prey resources will be analyzed using geographic information system technology and fisheries and oceanographic data primarily archived at the NEFSC. Results of these analyses will be helpful in understanding direct and indirect marine mammal fisheries interactions.

Topic 4. Western Gulf of Maine Humpback and Fin Whales

Beginning in October 1984, researchers at the Center for Coastal Studies (CCS) in Provincetown, Massachusetts, conducted tract surveys to document the seasonal distribution and abundance of the fin whale and humpback in Cape Cod Bay and on the Provincetown Slope. Oceanographic, behavioral, photographic, and population demographic data were also collected. Additionally, in high-use habitats, researchers documented the oceanographic (*i.e.*, biological and physical) and geographic characteristics of those regions to identify the mechanisms which attract and maintain groups of whales. In latter years, summer shipboard surveys were expanded to include the Great South

Channel, the northern edge of Georges Bank, and major banks and ridges within the Gulf of Maine. Furthermore, a cooperative data exchange program begun in the latter years with researchers in Nova Scotia provided information on individual animal spatial/temporal patterns.

CCS researchers collected sighting, photo-identification, habitat use, and demographic data while serving as naturalists aboard commercial whale watch vessels. These data were incorporated into the data base, and have provided insights into daily and seasonal movements.

Topic 5. Humpback Biopsy Sampling

The NEFSC funded a small study on the biology of the humpback on Stellwagen Bank in the Gulf of Maine. Researchers used photo-identification techniques to identify individual animals and to document social and feeding behavior on an important summer feeding site in the western gulf.

During the mid-1980s, humpback tissue samples were collected using a biopsy dart and were cultured for karyotypic analyses. Karyotypic analyses included sex determination according to chromosome complement, and measures of chromosome variability. Geographically isolated populations were sampled to allow a quantitative comparison of chromosome variability between Atlantic and Pacific humpback populations. Results of these studies indicated that karyotyping is a useful technique for determining sex and for tracking family lineages, and that ongoing photo-identification studies complement biopsy work. Results also suggested that R-banding patterns can be used as a measurement of chromosomal variability in geographically isolated populations. Fluke photographs were taken of all animals sampled, and the behavioral responses of the whale to the biopsy dart were documented.

Topic 6. Biological Sampling of Fishery Bycatch

Beginning in 1986, observers aboard East Coast foreign fishing/processing vessels froze, when feasible, all carcasses of nonendangered marine mammals incidentally taken in fishing operations for later processing at the Smithsonian Institution. Beginning in 1989, biological samples were also collected by observers aboard domestic fishing vessels (see Topic 8).

These specimens are providing new information on the food habits, morphometrics, reproductive biology, physiology, and parasitology of the offshore delphinid complex, particularly the long-finned pilot whale, common dolphin, bottlenose dolphin, and pan-tropical spotted dolphin. Furthermore, because these animals were apparently healthy, analyses of tissue contaminants are providing important baseline information for non-bycatch-related mortality events (*i.e.*, 1987-88 bottlenose dolphin mass stranding event).

Topic 7. Northern Right Whale Habitat Requirements

Under a Congressional initiative supporting research on the northern right whale, the NEFSC's ongoing research on habitat requirements of the right whale (see Topic 15) increased in 1987. Studies were begun by the CCS utilizing fine-scale observations of right whale distribution and feeding behavior in Cape Cod Bay. This approach was complemented by related studies sponsored by the National Science Foundation through URI, and by the State of Massachusetts. The results are leading to improved understanding of the prey densities required by the right whale.

HUMAN INTERACTIONS

Topic 8. Marine Mammal - Fishery Interactions

During the early 1980s, researchers at the University of Maine - Orono (UMO) conducted studies to document the species, number, seasonality, and population characteristics of marine mammals incidentally taken in New England groundfish gill nets. The researchers secured a small-take exemption permit on behalf of cooperative gill-netters, and these fishermen sent take forms to the university; carcasses from incidentally taken marine mammals were brought to shore for necropsy by UMO personnel. Based on a 60-percent logbook return rate, the number of harbor porpoise reported killed was 30 for 1984 and 107 for 1985, or 4.3 and 8.2 animals per fisherman. The researchers suggested that the reported number of kills by permit holders was a lower limit for the actual number killed, and that an upper limit might be 600 based on the mean annual kill rate per fisherman and on the researchers' estimate of a maximum of 120 gill-netters. In addition, the researchers identified other fisheries (*i.e.*, halibut tub trawl, lobster pot, and groundfish longline) in the Gulf of Maine which should be investigated. Information on incidental catch of cetaceans in foreign fisheries for Atlantic mackerel and Atlantic squid has been collected by observers since 1977. Waring *et al.* (1990) used these data to estimate total numbers of animals killed, and to examine causes of the interactions. Principal species killed were pilot whales and the common dolphin. Costs of this data collection program are not reflected in Table 4.

Starting in 1989, observers were put aboard domestic fishing vessels to record information on fishing operations and discards of fish, marine mammals, and sea turtles. Significant levels of marine mammal takes were confirmed in the Gulf of Maine sink gill-net fishery (primarily harbor porpoise) and in the swordfish drift gill-net fishery (some 10 different cetacean species). Costs of this data collection program are not reflected in Table 4.

Topic 9. Whale - Vessel Interactions

At WHOI, researchers analyzed over 25 yr (1957-82) of observations on responses of large cetaceans to human-induced stimuli in waters in and around Cape Cod Bay. Results of these analyses indicated that the reactions of whales to human activities vary by species, and may vary within a species over time: the minke whale remained generally uninterested and undisturbed by vessel traffic; fin whale behavior changed from uninterested and often negative to much more uninterested and less often negative; northern right whale behavior remained about the same, their responses were nearly equally distributed between uninterested and negative reactions; and the humpback changed from mixed responses in earlier years to more positive responses in recent years.

OPTIMUM SUSTAINABLE POPULATION SIZE

Topic 10. Harbor Seal Distribution and Abundance

In 1985-86, researchers at UMO conducted aerial surveys along the Maine coast to obtain population, recruitment, and distribution information on the harbor seal. These surveys were comparable to the first Maine coast survey conducted by UMO researchers in 1972. The 1972 survey was also funded by NEFSC. Results of the mid-1980s study indicated that the harbor seal population was still growing, but at a declining rate. The harbor seal population was estimated to be 12,000-15,000 animals which was more than double the 1972 estimates.

Topic 11. Harbor Porpoise Distribution and Abundance

The New England Aquarium (NEA) conducted shipboard surveys along the Maine coast in July 1982 to determine coastal distribution patterns and to estimate population size using line-transect methods. Harbor porpoise were observed in a continuous area from Port Clyde to Cutler, Maine. No harbor porpoise were observed southwest of this area, and the survey did not extend to the northeast. A population estimate of roughly 8,000 (with a 95-percent confidence interval of ±1,327) was derived. Furthermore, this estimate was expanded by 52 percent to roughly 15,000, based on the likelihood that all animals on the trackline were not seen.

NEA researchers used harbor porpoise sightings made aboard whale watch and research vessels working in the coastal waters of the Gulf of Maine to document seasonal distribution. The results indicated that most of the harbor porpoise population was along the eastern Maine coast and in the Bay of Fundy in late summer, and that some animals made a coastwide north-south seasonal migration in spring and autumn.

Sighting survey methodology experiments that began in 1987 by NEFSC researchers (see Topic 12) improved the documentation of seasonal distribution, better defining the southern edge of the summer range and the northeastern distribution pattern of the species.

Topic 12. Harbor Porpoise Survey Methodology

Beginning in 1987, the NEFSC conducted experimental line-transect harbor porpoise surveys in the Gulf of Maine. The objectives of these surveys were to test line-transect sighting methods using two teams of observers. Preliminary results of these studies indicated that harbor porpoise elicited negative response to the survey vessel, that a large fraction of animals along the track line were missed, and that observer elevation above sea surface has little effect on sighting rate.

Topic 13. Humpback Photo-identification Catalog

Beginning in 1980, COA was funded to maintain the western North Atlantic humpback photo-identification catalog, receiving photographs from cooperative researchers between Iceland and Puerto Rico. The catalog contains over 3,500 individually identified whales. In cooperation with NMFS National Marine Mammal Laboratory staff, COA researchers incorporated the catalog into a computer-assisted photomatching system. Photographs were stored on a video disc, and an interactive computer program allowed the matcher to scan the entire collection rapidly to make a match.

Using mark-recapture methods, researchers derived population estimates for the five western North Atlantic substocks. In addition, individual photo-identification data, together with DNA fingerprint studies, provided information on family lines and stock interchange.

Researchers at the CCS conducted a study on the stability of humpback fluke patterns over time. This analysis was conducted using a time series of photographs archived at CCS. Conclusions were that the most dramatic change in fluke patterns occurs in calves during their first 2 yr of life, particularly calves with darker flukes, but experienced matchers were able to detect these changes. This study supported the validity of using fluke patterns for long-term studies of individual animals.

During the early 1980s, several research organizations were funded to conduct song recordings and photo-identification studies on the western North Atlantic humpback on overwintering and calving grounds in the Caribbean Sea. These studies provided information on breeding behavior, stock intermixing, individual identification, and habitat use.

Topic 14. Northern Right Whale Photo-identification Catalog

Under a Congressional initiative supporting research on the northern right whale, the NEFSC's ongoing support (see Topic 15) for a photo-identification catalog increased in 1987. Sets of individual identification photographs were integrated into a single data base by researchers at NEA, WHOI, URI, and the CCS. This resulted in an improved count of individually known animals and a published catalog, as well as an ongoing system for integrating new photographs. The results are being used to provide information on vital rates and abundance.

Topic 15. Northern Right Whale Distribution and Abundance

During the early 1980s, the NEFSC funded several northern right whale studies that focused on photo-identification, calving rates, population estimation, demographics, and habitat use. These early studies provided data on seasonal movements of individual animals between the overwintering calving grounds off the southeastern U.S. coast and the spring-summer feeding grounds off New England and in the Bay of Fundy. Aerial and shipboard photo-identification studies provided population estimates and allowed researchers to track individual animals and to document calving intervals for known animals.

In the mid-1980s, the NEFSC contributed to right whale research supported by the NMFS Southeast Fisheries Science Center's Miami Laboratory. These studies involved the documentation of historic right whale whaling activities along the southeastern U.S. coast, particularly off North Carolina.

Under a Congressional initiative, an integrated study on the North Atlantic right whale was implemented in 1987 through a cooperative agreement with URI. The overall goal of this research was detecting changes and causes of changes in population distribution and size.

To meet these goals, aerial and shipboard sighting data were collected to document seasonal distribution and abundance patterns, especially in the region of the Great South Channel and the Bay of Fundy, and more broadly on the East Coast to document the species range; some of these studies provided photo-identification materials (see Topic 14). This effort was complemented by studies funded by the Minerals Management Service on winter distributions along the southeastern U.S. coast, and on development of satellite tag methods.

Topic 16. Bottlenose Dolphin Distribution and Abundance along the Virginia Capes

Aerial surveys conducted during July-October 1980 in the mouth of Chesapeake Bay and along the Virginia coast indicated bottlenose dolphin herd density was higher in the coastal areas. Furthermore, researchers hypothesized that herds in the bay were part of the coastal stock.

RESEARCH PLANNING AND ARCHIVING

Topic 17. Workshop Support

Following the 1979 Marine Mammal Research Planning Workshop (Prescott *et al.* 1980), several other more specialized research planning workshops were conducted. The NEFSC participated in most of these, and provided funds to support many of them.

The NEFSC contributed to a 1981 humpback workshop that was held at the NEA. The purpose of this workshop was to determine the status of knowledge and research needs for East Coast humpback research. Recommendations from this workshop were used by the NEFSC to fund humpback studies.

In 1983, researchers supported by the NEFSC participated in a workshop on the status of the northern right whale which identified key research needs relative to this species. In 1985, NEFSC staff participated in a workshop with other NMFS scientists to define research priorities for large whales.

The NEFSC contributed to a 1986 workshop on fin whale photo-identification techniques. The focus of this workshop was to review field photographic techniques, and animal characteristics that are used to identify individual animals. The workshop concluded that photo-identification techniques could be used to identify individuals, and agreed to establish a fin whale catalog at COA.

To implement a research program on the North Atlantic right whale funded directly by Congressional initiative, the NEFSC began in 1987 to work with scientists in several regional scientific institutions to design a long-term research program on photo-identification, habitat use, and distribution and abundance. Also in 1987, NEFSC staff began to participate in the Scientific Committee of the International Whaling Commission (IWC), and in meetings of the Marine Mammal Committee of the International Council for the Exploration of the Sea (ICES).

Topic 18. Documentation and Archiving Project

A small study was funded to examine whaling records archived at the Kendall Whale Museum. Purpose of this study was to document historical distribution of the northern right whale along the East Coast.

Researchers at URI were funded to transfer an edited and documented copy of the CeTAP data base to a format that was compatible to NEFSC data bases. This acquisition provided the NEFSC and NMFS Northeast Regional Operations Office staff with access to one of the most comprehensive data sources on

distribution and abundance of cetaceans and sea turtles in the Northeast. The CeTAP was run by URI under contract to the U.S. Department of the Interior. These data have been used in developing additional sighting surveys, preparing management plans, and commenting on environmental impact statements.

Researchers at WHOI designed a comprehensive reference data base for marine mammal literature. The system used INMAGIC software to format, search, sort, and store the data. The data base was organized to complement the format used by William E. Schevill for his extensive collection of cetacean literature. The data base allows the user to retrieve references based on topic, author, species, geographic region, and taxonomic level. A copy of this data base resides at the NEFSC, and NEFSC staff have added references for all NEFSC marine mammal contract reports.

SUMMARY OF RESULTS IN THE FOUR RESEARCH AREAS

The decade of research described here addressed many, but not all, of the issues raised in the 1979 planning workshop, with progress being made on most of the recommended topics. Several studies were supported nearly continuously throughout the decade, with the simultaneous cetacean, seabird, and fishery resource surveys (marine observer program) and humpback photo-identification catalog being most notable. Research emphasis increased on large whales in the last half of the decade. Other studies were supported only once or for a few years. The research on marine mammals increased in magnitude and scope over the decade, with major increases in funding occurring in 1986, and with increasing amounts of NEFSC staff time being devoted to this work.

Activities in research planning and archiving continued throughout the decade as the recommendations of earlier planning workshops were addressed, and as plans were revised to address increasing interest in marine mammals. Late in the decade, additional research planning began to be conducted directly by NEFSC staff, especially on the northern right whale. Several research projects began to be conducted by NEFSC staff, especially on harbor porpoise. Additionally, NEFSC staff participated more frequently in national and international activities related to marine mammals, including the Scientific Committee of the IWC, the Committee of Scientific Advisors of the USMMC, and the Marine Mammal Committee and Multispecies Working Group of ICES.

Research on human interactions had identified the principal direct interactions by mid-decade, but lack of systematic observations aboard fishing vessels precluded assessing the seriousness of the interactions. This was remedied late in the decade with establishment of a systematic fishing vessel observer program to monitor all types of bycatch (funding not shown in Table 4), and future studies will use these data to estimate total bycatch.

Research on ecological roles and habitat requirements initially focused on the harbor seal and the relationships between marine mammals and fishery resources. The simultaneous surveys for cetaceans, seabirds, and fishery resources continued throughout the decade, providing information on the co-distribution of cetaceans and especially pelagic fishery resources, as well as documenting the main aspects of seasonal movements of seabirds through the area. The emphasis on seal biology and ecology gradually gave way to an increasing focus on large whale habitat and ecological relationships.

Research on optimum sustainable population size includes those projects that primarily focused on distribution and abundance; over the decade emphasis has been given to the harbor seal, harbor porpoise, humpback, and northern right whale. Photo-identification catalogs have been supported, first for the humpback, and then for right and fin whales later in the decade. The need for improved estimates of total abundance for species subject to bycatch in commercial fisheries prompted a study in sighting survey methodology late in the decade.

IMPLICATIONS FOR FUTURE RESEARCH DIRECTIONS

Throughout the 1980s, research on marine mammals in the Northwest Atlantic expanded greatly, and many of the questions identified in 1979 were at least partially answered. In addition to the research described here, other studies by WHOI, URI, CCS, University of Guelph, and UMO contributed greatly to our understanding of marine mammals, especially cetaceans, in the Northwest Atlantic.

The information needs have changed, as a result both of the questions answered and of new issues arising. The 1988 amendment of the MMPA focused on interactions with commercial fisheries. While the initial emphasis was on direct effects through bycatch and entanglement, indirect interactions of marine mammals and fisheries through ecological interactions are becoming increasingly important nationally in the seemingly contradictory goals of the MMPA and the Magnuson Fishery Conservation Management Act. International concerns about the possible resumption of commercial whaling and the expressed interest in culling of marine mammal populations to improve commercial fisheries for marine mammal prey species also raise the need for additional information on indirect interactions. Similarly, the likely adoption by NMFS of Endangered Species Act recovery plans and MMPA conservation plans for such species as the humpback and northern right whale provides well defined research needs relating to status, habitat requirements, and the likely effects of various regulations of human activity.

All of these information needs require improved basic knowledge of marine mammal biology and ecology. Some of this information can only be obtained through basic scientific studies that can only be undertaken on an opportunistic basis. For example, in the Northwest Atlantic, many aspects of the biological study of cetaceans can be undertaken using specimens

collected from the commercial fisheries bycatch and from mass strandings. The extensive fishery observer program conducted by NEFSC includes collection of carcasses and biological samples wherever possible, samples that can be used by the scientific community at large. Similarly, mass strandings on Cape Cod and elsewhere are regular if infrequent events that the scientific community should be prepared to take maximum advantage of. On the other hand, some information can only be obtained by long-term observations of "naturally" occurring experiments. For example, fluctuations in the distribution and abundance of the pelagic fishes in the region from Cape Hatteras to the Gulf of Maine on the scale of decades have been documented during the regular fishery monitoring programs of NMFS. Such fluctuation may well be reflected in changes in the distribution and possibly the abundance of cetaceans (Sissenwine *et al.* 1984), changes that can only be detected by long-term cetacean monitoring programs (Smith *et al.* 1990). Research opportunities such as these must be identified, and suitable programs put into place both to respond as opportunities arise and to ensure that long-term monitoring is done in a manner that will allow strong inferences in the long term.

Major advances in marine mammal research methods are being made, advances that will allow new questions to be addressed. For example, attachment devices and packaging of satellite tags have improved so that successful attachments to either restrained or free-swimming cetaceans of all sizes are possible. Similarly, biochemical studies of the genetics and feeding ecology of marine mammals can be conducted using biopsy samples. Line-transect survey methods have come into regular use, especially within the IWC's Scientific Committee, and the assumptions and methods are being critically investigated, and major advances are being made. The routine use of individual whale photo-identification has been achieved for the humpback and northern right whale, and is being explored for other species. The applications of these approaches to other species (such as the fin whale) and to larger populations need to be explored. The latter is especially important to meet questions being raised in the context of possible resumption of commercial whaling in the North Atlantic and Antarctic. Research programs need to identify the possible application of these methods to the questions being addressed, advances need to be capitalized on, and further advances supported.

The focus of marine mammal studies by scientists in the northeastern United States has been primarily within the continental shelf, with only limited sampling being done beyond the 2000-m depth contour. Many important species occur seasonally well off the shelf, including both animals (such as the sperm whale and bottlenose dolphin) that occur along the Gulf Stream wall in summer, and others (such as the humpback) that migrate to wintering grounds in the Caribbean Sea. An understanding of the biology and ecology of cetaceans will require understanding the importance of their use of these habitats, a critically important issue, for example, in evaluating the status of the North Atlantic humpback (Beard *et al.* 1990).

The marine mammal research program at the NEFSC was expanded substantially in 1990, with the assignment of six scientists and technicians. The focus of that program is developing from the research conducted in the 1980s, but necessarily will be changed to accommodate new information needs and new research methods. Assistance will be needed from marine mammal scientists and from resource managers to ensure both that short-term and long-term information needs are met, and that opportunities for collaboration and coordination of efforts are fully realized.

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APPENDICES

APPENDIX A

Published Scientific Papers Based on Marine Mammal Research Projects Supported by the NEFSC between 1980 and 1989

1. Blaylock, R.A. 1988. Distribution and abundance of the bottlenose dolphin, *Tursiops truncatus* (Montagu, 1821), in Virginia. *Fish. Bull. (U.S.)* 86(4): 797-805.

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41. Seipt, I.E.; Clapham, P.J.; Mayo. C.A.; Hawvermale, M.P. 1989. Population characteristics of individually identified fin whales, *Balaenoptera physalus*, in Massachusetts Bay. *Fish. Bull. (U.S.)* 88(2): 271-278.

42. Selzer, L.A.; Payne, P.M. 1989. Ecological differences in the distribution of the white-sided dolphin (*Lagenorhynchus acutus*) and common dolphin (*Delphinus delphis*) in the shelf waters of the Northwest Atlantic. *Mar. Mammal Sci.* 4: 141-153.

43. Smith, T.D.; Payne, P.M.; Heinemann, D.; Waring, G.T.; Lange, A. 1990. Simultaneous fishery resource and seabird and cetacean sighting surveys: advantages and disadvantages. *N. Atl. Stud.* 2(1-2): 90-101.

44. Smith, T.D.; Payne, P.M.; Heinemann, D.; Waring, G.T.; Lange, A. 1988. Utility of cetacean and seabird surveys conducted during fishery surveys. *Int. Counc. Explor. Sea C.M.* 1988/N:5; 40 p.

45. Stone, G.S.; Hammer, W.M. 1988. Humpback whales, *Megaptera novaeangliae*, and southern right whales, *Eubalaena australis*, in Gerlache Strait, Antarctica. *Polar Rec.* 24(148): 15-20.

46. Stone, G.S.; Kraus, S.D.; Prescott, J.H.; Hazard, K.W. 1988. Significant aggregations of the endangered right whales, *Eubalaena glacialis*, on the continental shelf of Nova Scotia. *Can. Field-Nat.* 102(3): 471-474.

47. Stone, G.S.; Katona, S.K.; Tucker, E.B. 1987. History, migration and present status of humpback whales (*Megaptera novaeangliae*) at Bermuda. *Biol. Conserv.* 42(2): 133-145.

48. Waring, G.T.; Gerrior, P.; Payne, P.M.; Parry, B.L.; Nicolas, J.R. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States. *Fish. Bull. (U.S.)* 88(2): 347-360.

49. Watkins, W.A. 1986. Whale reactions to human activities in Cape Cod waters. *Mar. Mammal Sci.* 2(4): 251-262.

50. Wenzel, F.; Mattila, D.K.; Clapham, P.J. 1988. *Balaenoptera musculus* in the Gulf of Maine. *Mar. Mammal Sci.* 4(2): 172-175.

APPENDIX B

Contract Reports, Manuscripts, and Working Papers Based on Marine Mammal Research Projects Supported by the NEFSC

1. Beard, J.; Clapham, P.; Hammond, P.; Katona, S.; Larsen, F.; Lien, J.; Mattila, D.; Mayo, C.; Øien, N.; Palsbøl, P.; Polacheck, T.; Sigurjónsson, J.; Smith, T. 1990. YoNAH: years of the North Atlantic humpback whale -- a proposal for discussion. *Int. Whaling Comm. Sci. Doc.* SC/42/O25; 9 p. [Work primarily related to research topic no. 13; see Table 3.]

2. Blaylock, R.A. 1980. Aerial surveys of bottlenose dolphins, *Tursiops truncatus*, in Virginia's nearshore coastal waters: second interim report. NOAA contract (No. NA-80FAD0008) report *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 16; see Table 3.]

3. Carlson, C.A.; Mayo, C.A. 1988. Changes in the ventral fluke pattern of the humpback whale, *Megaptera novaeangliae*, and its affect on matching. NOAA contract (No. 40EANF702183) report *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 13; see Table 3.]

4. Clapham, P.J. 1987. North Atlantic fin whale research – 1987: proceedings of a meeting to review methodology and to coordinate information exchange. NOAA contract (No. 40ENF7001740) report *prepared by* North Atlantic Marine Mammal Association, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 17; see Table 3.]

5. Crone, M.J.; Kraus, S.D. 1990. Right whales (*Eubalaena glacialis*) in the western North Atlantic: a catalog of identified individuals. Unpublished manuscript *available from* New England Aquarium, Boston, MA. [Work primarily related to research topic no. 14; see Table 3.]

6. Finn, J.T. 1986. Response surface analysis of a large-scale marine ecosystem fishery model. Report on task 2: programs and documentation for running fractional factorial designs of the ICES MSVPA program. NOAA contract (Nos. 43EAF7325220 and 40EAF7007210) report *prepared by* University of Massachusetts, Amherst, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 3; see Table 3.]

7. Geraci, J.R.; St. Aubin, D.J.; Barker, I.K.; Webster, R.; Hinshaw, V.; Bean, W.; Ruhnke, H.L.; Madoff, S.; Prescott, J. 1981. Investigation of harbor seal mortality and determination of infectious agent, New England region. NOAA contract (No. NA80FAH00009) report *prepared by* University of Guelph, Guelph, ON, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 1; see Table 3.]

8. Gilbert, J.R. 1987. Marine mammal interaction with New England gillnet fisheries: draft. NOAA contract (No. NA84EAC00070) report *prepared by* University of Maine, Orono, ME, *available from* National Marine Fisheries Service, Woods Hole, MA; 21 p. [Work primarily related to research topic no. 8; see Table 3.]

9. Gilbert, J.R.; Wynne, K.M. 1985. Harbor seal populations and fisheries interactions with marine mammals in New England, 1984. NOAA contract (Nos. NA80FAC00029 and NA84EAC00070) report *prepared by* University of Maine, Orono, ME, *available from* National Marine Fisheries Service, Woods Hole, MA; 15 p. [Work primarily related to research topic no. 8; see Table 3.]

10. Gilbert, J.R.; Wynne, K.M. 1984. Harbor seal populations and marine mammal - fisheries interactions, 1983. NOAA contract (No. NA80FAC00029) report *prepared by* University of Maine, Orono, ME, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 8; see Table 3.]

11. Gilbert, J.R.; Wynne, K.M. 1983. Harbor seal populations and marine mammal - fisheries interactions, 1982. NOAA contract (No. NA80FAC00029) report *prepared by* University of Maine, Orono, ME, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 8; see Table 3.]

12. Gilbert, J.R.; Stein, J.L. 1981. Harbor seal populations and marine mammal - fisheries interactions. NOAA contract (No. NA80FAC00029) report *prepared by* University of Maine, Orono, ME, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 8; see Table 3.]

13. Katona, S.K.; Kraus, S.D.; Harcourt, P.; Perkins, J.S. 1988. Humpback whales -- a catalogue of individuals by fluke photographs. NOAA contract (No. NA80FAD00006) report *prepared by* College of the Atlantic, Bar Harbor, ME, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 13; see Table 3.]

14. Katona, S.K.; Beard, J.A. 1988. Population size, migrations and substock structure of the humpback whale (*Megaptera novaeangliae*) in the western North Atlantic Ocean. NOAA contract (No. 40EANF700314) report *prepared by* College of the Atlantic, Bar Harbor, ME, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 13; see Table 3.]

15. Katona, S.K.; Beard, J.A. 1987. The humpback whale fluke catalogue: final report. NOAA contract (No. 40EANF700314) report *prepared by* College of the Atlantic, Bar Harbor, ME, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 13; see Table 3.]

16. Katona, S.K.; Beard, J.A.; Balcomb, K.C., III. 1986. The humpback whale catalogue: final report. NOAA contract (No. NA81FAC00027) report *prepared by* College of the Atlantic, Bar Harbor, ME, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 13; see Table 3.]

17. Kenney, R.D.; Winn, H.E. 1987. Aerial surveys of right whales in the Great South Channel, spring 1987: final report. Report (Order No. 14626) *prepared by* University of Rhode Island, Narragansett, RI, *available from* Minerals Management Service, Washington, DC. [Work primarily related to research topic no. 15; see Table 3.]

18. Kenney, R.D.; Winn, H.E.; Brown, C.W. 1986. Aerial surveys for right whales in the Great South Channel, spring 1985. NOAA contract (No. NA84EAC00079) report *prepared by* University of Rhode Island, Narragansett, RI, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 15; see Table 3.]

19. Kenney, R.P.; Winn, H.E. 1986. Marine mammal data transfer and documentation. NOAA contract (No. 40EANF501629) report *prepared by* University of Rhode Island, Narragansett, RI, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 18; see Table 3.]

20. Kenney, R.D.; Hyman, M.A.M.; Winn, H.E. 1985. Calculation of standing stocks and energetic requirements of the cetaceans of the northeast United States outer continental shelf. *NOAA Tech. Memo. NMFS-F/NEC*-41; 99 p. [Work primarily related to research topic no. 3; see Table 3.]

21. Kenney, R.D.; Hyman, M.A.M.; Winn, H.E. 1983. Calculation of standing stocks and energetic requirements of the cetaceans of the northeast U.S. outer continental shelf. NOAA contract (No. NA83FAC00009) report *prepared by* University of Rhode Island, Narragansett, RI, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 3; see Table 3.]

22. Kraus, S.D.; Prescott, J.H.; Stone, G.S. 1984. Right whales (*Eubalaena glacialis*) in the western No. Atlantic: a summary of research conducted from 1980 to 1984. Unpublished manuscript *available from* New England Aquarium, Boston, MA. [Work primarily related to research topic no. 15; see Table 3.]

23. Kraus, S.D.; Prescott, J.H. 1984. Seasonal movements of harbor porpoise (*Phocoena phocoena*) in the Gulf of Maine. NOAA contract (No. NA80FAD00009) report *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 11; see Table 3.]

24. Kraus, S.D.; Prescott, J.H. 1983. A summary of 1982 research on the No. Atlantic right whale, *Eubalaena glacialis*, with notes on seasonal distribution and abundance and significant re-sightings of individuals. NOAA contract (No. NA81FAC00030) report *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 15; see Table 3.]

25. Kraus, S.D.; Prescott, J.H.; Stone, G.S. 1983. Harbor porpoise, *Phocoena phocoena*, in the U.S. coastal waters off the Gulf of Maine: a survey to determine seasonal distribution and abundance. NOAA contract (No. NA80FAD00009) report *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 11; see Table 3.]

26. Kraus, S.D.; Prescott, J.H. 1981. The No. American right whale (*Eubalaena glacialis*) in the Bay of Fundy, 1981, with notes on distribution, abundance, biology, and behavior. NOAA contract (No. NA81FAC00030) report *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 15; see Table 3.]

27. Kraus, S.; Prescott, J. 1980. Distribution, abundance and notes on the large cetaceans of the Bay of Fundy. NOAA contract (No. NA80FA200048) report *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 15; see Table 3.]

28. Lambertsen, R.H.; Duffield, D.A. 1987. Biopsy studies of the humpback whale, *Megaptera novaeangliae*. NOAA contract (No. 50EANF500094) report *prepared by* University of Pennsylvania, Philadelphia, PA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 5; see Table 3.]

29. Lambertsen, R.H. 1983. Status report on biopsy studies of the North Atlantic humpback whale (*Megaptera novaeangliae*) for karyologic determination of the sex of photographically identified individuals. NOAA contract (No. NA83FACC00017) report *prepared by* University of Pennsylvania, Philadelphia, PA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 5; see Table 3.]

30. Mattila, D.; Clapham, P.J.; Mayo, C.A.; Katona, S.K.; Stone, G. 1985. Humpback whale studies on Silver Bank, 1984. NOAA contract (No. NA83FAC00004) report *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 13; see Table 3.]

31. Mattila, D.K. 1983. Humpback whales in Mona Passage, Puerto Rico: a summary. NOAA contract (No. NA83FAC00004) report *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 13; see Table 3.]

32. Mattila, D. 1982. 1982 fluke identification survey and song recordings of humpback whales (*Megaptera novaeangliae*) along the northwest coast of Puerto Rico. NOAA contract (No. NA81FAD00003) report *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 13; see Table 3.]

33. Mattila, D. 1981. 1981 fluke identification survey and song recordings of humpback whales, *Megaptera novaeangliae*, along the northwest coast of Puerto Rico. NOAA contract (No. NA81FAD00003) report *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 13; see Table 3.]

34. Mayo, C.A.; Mattila, D.K.; Pittman, S.; Baraff, L. 1988. Abundance, distribution and habitat use of large whales in Massachusetts Bay and the Great South Channel. NOAA contract (No. 50EANF600059) report *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 4; see Table 3.]

35. Mayo, C.A.; Hamilton, P.; Marx, M.K. 1988. Population characteristics and habitat use of the right whale, *Eubalaena glacialis*, in Cape Cod and Massachusetts Bays. NOAA contract (No. NA84EAC00080) report *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 14; see Table 3.]

36. Mayo, C.A.; Mattila, D.K.; Pittman, S.; Christian, P.; Baraff, L. 1986. Abundance, distribution and habitat use of large whales in the southern Gulf of Maine: May 1 - Sept. 30, 1986. NOAA contract (No. 50EANF600059) report *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 4; see Table 3.]

37. Nelson, G.A.; Ross, M.R. 1988. The population dynamics of sand lance (*Ammodytes dubius*) in the Northwest Atlantic. I. Abundance and distribution. NOAA contract (No. 43EANF732522) report *prepared by* University of Massachusetts, Amherst, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 3; see Table 3.]

38. NMFS/URI/NEA/CCS/WHOI Cooperative Right Whale Research Program. 1987. Integrated program for research on the northern right whale off the eastern United States: 6 month progress report. NEFSC cooperative agreement (No. NA86EAH00053) report *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 7,12,14; see Table 3.]

39. Payne, P.M.; Heinemann, D.W.; Smith, T.D. 1990. Seasonal distribution of minke whales in the shelf and shelf-edge waters of northeastern U.S. *Int. Whaling Comm. Sci. Doc.* SC/42/NHMi32; 12 p. [Work primarily related to research topic no. 2; see Table 3.]

40. Payne, P.M.; Selzer, L.A. 1989. The distribution, abundance and selected prey of the harbor seal, *Phoca vitulina concolor*, in Southern New England. NOAA contract (Nos. NA84ENA00149, 40ENF5002570, and 40EAF8702181)) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 1; see Table 3.]

41. Payne, P.M. 1988. Monitoring and assessment of cetaceans and seabirds in the shelf waters of the northeast U.S.: progress report. NOAA contract (No. 50EANF600028) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 2; see Table 3.]

42. Payne, P.M. 1986. Monitoring and assessment of cetaceans and seabirds in the shelf waters of the northeast U.S. NOAA contract (No. 50EANF600028) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 2; see Table 3.]

43. Payne, P.M. 1986. Marine mammals, sea birds and marine turtles in the Gulf of Maine and Massachusetts Bay with special emphasis on the locations of the foul-area disposal site and the Cape Arundel disposal site. NOAA contract (No. 50EANF600028) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 2; see Table 3.]

44. Payne, P.M. 1986. Assessment of cetaceans, marine turtles and seabirds at the proposed Blake Plateau incineration site (BPIS), between 17-23 November, 1986. Subcontract (No. G-9055(8834)-553) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Battelle, Inc., Duxbury, MA, *available from* National Marine Fisheries Service, Woods Hole, MA; 20 p. [Work primarily related to research topic no. 2; see Table 3.]

45. Payne, P.M. 1986. An overview of high-use areas by all cetaceans in the shelf waters of the northeastern United States between Cape Hatteras and Nova Scotia. *In* Payne, P.M.; Selzer, L.A., eds. A characterization of whale use of the Massachusetts Bay and Cape Arundel, Maine areas: final report. USDOD contract (No. DACW33-85-D-0002-0003) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Sanford Ecological, Inc., Natick, MA, *available from* U.S. Army Corps of Engineers, Waltham, MA; p. 14-21. [Work primarily related to research topic no. 2; see Table 3.]

46. Payne, P.M.; Selzer, L.A., editors. 1986. A characterization of whale use of the Massachusetts Bay and Cape Arundel, Maine areas: final report. USDOD contract (No. DACW33-85-D-0002-0003) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Sanford Ecological, Inc., Natick, MA, *available from* U.S. Army Corps of Engineers, Waltham, MA; 204 p. [Work primarily related to research topic no. 2; see Table 3.]

47. Payne, P.M.; Selzer, L.A. 1986. Distribution and abundance of rare and endangered cetaceans and marine turtles in the Gulf of Maine and adjacent water (north of 40°00'N latitude): an overview. *In* Payne, P.M.; Selzer, L.A., eds. A characterization of whale use of the Massachusetts Bay and Cape Arundel, Maine areas: final report. USDOD contract (No. DACW33-85-D-0002-0003) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Sanford Ecological, Inc., Natick, MA, *available from* U.S. Army Corps of Engineers, Waltham, MA; p. 22-55. [Work primarily related to research topic no. 2; see Table 3.]

48. Payne, P.M.; Selzer, L.A. 1986. Areal and temporal distributional behavior of threatened and endangered marine mammals and turtles in waters within and immediately adjacent to the Cape Arundel disposal site (CADS). *In* Payne, P.M.; Selzer, L.A., eds. A characterization of whale use of the Massachusetts Bay and Cape Arundel, Maine areas: final report. USDOD contract (No. DACW33-85-D-0002-0003) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Sanford Ecological, Inc., Natick, MA, *available from* U.S. Army Corps of Engineers, Waltham, MA; p. 121-134. [Work primarily related to research topic no. 2; see Table 3.]

49. Payne, P.M.; Selzer, L.A.; Agler, B.A.; Kelly, J.T. 1986. Assessment of cetaceans, marine turtles and seabirds at the deepwater dumpsite (DS-106) between 5-24 February, 1986. Subcontract (No. G-9055(8834)-553) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Battelle, Inc., Duxbury, MA, *available from* National Marine Fisheries Service, Woods Hole, MA; 17 p. [Work primarily related to research topic no. 2; see Table 3.]

50. Payne, P.M. 1985. Distribution and abundance of cetaceans and seabirds in the waters adjacent to the foul-area dumpsite, Massachusetts Bay, 7-8 June, based on shipboard observations. USDOD contract (No. DACW33-85-D-0002-0003) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Sanford Ecological, Inc., Natick, MA, *available from* U.S. Army Corps of Engineers, Waltham, MA. [Work primarily related to research topic no. 2; see Table 3.]

51. Payne, P.M.; Selzer, L.A.; Agler, B.A. 1985. Assessment of cetaceans, marine turtles and seabirds at the deepwater dumpsite (DS-106) between 9-19 November, 1985. Subcontract (No. G-9055(8834)-553) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Battelle, Inc., Duxbury, MA, *available from* National Marine Fisheries Service, Woods Hole, MA; 15 p. [Work primarily related to research topic no. 2; see Table 3.]

52. Payne, P.M.; Selzer, L.A.; Kelly, J.T. 1985. Assessment of cetaceans, marine turtles and seabirds at the deepwater dumpsite (DS-106) and at the proposed Blake Plateau incineration site (BPIS) between 18 August-23 September, 1985. Subcontract (No. G-9055(8834)-553) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Battelle, Inc., Duxbury, MA, *available from* National Marine Fisheries Service, Woods Hole, MA;

20 p. [Work primarily related to research topic no. 2; see Table 3.]

53. Payne, P.M.; Selzer, L.A.; Kelly, J.T. 1985. Assessment of cetaceans, marine turtles and seabirds at the North Atlantic incineration site (NAIS) between 6-16 November, 1985. Subcontract (No. G-9055(8834)-553) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Battelle, Inc., Duxbury, MA, *available from* National Marine Fisheries Service, Woods Hole, MA; 17 p. [Work primarily related to research topic no. 2; see Table 3.]

54. Payne, P.M.; Selzer, L.A.; Knowlton, A.R. 1984. Distribution and density of cetaceans, marine turtles and seabirds in the shelf waters of the northeast U.S., June 1980 - Dec. 1983, based on shipboard observations. NOAA contract (No. NA81FAC00023) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 2; see Table 3.]

55. Payne, P.M.; Selzer, L.A. 1983. Population distribution, abundance, and prey requirements of the harbor seal in Southern New England. NOAA contract (No. NA82FA00007) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 1; see Table 3.]

56. Payne, P.M.; Rimmer, C.C. 1982. Radio-telemetry of a rehabilitated harbor seal during the winter 1982 with comments on movements and numbers of the harbor seal in Massachusetts. NOAA contract (No. NA82FA00007) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 1; see Table 3.]

57. Polacheck, T.; Smith, T.D.; Waring, G.T. 1990. Review of methods for assessing the status of the harbor porpoise population in the Gulf of Maine and Bay of Fundy region: results of an at-sea workshop. Unpublished manuscript *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 11; see Table 3.]

58. Polacheck, T.; Wenzel, F.W. 1990. What do stranding data say about harbor porpoise (*Phocoena phocoena*)? *Int. Whaling Comm. Sci. Doc.* SC/42/SM39; 12 p. [Work primarily related to research topic no. 11; see Table 3.]

59. Powers, K.D. 1983. Pelagic distribution of marine birds off the northeastern United States. *NOAA Tech. Memo. NMFS-F/NEC-27*; 201 p. [Work primarily related to research topic no. 2; see Table 3.]

60. Powers, K.D. 1982. Manomet Bird Observatory marine observer program 1982 cruise reports. NOAA contract (No. NA81FAC00023) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 2; see Table 3.]

61. Powers, K.D.; Payne, M.P.; Fitch, S.F. 1981. Distribution of cetaceans, sea birds and turtles, Cape Hatteras to Nova Scotia. NOAA contract (No. NA81FAC00023) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 2; see Table 3.]

62. Powers, K.D.; Payne, P.M.; Miller, D.S. 1981. A marine mammal observer training program. NOAA contract (No. NA80FAD0004) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 2; see Table 3.]

63. Powers, K.; Payne, P.M. 1981. Manomet Bird Observatory marine observer program 1981 cruise reports. NOAA contract (No. NA81FAC00023) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 2; see Table 3.]

64. Prescott, J.H.; Kraus, S.D.; Gilbert, J.R. 1981. Proceedings of a workshop on humpback whales of the western North Atlantic: draft. NOAA contract (No. NA80FAC55) report *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 17; see Table 3.]

65. Prescott, J.H.; Kraus, S.D.; Fiorelli, P.; Gaskin, D.E.; Smith, G.J.D.; Branser, M. 1981. Harbor porpoise (*Phocoena phocoena*) distribution, abundance, survey methodology and preliminary notes on habitat use and threats. NOAA contract (No. NA80FAD00009) report *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 11,12; see Table 3.]

66. Reeves, R.R.; Mitchell, E. 1987. The history of whaling in and near North Carolina: partial fulfillment report. NOAA contract (NA85WCC06194) report *prepared by* National Marine Fisheries Service, Miami, FL, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 15; see Table 3.]

67. Reeves, R.R.; Mitchell, E. 1987. Shore whaling for right whales in the northeastern United States: partial fulfillment. NOAA contract (No. NA85WCC06194) report

prepared by National Marine Fisheries Service, Miami, FL, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 15; see Table 3.]

68. Schneider, D.C.; Rosenfeld, M.B.; Twichell, D.C.; Kesselheim, C. 1980. Studies of the harbor seal (*Phoca virtulina concolor*) at a winter haul-out site in Massachusetts. NOAA contract (No. NA80FAD00005) report *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 1; see Table 3.]

69. Scott, G.P. 1985. Report of the working group on NEFSC/SEFSC marine mammal research: results of the meeting held 8-9 January, 1985. *NOAA Tech. Memo. NMFS-SEFSC*-16B; 27 p. [Work primarily related to research topic no. 17; see Table 3.]

70. Sears, R. 1980. Report on observations of cetaceans along the north shore of the Gulf of St. Lawrence. NOAA contract (No. NA80FBA241) report *prepared by* Mingan Island Cetacean Study, Inc., Quebec, PQ, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 15; see Table 3.]

71. Selzer, L.A.; Payne, P.M.; Brown, J.M.; Whitman, A.A. 1986. An overview of the distribution and abundance of non-endangered cetaceans, pinnipeds and seabirds in the Gulf of Maine and adjacent waters (north of 40°00'N latitude) with special emphasis on the foul-area disposal site and the Cape Arundel disposal site. *In* Payne, P.M.; Selzer, L.A., eds. A characterization of whale use of the Massachusetts Bay and Cape Arundel, Maine areas: final report. USDOD contract (No. DACW33-85-D-0002-0003) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Sanford Ecological, Inc., Natick, MA, *available from* U.S. Army Corps of Engineers, Waltham, MA; p. 125-168. [Work primarily related to research topic no. 2; see Table 3.]

72. Shurman, V.R. 1983. Report on Nantucket grey seals, winter and spring 1983. NOAA contract (No. NA83FBA00075) report *prepared by* Cape Cod Museum of Natural History, Brewster, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 1; see Table 3.]

73. Shurman, V.R. 1981. A small population of grey seals at Nantucket, MA. NOAA contract (No. NA81FBA00282) report *prepared by* Cape Cod Museum of Natural History, Brewster, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 10; see Table 3.]

74. Smith, T.D. 1990. The marine sanctuary act and the biology of Stellwagen Bank. Unpublished manuscript *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 2; see Table 3.]

75. Smith, T.D. 1990. Simultaneous fishery resource and seabird and cetacean sighting surveys: advantages and disadvantages. *N. Atl. Stud.* 2(1-2): 90-101. [Work primarily related to research topic no. 2; see Table 3.]

76. Stone, G.S.; Mainwaring, A.; Katona, S.K.; Beard, J.A.; Corbett, H.D. 1988. Surfacing, respiration, and dive characteristics of finback whales (*Balaenoptera physalus*) observed from Mount Desert Rock, Maine. NOAA contract (Nos. 40EANF501300 and 40EANF601426) report *prepared by* College of the Atlantic, Bar Harbor, ME, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 3; see Table 3.]

77. Watkins, W.A.; Bird, J.E.; Moore, K.E.; Tyack, P. 1987. Marine mammal literature: reference data base. NOAA contract (No. 40EANF7022770) report *prepared by* Woods Hole Oceanographic Institution, Woods Hole, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 18; see Table 3.]

78. Watkins, W. 1985. Changes observed in the reaction of whales to human activities. NOAA contract (No. 50EANF500068) report *prepared by* Woods Hole Oceanographic Institution, Woods Hole, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 9; see Table 3.]

79. Weinrich, M.T.; Selzer, L.A.; Payne, P.M. 1986. Areal and temporal distribution and behavior of rare and endangered marine mammals and turtles in waters within and adjacent to the foul-area disposal site (FADS). *In* Payne, P.M.; Selzer, L.A., eds. A characterization of whale use of the Massachusetts Bay and Cape Arundel, Maine areas: final report. USDOD contract (No. DACW33-85-D-0002-0003) report *prepared by* Manomet Bird Observatory, Manomet, MA, *under subcontract to* Sanford Ecological, Inc., Natick, MA, *available from* U.S. Army Corps of Engineers, Waltham, MA; p. 56-76. [Work primarily related to research topic no. 2; see Table 3.]

80. Weinrich, M.T. 1982. Biology of the humpback whale (*Megaptera novaeangliae*): northern Stellwagen Bank, summer 1981. NOAA contract (No. NA81FBA00231) report *prepared by* Gloucester Fisherman's Museum, Gloucester, MA, *available from* National Marine Fisheries Service, Woods Hole, MA. [Work primarily related to research topic no. 5)

APPENDIX C

Abstracts of Oral Presentations at Scientific Conferences Based on Marine Mammal Research Projects Supported by the NEFSC between 1980 and 1989

Fourth Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, 14-18 December 1981

1. Blaylock, R.A. Aerial surveys of bottlenose dolphins, *Tursiops truncatus*, in Virginia's nearshore coastal waters. Abstract *prepared by* Virginia Institute of Marine Science, Gloucester Point, VA, *available from* National Marine Fisheries Service, Woods Hole, MA.

2. Kraus, S.C.; Prescott, J.H.; Reeves, R.; Turnbull, P. Right whales in the northern Gulf of Maine. Abstract *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

3. Kraus, S.D.; Gilbert, J.R.; Prescott, J.H. A comparison of air, ship and land-based survey methodology for the harbor porpoise, *Phocoena phocoena*. Abstract *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

Fifth Biennial Conference on the Biology of Marine Mammals, Boston, MA, 27 November - 1 December 1983

4. Carlson, C.A.; Mayo, C.A. Changes in the pigment and scar patterns on the ventral surface of the flukes of humpback whales observed in the waters of Stellwagen Bank, Massachusetts. Abstract *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

5. Gallivan, G.J.; Geraci, J.R.; St. Aubin, D.J.; Fiorelli, P.; Early, G. Harbor seal mortalities in New England: a retrospective study, 1973-1982. Abstract *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

6. Katona, S.K.; Balcomb, K.C., III; Beard, J.A.; Whitehead, H.; Mattila, D. The Atlantic humpback whale catalogue. Abstract *prepared by* College of the Atlantic, Bar Harbor, ME, *available from* National Marine Fisheries Service, Woods Hole, MA.

7. Kraus, S.D.; J.H. Prescott. The use of callosity patterns and natural markings to determine distribution, abundance and movements of the North Atlantic right whale, *Eubalaena glacialis*. Abstract *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

8. Kraus, S.D.; Prescott, J.H.; Stone, G.S. Harbor porpoise, *Phocoena phocoena*, in the U.S. coastal waters of the Gulf of Maine: a survey to determine seasonal distribution and abundance. Abstract *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

9. Mattila, D.K. Humpback whales off Puerto Rico: population composition and habitat use. Abstract *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

10. Payne, P.M.; L.A. Selzer. Distribution and abundance of the harbor seal, *Phoca vitulina*, in Southern New England. Abstract *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

Sixth Biennial Conference on the Biology of Marine Mammals, Vancouver, BC, 22-26 November 1985

11. Clapham, P.J.; Mayo, C.A.; Seipt, I.; Carlson, C.E. Humpback whale mothers and calves on Stellwagen Bank, Massachusetts: 1979-1985. Abstract *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

12. Hammond, P.S. North Atlantic humpback whales; estimating population size from photo-identification data using variations of the Jolly-Seber open population model. Abstract *prepared by* Natural Environment Research Council, Cambridge, England, *available from* National Marine Fisheries Service, Woods Hole, MA.

13. Kraus, S.D.; Prescott, J.H.; Knowlton, A.R. Reproductive rates in North Atlantic right whales (*Eubalaena glacialis*). Abstract *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

14. Mayo, C.A.; Carlson, C.A.; Gilmore, M.K. Food and feeding of right whales in Cape Cod Bay, Massachusetts. Abstract *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

15. Payne, M.P.; Katona, S.K.; Scott, G.P. A comparison between three methods of estimating humpback whale, *Megaptera novaeangliae,* numbers in the shelf waters of the northeastern United States. Abstract *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

16. Selzer, L.A.; Payne, M.P. Ecological differences in the distribution of white-sided dolphin (*Lagenorhynchus acutus*) and common dolphin (*Delphinus delphis*) in the shelf waters of the Northwest Atlantic. Abstract *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

17. Waring, G.T.; Gerrior, P.; Nicolas, J.; Payne, P.M. Incidental take of marine mammals in foreign fishery activities off the northeast USA, 1977-1985. Abstract *prepared by* and *available from* National Marine Fisheries Service, Woods Hole, MA.

18. Wynne, K.M.; Gilbert, J.R. Biological information recovered from incidentally taken harbor porpoise (*Phocoena phocoena*) in the Gulf of Maine. Abstract *prepared by* University of Maine, Orono, ME, *available from* National Marine Fisheries Service, Woods Hole, MA.

Seventh Biennial Conference on the Biology of Marine Mammals, Miami, FL, 5-9 December 1987

19. Baker, C.S.; Lambertsen, R.H.; Palumbi, S.R. The extraction and identification of mitochondrial (mt) DNA from the epidermal tissue of individually identified humpback whales. Abstract *prepared by* University of Hawaii, Honolulu, HI, *available from* National Marine Fisheries Service, Woods Hole, MA.

20. Bird, J.E.; Moore, K.E.; Watkins, W.A.; Tyack, P. A database management system for a cetacean literature library. Abstract *prepared by* Woods Hole Oceanographic Institution, Woods Hole, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

21. Katona, S.K.; Beard, J.A. The North Atlantic humpback whale fluke catalogue. Abstract *prepared by* College of the Atlantic, Bar Harbor, ME, *available from* National Marine Fisheries Service, Woods Hole, MA.

22. Krieger, K.; Prescott, J.; Early, G.; Dayton, J. Evaluating the release of rehabilitated stranded pilot whales (*Globicephala melaena*). Abstract *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

23. Mate, B.R.; Prescott, J.; Geraci, J. Free-ranging movements of a pilot whale from a satellite-monitored radio. Abstract *prepared by* Oregon State University, Newport, OR, *available from* National Marine Fisheries Service, Woods Hole, MA.

24. Mattila, D.; Clapham, P.; Stone, G.; Corbett, H.; Katona, S. Humpback whales of Virgin Bank: population composition and habitat use. Abstract *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

25. Mayo, C.A.; Marx, M.K.; Letcher, B.H. Estimated zooplankton consumption rate and caloric intake of the North Atlantic right whale, *Eubalaena glacialis.* Abstract *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

26. Payne, P.M.; Selzer, L.A. Distribution, abundance, and prey items of the harbor seal *Phoca vitulina* in Southern New England. Abstract *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

27. Schilling, M.R.; Weinrich, M.T.; Belt, C.R.; Lambertsen, R.H. Behavioral reactions of humpback whales to biopsy darts: reaction to an applied stimulus. Abstract *prepared by* Gloucester Fishermen's Museum, Gloucester, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

28. Selzer, L.A.; Payne, P.M.; Hagan, J.M. Environmental factors related to the distribution and abundance of cetaceans in the Northwest Atlantic. Abstract *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

29. Weinrich, M.T. Social grouping patterns of humpback whales (*Megaptera novaeangliae*) on the feeding grounds. Abstract *prepared by* Gloucester Fishermen's Museum, Gloucester, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

Eighth Biennial Conference on the Biology of Marine Mammals, Pacific Grove, CA, 7-11 December 1989

30. Fairfield, C.P.; Waring, G.T. Co-distribution and interactions of pilot whales and the foreign mackerel fishery in the Mid-Atlantic Bight, 1984-1988. Abstract *prepared by* and *available from* National Marine Fisheries Service, Woods Hole, MA.

31. Knowlton, A.R.; Kraus, S.D. Calving intervals, rates and success in North Atlantic right whales. Abstract *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

32. Kraus, S.D. Mating strategies in North Atlantic right whales. Abstract *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

33. Payne, P.M.; Wiley, D.; Young, S.; Pittman, S.; Clapham, P.J. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in prey abundance, with emphasis on the role of sandlance in structuring the cetacean community. Abstract *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

34. Polacheck, T. Field testing shipboard line transect methods for harbor porpoise. Abstract *prepared by* and *available from* National Marine Fisheries Service, Woods Hole, MA.

35. Winn, H.E.; Goodyear, J.R.; Kenney, R.D.; Petricig, R.O.; Dorf, B.A. Dive patterns of right whales in the Great South Channel. Abstract *prepared by* University of Rhode Island, Narragansett, RI, *available from* National Marine Fisheries Service, Woods Hole, MA.

North Atlantic Marine Mammal Association Conference, Woods Hole, MA, 3 November 1989

36. Kraus, S.D.; Harrison, J.E.; Reeves, R.R. Preliminary notes on the causes of mortality and injuries in North Atlantic right whales (*Eubalaena glacialis*). Abstract *prepared by* New England Aquarium, Boston, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

37. Mayo, C.A.; Marx, M.K. Feeding strategy and area restricted searching patterns of right whales, *Eubalaena glacialis*, in Massachusetts waters. Abstract *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

38. Payne, P.M.; Selzer, L.A.; Whitman, A.A. Prey items of the harbor seal *Phoca vitulina* in Southern New England based on an analysis of fecal samples. Abstract *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

39. Payne, P.M.; Selzer, L.A. The abundance of gray seals in Southern New England during 1983-1986. Abstract *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

40. Pittman, S.; Mattila, D. Humpback whales' use of a major foraging area. Abstract *prepared by* Center for Coastal Studies, Provincetown, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

41. Weinrich, M.T.; Belt, C.R.; Lambertsen, R.H.; Schilling, M.R.; Iken, H.J. Behavioral reactions of humpback whales to biopsy darts: reaction to an applied stimulus. Abstract *prepared by* Gloucester Fishermen's Museum, Gloucester, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

International Whaling Commission Symposium on Mortality of Cetaceans in Passive Fishing Nets and Traps, La Jolla, CA, 20-21 October 1990

42. Payne, P.M.; Power, G.; Yustin, C.T. Interaction between the New England sink-gillnet fishery and the harbor porpoise, *Phocoena phocoena*. Abstract *prepared by* Manomet Bird Observatory, Manomet, MA, *available from* National Marine Fisheries Service, Woods Hole, MA.

APPENDIX D

Cruise Period, Area, and Objectives of NEFSC Harbor Porpoise Sighting Surveys from 1987 to 1989

NOAA R/V *Gloria Michelle* Cruise No. GM 87-11: Harbor Porpoise Survey Planning Cruise

The cruise period was 21-23 August 1987. The cruise consisted of visual surveys for schools of harbor porpoise (*Phocoena phocoena*) along repeated tracks in the western Bay of Fundy in the vicinity of Campobello Island, the Wolves Island group, and Grand Manan Island. Objectives of the cruise were to review and evaluate methods of conducting cetacean sighting surveys that might be used to estimate the size of the population or populations of harbor porpoise in the Gulf of Maine and Bay of Fundy region.

NOAA R/V *Gloria Michelle* Cruise No. GM 88-14: Testing Harbor Porpoise Survey Methods

The cruise period was 22-25 August 1988. The cruise consisted of research on the estimation of radial sighting distances and visual surveys for schools of harbor porpoise (*Phocoena phocoena*). All research was conducted in the western Bay of Fundy in the vicinity of Campobello Island, the Wolves Island group, and Grand Manan Island. Purpose of the cruise was to conduct a field test of line-transect survey methods for harbor porpoise. The three main objectives were to: (1) test and develop procedures for estimating radial sighting distances, (2) test the robustness of line-transect methods for harbor-porpoise-to-observer height, and (3) test the effect on line-transect methods on the movement rates of harbor porpoise relative to the vessel.

NOAA R/V *Chapman* Cruise No. Ch. 89-30B: Harbor Porpoise Survey

The cruise period was 17-28 July 1989. Area of operation was the inshore waters of Machias and Penobscot Bays, Maine, and offshore waters along the Maine and southwestern Nova Scotian coasts and around Jeffreys Ledge, Platts Bank, Cashes Ledge, Grand Manan Banks, and Fippennies Ledge. Objectives were to: (1) determine the southwestern and seaward limits of the distribution of harbor porpoise (*Phocoena phocoena*) in the Gulf of Maine during summer, (2) train and test observers in their ability to estimate sighting distances, and (3) collect distributional data on other cetaceans in the Gulf of Maine.

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