NOAA TECHNICAL MEMORANDUM
NMFS-NEFSC-

U.S. ATLANTIC
MARINE MAMMAL STOCK ASSESSMENTS - 1998

By

Gordon T. Waring, Debra L. Palka, Phillip J. Clapham, Steve Swartz, Marjorie Rossman, Tim Cole, Kathryn D. Bisack and Larry J. Hansen

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts 02543-1026
December 1998

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Under the 1994 amendments of the Marine Mammal Protection Act (MMPA), the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) were required to generate stock assessment reports (SAR) for all marine mammal stocks in waters within the U.S. Exclusive Economic Zone (EEZ). The first reports for the Atlantic (includes the Gulf of Mexico) were published in July 1995 (Blaylock et al. 1995). The MMPA requires NMFS and USFWS to review these reports annually for strategic stocks of marine mammals and at least every 3 years for stocks determined to be non-strategic. The second edition of the SARs (1996 assessments) was published in October 1997 and contained all the previous reports, but major revisions and updating were only completed for strategic stocks (Waring et al. 1997). Updated reports were identified by a 1997 date-stamp at the top right corner at the beginning of each report. The current report contains only assessment reports for the Atlantic stocks, and updated reports are identified by a December 1998 date-stamp. This format was selected to facilitate availability and because the draft 1999 SARs are expected to be available in February 1999.

This report was prepared by staff of the Northeast Fisheries Science Center (NEFSC), and Southeast Fisheries Science Center (SEFSC). NMFS staff presented the reports at the May 1998 meeting of the Atlantic Scientific Review Group (ASRG), and subsequent revisions were based on their contributions and constructive criticism. In July 1998, the revised report was available for a 90-day public comment period. The current version reflects changes made in response to the public comments.

Table 1 contains a summary, by species, of the information included in the stock assessments, and also indicates those that have been revised since the 1997 publication. A total of 27 of the 31 Atlantic stock assessment reports were revised for 1998. Most proposed changes incorporate new information into abundance or mortality estimates. The revised SARs include 15 of the strategic stocks and 12 of the non-strategic stocks relative to the 1996 assessments. Some of the revisions clarified fisheries mortality information which resulted in changes to the status of some stocks. Information on human interactions (fishery and ship strikes) between the North Atlantic right whale and North Atlantic humpback whale stocks were re-reviewed and updated. The 1993 fishery induced mortality of a North Atlantic right whale has been reassigned from the pelagic driftnet fishery to the lobster fishery based on a re-examination of all information. Abundance estimates for humpback whales, Canadian east coast stock of Minke whales, Western North Atlantic stocks of common dolphins, and harbor seals have been revised. The Western North Atlantic stock of Atlantic white-sided dolphins is now considered “strategic” based on incidental mortality in the New England sink gillnet and North Atlantic bottom trawl fisheries. The Western North Atlantic stock of long-finned pilot whales will remain “strategic” based on mortality in the Atlantic squid, mackerel, butterfish trawl fishery. The Western North Atlantic stock of pygmy sperm whale is no longer considered “strategic”. One strategic stock that was not updated, but extensively reviewed by the ASRG was the Western North Atlantic stock (stock complex) of coastal bottlenose dolphins. New information on observed mortality in the 1995-1996 mid-Atlantic coastal gillnet fishery was presented. One mortality was observed in 1996, and the preliminary mortality estimate was 4.1 (CV = 0.88). Fishery effort data are under review and 1996-1997 mortality estimates will be provided in the draft 1999 assessment report.

This is a working document and individual stock assessment reports will be updated as new information becomes available and as changes to marine mammal stocks and fisheries occur. The authors solicit any new information or comments which would improve future stock assessment reports.

ACKNOWLEDGMENTS

The authors wish to thank and acknowledge Janeen Quintal for her technical assistance throughout the preparation of this report. The authors also wish to acknowledge contributions by the Northeast Fisheries Science Center (NEFSC) Sea Sampling Investigation, Dana Hartley and Kim Thounhurst (Northeast Regional Office), and Blair Mase, Keith Mullin, and Jim Tobias (Southeast Fisheries Science Center). Also, we acknowledge advice and comments provided by NEFSC: Richard Merrick and Fred Serchuk; and the Atlantic Scientific Review Group: Donald Baltz, Solange Brault, Joseph DeAlteris, James Gilbert, Mike Harris, Robert Kenney, Robert MacKinnon, James Mead, Daniel Odell, Andrew Read, Randall Wells, and Graham Worthy. We also thank Paul Wade, NMFS, Office of Protected Species, for his comments and guidance at the SRG review meeting, the Marine Mammal Commission, the Humane Society of the United States, the Blue Water Fishermen's Association and Hal Caswell (Woods Hole Oceanographic Institution) for their constructive comments and advice.

INTRODUCTION

Section 117 of the 1994 amendments to the Marine Mammal Protection Act (MMPA) requires that an annual stock assessment report (SAR) for each stock of marine mammals that occurs in waters under U.S. jurisdiction, be prepared by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS), in consultation with regional Scientific Review Groups (SRG). The SRGs are a broad representation of marine mammal and fishery scientists and members of the commercial fishing industry mandated to review the marine mammal stock assessments and provide advice to the Assistant Administrator for NMFS. The reports are then made available on the *Federal Register* for public review and comment before final publication.

The MMPA requires that each SAR contain several items, including: (1) a description of the stock, including its geographic range; (2) a minimum population estimate, a maximum net productivity rate, and a description of current population trend, including a description of the information upon which these are based; (3) an estimate of the annual human-caused mortality and serious injury of the stock, and, for a strategic stock, other factors that may be causing a decline or impeding recovery of the stock, including effects on marine mammal habitat and prey; (4) a description of the commercial fisheries that interact with the stock, including the estimated number of vessels actively participating in the fishery and the level of incidental mortality and serious injury of the stock by each fishery on an annual basis; (5) a statement categorizing the stock as strategic or not, and why; and (6) an estimate of the potential biological removal (PBR) level for the stock, describing the information used to calculate it. The MMPA also requires that SARs be updated annually for stocks which are specified as strategic stocks, or for which significant new information is available, and once every three years for nonstrategic stocks.

Following enactment of the 1994 amendments, the NMFS and FWS held a series of workshops to develop guidelines for preparing the SARs. The first set of stock assessments for the Atlantic Coast (including the Gulf of Mexico) were published in July 1995 in the *NOAA Technical Memorandum* series (Blaylock *et al.* 1995). In April 1996, the NMFS held a workshop to review proposed additions and revisions to the guidelines for preparing SARs (Wade and Angliss 1997). Guidelines developed at the workshop were followed in preparing the 1996 (Waring *et al.* 1997) and 1998 SARs. A 1997 SAR was not produced.

In this document, major revisions and updating of the SARs were only completed for Atlantic Coast strategic stocks and stocks for which significant new information were available. These are identified by the 1998 date-stamp at the top right corner at the beginning of each report. Gulf of Mexico SARs were not updated from Waring (et al. 1997), therefore were not included in this document. Except for some minor editorial changes, stocks designated by the 1995 or 1997 date-stamp are unchanged from the 1997 document (Waring *et al.* 1997).

In this document, the status of long-finned pilot whale was changed to non-strategic because the 5-year (1992-1996) mean annual mortality in fishing operations was below PBR.

REFERENCES

Blaylock, R. A., J. W. Hain, L. J. Hansen, D. L. Palka, and G. T. Waring. 1995. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments. NOAA Tech. Memo. NMFS-SEFSC-363, 211 pp.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., D. L. Palka, K. D. Mullin, J. H. W. Hain, L. J. Hansen, and K. D. Bisack. 1997. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments. NOAA Tech. Memo. NMFS-NE-114, 250 pp.

TABLE 1. A SUMMARY OF ATLANTIC MARINE MAMMAL STOCK ASSESSMENT REPORTS FOR STOCKS OF MARINE MAMMALS UNDER NMFS AUTHORITY THAT OCCUPY WATERS UNDER U.S. JURISDICTION. (A "Y" under the heading "SAR revised" indicates which 1998 stock assessment reports have been revised relative to the 1996 reports.)

Species	Stock Area	SRG Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mort.	Annual Fish. Mort.	Strategic Status	SAR Revised
Harbor seal	Western North Atlantic	ATL	NEC	30,990	0.12	1.0	1,859	898	898	N	Y
Gray seal	Northwest North Atlantic	ATL	NEC	2,010	0.12	1.0	121	41	41	N	Y
Harp seal	Northwest North Atlantic	ATL	NEC	N/A	N/A	N/A	N/A	329	329	N	Y
Hooded seal	Northwest North Atlantic	ATL	NEC	N/A	N/A	N/A	N/A	5.6	5.6	N	Y
Harbor porpoise	Gulf of Maine/Bay of Fundy	ATL	NEC	48,289	0.04	0.5	483	1,667	1,667	Y	Y
Risso's dolphin	Western North Atlantic	ATL	NEC	11,140	0.04	0.5	111	18	18	N	Y
Atlantic white-sided dolphin	Western North Atlantic	ATL	NEC	19,196	0.04	0.5	192	218	218	Y	Y
White-beaked dolphin	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	0.00	0.00	N	N
Common dolphin	Western North Atlantic	ATL	NEC	15,470	0.04	0.5	155	247[1]	247[1]	Y	Y
Atlantic spotted dolphin	Western North Atlantic	ATL	NEC	1,617[2]	0.04	0.5	16	16[3]	16[3]	Y	Y
Pantropical spotted dolphin	Western North Atlantic	ATL	NEC	1,617[2]	0.04	0.5	16	16[2]	16[3]	Y	Y
Striped dolphin	Western North Atlantic	ATL	NEC	18,220	0.04	0.5	182	11	11	N	Y
Spinner dolphin	Western North Atlantic	ATL	NEC	N/A	N/A	N/A	N/A	0.31	0.31	N	Y

Species	Stock Area	SRG Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mort.	Annual Fish. Mort.	Strategic Status	SAR Revised
Bottlenose dolphin	Western North Atlantic, offshore	ATL	NEC	8,794[4]	0.04	0.5	88	58	58	N	Y
Bottlenose dolphin	Western[5] North Atlantic, coastal	ATL	SEC	2,482	0.04	0.5	25	29	29	Y	N
Dwarf sperm whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	0.2	0.2	Y	Y
Pygmy sperm whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	N/A	N/A	N	Y
Killer whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	0.00	0.00	N	N
Pygmy killer whale	Western North Atlantic	ATL	SEC	6	0.04	0.5	0.1	0.00	0.00	N	N
Northern bottlenose whale	Western North Atlantic	ATL	NEC	N/A	0.04	N/A	N/A	0.00	0.00	N	Y
Cuvier's beaked whale	Western North Atlantic	ATL	NEC	895[6]	0.04	0.5	8.9	9.7	9.7[7]	Y	Y
Mesoplodon beaked whale	Western North Atlantic	ATL	NEC	895[6]	0.04	0.5	8.9	9.7	9.7[7]	Y	Y
Pilot whale, long-finned (Globicephala spp..)	Western North Atlantic	ATL	NEC	4,968[8]	0.04	0.5	50	32	32[9]	N	Y
Pilot whale, short-finned	Western North Atlantic	ATL	NEC	457	0.04	0.5	4.6	32	32[9]	Y	Y
Sperm whale	Western North Atlantic	ATL	NEC	1,617	0.04	0.1	3.2	0.0	0.0	Y	Y
North Atlantic right whale	Western North Atlantic	ATL	NEC	295	0.025	0.1	0.4	2.3	1.0[10]	Y	Y
Humpback whale	Western North Atlantic	ATL	NEC	10,019	0.065	0.1	32.6	5.7	4.4[11]	Y	Y
Fin whale	Western North Atlantic	ATL	NEC	1,704	0.04	0.1	3.4	0.5	0.20	Y	Y

Species	Stock Area	SRG Region	NMFS Center	Nmin	Rmax	Fr	PBR	Total Annual Mort.	Annual Fish. Mort.	Strategic Status	SAR Revised
Sei whale	Western North Atlantic	ATL	NEC	N/A	0.04	0.1	N/A	0.00	0.00	Y	Y
Minke whale	Canadian east coast	ATL	NEC	2,145	0.04	0.5	21	0.8	0.8	N	Y
Blue whale	Western North Atlantic	ATL	NEC	N/A	0.04	0.1	N/A	0.00	0.00	Y	Y

1. Effort data for the 1996 Atlantic squid, mackerel, butterfish trawl fisheries are currently under review. The estimated mortalities attributed to these fisheries will be included in the1999 SAR.

2. This value includes either or both of *Stenella frontalis* or *Stenella attenuata*.

3. Mortality data are not separated by species; therefore, species-specific estimates are not available. The mortality estimate represents both Atlantic and Pantropical spotted dolphins.

4. Estimates may include sightings of the coastal form.

5. This stock assessment has not been updated. However, a revised assessment, including bycatch data from the 1995-1997 Atlantic coastal sink gillnet fishery, will be prepared in 1999.

6. This estimate includes Cuvier's beaked whales and *Mesoplodon* spp. beaked whales.

7. This is the average mortality of beaked whales (*Mesoplodon* spp.) based on 5 years of observer data. This annual mortality rate includes an unknown number of Cuvier's beaked whales.

8. This estimate may include both long-finned and short-finned pilot whales.

9. Mortality data are not separated by species; therefore, species-specific estimates are not available. This mortality estimate represents both long-finned and short-finned pilot whales.

10. This is the average mortality of right whales based on 5 years of observer data (0.0) and additional fishery impact records (1.0).

11. This is the average mortality of humpback whales based on 5 years of observer data (0.6) and additional fishery impact records (3.8).

NORTH ATLANTIC RIGHT WHALE (*Eubalaena glacialis*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Individuals of the western North Atlantic right whale population range from wintering and calving grounds in coastal waters of the southeastern United States to summer feeding, nursery, and presumed mating grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf. Knowlton *et al*. (1992) reported several long-distance movements as far north as Newfoundland, the Labrador Basin, and southeast of Greenland, indicating an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described. Likewise, a calving and wintering ground has been described for coastal waters of the southeastern U.S.; sightings from the Gulf of Mexico (Moore and Clark 1963; Schmidly *et al*. 1972), are either geographic anomalies or indicate a more extensive historic range. Whichever the case, 85% of the population is unaccounted for during the winter. A small offshore survey effort in February 1996 reported three sightings in waters east of northeastern Florida and southeastern Georgia: a mother/calf pair, a single individual, and a group of four juveniles. These sightings suggest a distribution further offshore than previously reported.

Research results to date suggest five major habitats or congregation areas (southeastern United States coastal waters, Great South Channel, Cape Cod Bay, Bay of Fundy, and Scotian Shelf) for western North Atlantic right whales. However, movements within and between habitats may be more extensive than sometimes thought. Results from a few successfully attached satellite telemetry tags suggest that sightings separated by perhaps two weeks should not be assumed to indicate a stationary or resident animal. Instead, telemetry data have shown rather lengthy and somewhat distant excursions (Mate *et al*. 1992). These findings cast new light on movements and habitat use, and raise questions about the purpose or strategies for such excursions.

New England waters are a primary feeding habitat for the right whale, which appears to feed primarily on copepods (largely of the genera *Calanus* and *Pseudocalanus*) in this area. Research suggests that right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently. These dense zooplankton patches are likely a primary characteristic of the spring, summer, and fall right whale habitat (Kenney *et al*. 1986). The acceptable surface copepod resource is limited to perhaps 3% of the region during the peak feeding season in Cape Cod and Massachusetts Bays (Mayo and Goldman, pers. comm.). While feeding in the coastal waters off Massachusetts has been better studied, feeding by right whales has been observed elsewhere over Georges Bank, in the Gulf of Maine, in the Bay of Fundy, and over the Scotian Shelf. The characteristics of acceptable prey distribution in these areas are not well known. New England waters also serve as a nursery for calves and, in some cases, for mating.

Genetic analyses of tissue samples are providing insights into stock definition. Schaeff *et al*. (1993) used Restriction Fragment Length Polymorphism (RFLP) analysis to suggest that western North Atlantic right whales represent a single breeding population that may be based on as few as three matrilines. However, more recent analyses based upon direct sequencing of mitochondrial DNA (mtDNA) have identified five mtDNA haplotypes (Malik, 1997). Schaeff *et al.* (1997) compared the genetic variability of northern and southern (*E. australis*) right whales, and found the former to be significantly less diverse. They suggested that this might be indicative of inbreeding in the population, but no definitive conclusion can be reached using current data. Additional work comparing modern and historic genetic population structure in right whales, using DNA extracted from museum specimens of baleen and bone, is also underway (Rosenbaum *et al.* 1997). Preliminary results suggest that the eastern and western North Atlantic populations were not genetically distinct (Rosenbaum *et al.*, submitted). However, the virtual extirpation of the eastern stock and its lack of recovery this century strongly suggests population subdivision over a protracted (but not evolutionary) timescale.

To date, skin biopsy sampling has resulted in the compilation of a DNA library of more than 200 North Atlantic right whales. When work is completed, a genetic profile will be established for each individual, and an assessment provided on the level of genetic variation in the population, the number of reproductive individuals, reproductive fitness, the basis for associations and social units in each habitat area, and the mating system. Tissue analysis has also aided in sex identification: the sex ratio of the photo-identified and catalogued population (through December of 1995) is 137 females and 132 males (1.04:1), not significantly different from parity (P<0.001) (M.W. Brown, pers. comm.). Analyses based on sighting histories of photographically identified individuals also suggest that, in addition to the Bay of Fundy, there exists an additional and undescribed summer nursery area utilized by approximately one-third of the population. As described above, a related question is where individuals other than calving females and a few juveniles overwinter. One or more additional wintering and summering grounds may exist in unsurveyed locations, although it is also possible that "missing" animals simply disperse over a wide area at these times.

POPULATION SIZE

Based on a census of individual whales identified using photo-identification techniques, the western North Atlantic population size was estimated to be 295 individuals in 1992 (Knowlton *et al*. 1994). Because this was a nearly complete census, it is assumed that this represents a minimum population size estimate.

Historical Population Estimate

An estimate of pre-exploitation population size is not available. Basque whalers may have taken as many as 200 right whales a year at times during the 1500s in the Strait of Belle Isle region, and the stock of right whales may have already been substantially reduced by the time whaling was begun by colonists in the Plymouth area in the 1600s (Reeves and Mitchell 1987). A modest but persistent whaling effort along the eastern U.S. lasted three centuries, and the records include one report of 29 whales killed in Cape Cod Bay in a single day during January 1700. Based on incomplete historical whaling data, these authors could only conclude that there were at least some hundreds of right whales present in the western North Atlantic during the late 1600s. In a later study (Reeves *et al*. 1992), a series of population trajectories using historical data and an estimated present population size of 350 were plotted. The results suggest that there may have been at least 1,000 right whales in this population during the early to mid-1600s, with the greatest population decline occurring in the early 1700s. The authors cautioned, however, that the record of removals is incomplete, the results are preliminary, and refinements are required. Based on back calculations using the present population size and growth rate, the population may have numbered fewer than 100 individuals by the time that international protection for right whales came into effect in 1935 (Hain 1975; Reeves *et al*. 1992; Kenney *et al*. 1995).

Minimum Population Estimate

The western North Atlantic population size was estimated to be 295 individuals in 1992 (Knowlton *et al*. 1994), based on a census of individual whales identified using photo-identification techniques. A bias that might result from including catalogued whales that had not been seen for an extended period of time and therefore might be dead, was addressed by assuming that an individual whale not sighted for five years was dead (Knowlton *et al*. 1994). It is assumed that the census of identified and presumed living whales represents a minimum population size estimate. The true population size in 1992 may have been higher if: 1) there were animals not photographed and identified, and/or 2) some animals presumed dead were not.

Current Population Trend

The current population growth rate reported by Knowlton *et al*. (1994) of 2.5% (CV = 0.12) suggests that the stock is showing signs of slow recovery. However, as noted during a recent International Whaling Commission (IWC) workshop on right whale assessment, conflicting data exist and the status of this population is not known (IWC 1999). As further noted by the IWC, determination of this status is a high priority, notably in light of the known high levels of anthropogenic mortality in this population.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

During 1980-1992, 145 calves were born to 65 identified cows. The number of calves born annually ranged from five 5 to 17, with a mean of 11.2 (SE = 0.90). There was no detectable trend in the number of calves produced per year. The reproductively active female pool was static at approximately 51 individuals during 1987-1992. Mean calving interval, based on 86 records, was 3.67 years. There was an indication that calving intervals may be increasing over time, although the trend was not statistically significant (P = 0.083) (Knowlton *et al*. 1994). Since that report, total reported calf production in 92/93 was 6; 93/94, 8; 94/95, 7; and 95/96, 22. (The total calf production was reduced by reported calf mortalities: 2 in 1993, and 3 in 1996. Of the three calf mortalities in 1996, available data suggested one was not included in the reported 21 mother/calf pairs, resulting in a total of 22 calves born.) Of the 46 adult females considered to be available for calving in the 95/96 season, only 10 were documented to calve. The remaining 11 mothers were first observed with calves this year. Three of these were 10 years old or younger, two were 9 years old, and six were of unknown age. In 95/96, more mothers gave birth after a 5-year interval than in previous years, suggesting that the calving interval was increasing (L. Conger, pers. comm.). An updated analysis of calving interval through the 95/96 season suggests that calving interval is increasing (P<0.001) (R. Kenney and A. Knowlton, pers. comm.).

The current annual population growth rate during 1986-1992 was estimated to be 2.5% (CV = 0.12) using photo-identification techniques (Knowlton *et al*. 1994). A population increase rate of 3.8% was estimated from the annual increase in aerial sighting rates in the Great South Channel, 1979-1989 (Kenney *et al*. 1995). The current estimated population growth rate of the western North Atlantic stock is lower than that of the four stocks of southern-hemisphere right whales for which data are available: western Australia, 12.7%; Argentina, 7.3%; east and west Africa, 6.8% (Best 1993). This difference could be attributable in part to reproductive females in the population--only 38% of the females in the North Atlantic population are known to have given birth compared with 54% in the western South Atlantic population (Brown *et al*. 1994).

The relatively low population size strongly suggests that this stock is well below its optimum sustainable population (OSP); therefore, the current population growth rate should reflect the maximum net productivity rate for this stock. The current population growth rate reported by Knowlton *et al*. (1994) of 2.5% (CV = 0.12) was assumed to reflect the maximum net productivity rate for this stock for purposes of this assessment. This rate is no longer current and may reflect underlying methodological problems; nonetheless, it is used here in the absence of better information because a risk-averse approach is appropriate for this critically endangered population. The alternative default rate of 0.04 is not species-specific and, being higher, is less conservative.

POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) was specified as the product of minimum population size, one-half the maximum net productivity rate (½ of 2.5%), and a "recovery" factor for endangered, depleted, threatened stocks, or stocks of unknown status relative to OSP (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The recovery factor was 0.10 because this species is listed as endangered under the Endangered Species Act (ESA). PBR for the northern right whale is 0.4 whales.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 1991 through 1996, the total estimated human-caused mortality and serious injury to right whales is estimated as 2.3 per year. This is derived from two components: 1) non-observed fishery impact records, 1.0; and 2) ship strike records, 1.3.

Background

Approximately one-third of all right whale mortality is caused by human activities (Kraus 1990). Further, the small population size and low annual reproductive rate suggest that human sources of mortality may have a greater effect relative to population growth rates than for other whales. The principal factors believed to be retarding growth, and perhaps recovery, of the population are ship strikes and entanglement with fishing gear. An updated summary of right whale mortalities reports a total of 30 mortalities (29 if one eliminates a record with some doubt about species identification) for the period 1970 to early 1993 (Kenney and Kraus 1993). Eight (27%) were due to ship collisions, and two (7%) were due to entanglement with fishing gear. (Note that this report corrects one of the published records from the Kraus 1990 report, where a fishing vessel caught an already-dead carcass, making the actual cause of death unknown and possibly unrelated to fishing activity. Further, there was uncertainty about the species identification.) Both entanglements involved fixed fishing gear, and there was no evidence for right whale mortality from encounters with mobile fishing gear. The total of ten confirmed anthropogenic mortalities is one-third of all known mortalities for the period addressed. Young animals, ages 0-4 years, are apparently the most impacted portion of the population (Kraus 1990). Finally, entanglement or minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so that it is more likely to become vulnerable. Such was apparently the case with the two-year old right whale killed by a ship off Amelia Island, Florida, in March 1991 after having carried gillnet gear wrapped around its tail region since the previous summer (Kenney and Kraus 1993).

For one area of concern, the coastal waters of the southeastern U.S., an awareness and mitigation program, involving ten agencies and organizations, began in 1992, and has been upgraded and expanded annually. Other areas may be included in the future. For waters of the northeastern U.S., a present concern, not yet completely defined, is the possibility of habitat degradation in Massachusetts and Cape Cod Bays due to a Boston sewage outfall now under construction. Timetables for levels of treatment are under discussion.

Fishery-Related Serious Injury and Mortality

Reports of mortality and serious injury relevant to calculation of PBR as well as total human impacts are contained in records maintained by the New England Aquarium and the Northeast Regional Office/NMFS (Table 1). The examination of the large whale entanglement records shows that during 1991-96 7 of 13 records of mortality or serious injury likely to result in mortality included entanglement or fishery interactions. . The reports often do not contain the detail necessary to assign the entanglements to a particular fishery or location. On the other hand, based on re-examination of the records for the right whale observed entangled in pelagic drift gillnet in July 1993, which included the observer's documentation of lobster gear on the whale's tail stock and subsequent entanglement reports of this whale, the suspected mortality of this whale was reassigned to the Gulf of Maine and U.S. Mid-Atlantic lobster pot fisheries In this case, the pre-existing entanglement of lobster gear was judged to have been sufficient cause of eventual mortality independent of the drift net entanglement. Although some drift net gear was left on the tail by the fishing vessel, this would likely not have occurred had the lobster gear not have created a deep existing wound. In another instance, a 2 year-old dead male right whale with lobster line through the mouth and deeply embedded at the base of the right flipper beached in Rhode Island in July 1995. This individual had been sighted previously, entangled, east of Georgia in December 1993, and again in August 1994 in Cape Cod Bay. In this case, the entanglement became a serious injury, and perhaps, directly or indirectly, the cause of the mortality.

In January 1997 (62 FR 33, Jan. 2, 1997), NMFS changed the classification of the Gulf of Maine and U.S. Mid-Atlantic lobster pot fisheries from Category III to Category I based on examination of stranding and entanglement records of large whales from 1990 to 1994 (including the right whale records of 9 July 1993 and 17 July 1995, shown in Table 1).

Fishery Information

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year, several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and also provides observer coverage of vessels fishing south of Cape Hatteras. By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in either the pelagic longline, pelagic pair trawl, or other fisheries monitored by NMFS. The only documented by-catch of a right whale by NMFS Sea Samplers was a 1½ year-old female that was released from a pelagic drift gillnet along the southern edge of Georges Bank. At the time of the release, it was discovered that the animal was also entangled in lobster gear. After recent review of the evidence, the serious injury to the whale has since been attributed to the non-observed Gulf of Maine and U.S. Mid-Atlantic lobster pot fisheries (see above).

In a recent analysis of the scarification of right whales, a total of 61.6% of the whales bore evidence of entanglements with fishing gear (Hamilton *et al*. 1998). Entanglement records maintained by NMFS Northeast Regional Office (NMFS, unpublished data) from 1970-1996, included 42 right whale entanglements or possible entanglements, including right whales in weirs, entangled in gillnets, and trailing line and buoys. An additional record (M. J. Harris, pers. comm.) reported a 9.1-10.6 m right whale entangled and released south of Ft. Pierce, Florida, in March 1982 (this event occurred in the course of a sampling program and was not related to a commercial fishery). Incidents of entanglements in groundfish gillnet gear, cod traps, and herring weirs in waters of Atlantic Canada and the U.S. east coast were summarized by Read (1994). In six records of right whales becoming entangled in groundfish gillnet gear in the Bay of Fundy and Gulf of Maine between 1975 and 1990, the right whales were either released or escaped on their own, although several whales have been observed carrying net or line fragments. A right whale mother and calf were released alive from a herring weir in the Bay of Fundy in 1976. For all areas, specific details of right whale entanglement in fishing gear are often lacking. When direct or indirect mortality occurs, some carcasses come ashore and are subsequently examined, or are reported as "floaters" at sea; however, the number of unreported and unexamined carcasses is unknown, but may be significant in the case of floaters. More information is needed about fisheries interactions and where they occur.

Other Mortality

Ship strikes are a major cause of mortality and injury to right whales (Kraus 1990). Records from 1991 through 1996 have been summarized in Table 1, yielding a human-induced, non-fishery-related mortality or serious injury rate of between 1 and 3 (perhaps 4 in 1996) right whales a year.

In the period January to March 1996, an ‘unusual mortality event’ was declared for right whales in southeastern U.S. waters. Five mortalities were reported, at least one of which (on 1/30/96) was attributable to ship strike. A second mortality (on 2/22/96) showed evidence of barotrauma but no proximate cause of death could be determined. Of the remaining three mortalities, two were calves (½/96 and 2/19/96), one of which may have died from birthing trauma (inconclusive). . The third (2/7/96) was decomposed and could not be towed in for examination. The five mortalities in the southeast were followed by a sixth at Cape Cod, Massachusetts (3/9/96); this involved an animal killed by ship strike, with the possibility that an existing entanglement (first reported in 1995) may have impeded its mobility.

Table 1. Summarized records of mortality and serious injury likely to result in mortality, North Atlantic right whales, January 1991- December 1996. This listing includes only records related to U.S. commercial fisheries and/or U.S. waters. Cause of mortality or injury, assigned as primary or secondary, based on records maintained by NMFS/NER and NMFS/SER.

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unknown uncertain	
3/12/91	mortality, beached	2 y.o. female #1907	Amelia I. FL	P	S		fractured skull; net, line, buoys
7/6/91	mortality, offshore	calf	offshore NJ	P			documented vessel strike
1/5/93	mortality, offshore	calf	St. Augustine, FL	P			documented vessel strike
7/9/93	serious injury	1 y.o. female #2233	120 miles SE of Nantucket		P		lobster gear constricted on tail stock, subsequently became entangled in pelagic drift gillnet
12/12/93	mortality, offshore	female	offshore VA	P		S	photos show gash

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unknown uncertain	
2/22/94	serious injury	calf #2404	offshore NE FL		P	S	scars, wounds, flukes limp
11/16/94	serious injury	3 y.o. juv., #2151	nr. Plum I., MA		P		entangled head, 3 tail wraps, unsuccessful disentanglement
7/17/95	mortality, beached	2 y.o. male #2366	Middletown, RI		P		line through mouth, embedded deeply right flipper
8/13/95	serious injury, offshore	adult female, #1045	S. Georges Bank	P		S	large head wound, bone exposed
10/20/95	mortality, beached	adult male, #2250	Long I., N.S.	P		S	wound in back, spine damaged, prob. ship strike
1/30/96[a]	mortality, offshore	adult male, #1623	offshore GA	P		S	trauma event, skull shattered
8/5/96	serious injury	unknown	SE of Gloucester, MA		P		unknown type of gear entangled around head, judged to be a life threatening entanglement

Table notes
1) Assigned cause based on best judgement of available data. Additional information may result in revisions.
2) Entanglements of juvenile whales may become more serious as whale grows.

[a] Date changed from 2/1/96, as reported in previous SAR; 1/30/96 reflects the date of the first report.
[b] Date changed from 3/10/96, as reported in previous SAR; 3/9/96 reflects the date of the first report.

Several additional factors need to be considered when considering mortality and serious injury to right whales: 1) a ship strike or entanglement may occur at some distance from the report location, 2) the mortality or injury may involve multiple factors--struck and entangled whales are not uncommon, 3) in entanglements, several types of gear may be involved, 4) possible human-impacts aside from ship strikes and entanglements have been reported, 5) there are several records where a struck and injured whale is re-sighted later, apparently healthy, or, an entangled or partially disentangled whale is re-sighted later free of gear, and, lastly, 6) the actual vessel or gear type/source is often uncertain.

With these caveats, the average reported mortality and serious injury to right whales due to ship strikes was 1.3 whales per year (8 ship strike events in 6 years) during 1991-96. The total estimated annual average human-induced mortality and serious injury (including fishery and non-fishery related causes) was 2.3 right whales per year. As with entanglements, some injury or mortality due to ship strikes, particularly in offshore waters, may go undetected. Decomposed and/or unexamined animals (e.g., carcasses reported but not retrieved or necropsied) represent 'lost data', some of which may relate to human impacts. For these reasons, the 2.3 estimate must be regarded as a minimum estimate. Of the mortality and serious injury records for U.S. waters, 57% was attributable to ship strikes, and 43% to entanglement/fishery interaction.

While this assessment relates to U.S. fisheries and U.S. waters, there are additional records for Canadian waters. Three records are noteworthy: 1) the mortality of whale #1223 on 5 September 1992 in the Bay of Fundy was attributed to a probable ship strike, 2) whale #1247 was sighted 21 September 1994 in the Bay of Fundy entangled with line of unknown gear type tightly wrapped and has not been sighted since. This is considered a serious injury (A.R. Knowlton, pers. comm.), and 3) whale #2220, which came ashore on Cape Cod on 9 March 1996, was entangled in Canadian lobster gear set in the Bay of Fundy and noticed missing in mid-December 1995. While the primary cause of death was probably a ship strike, the entanglement may have played some role in the whale's death.

STATUS OF STOCK

The size of this stock is considered to be low relative to OSP in the U.S. Atlantic EEZ, and this species is listed as endangered under the ESA. A Recovery Plan has been published and is in effect (NMFS 1991). Three critical habitats, Cape Cod Bay/Massachusetts Bay, Great South Channel, and the Southeastern U.S., were designated by NMFS (59 FR 28793, June 3, 1994). The NMFS ESA 1996 Northern Right Whale Status Review, now in draft, concludes that the status of the western North Atlantic population of the northern right whale remains endangered. The total level of human-caused mortality and serious injury is unknown, but reported human-caused mortality and serious injury has been a minimum of 2.3 right whales per year since 1991. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the average annual fishery-related mortality and serious injury exceeds PBR, and because the North Atlantic right whale is an endangered species. Relative to other populations of right whales, there are also concerns about growth rate, percentage of reproductive females, and calving intervals in this population.

REFERENCES

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. *ICES J. Mar. Sci. 50: 169-186.*

Brown, M.W., S.D. Kraus, D.E. Gaskin, and B.N. White. 1994. Sexual composition and analysis of reproductive females in the North Atlantic right whale, *(Eubalaena glacialis)*, population. *Mar. Mamm. Sci. 10(3): 253-265.*

Hain, J.H.W. 1975. The international regulation of whaling. *Marine Affairs J. 3: 28-48.*

Hamilton, P.K., M.K. Marx, and S.D. Kraus. 1998. Scarification analysis of North Atlantic right whales (*Eubalaena glacialis*) as a method of assessing human impacts. Final report to the Northeast Fisheries Science Center, Contract No. 4EANF-6-0004.

International Whaling Commission. 1999. Report of the workshop on the comprehensive assessment of right whales: a worldwide comparison. *Rep. int. Whal. Commn*. (in press).

Kenney, R. D., M. A. M. Hyman, R. E. Owen, G. P. Scott, and H. E. Winn. 1986. Estimation of prey densities required by western North Atlantic right whales. *Mar. Mamm. Sci. 2(1): 1-13.*

Kenney, R. D. and S. D. Kraus. 1993. Right whale mortality — a correction and an update. *Mar. Mamm. Sci. 9:445-446.*

Kenney, R. D., H. E. Winn, and M. C. Macaulay. 1995. Cetaceans in the Great South Channel, 1979-1989: right whale (*Eubalaena glacialis*). *Cont. Shelf Res. 15: 385-414.*

Knowlton, A. R., J. Sigurjonsson, J. N. Ciano, and S. D. Kraus. 1992. Long-distance movements of North Atlantic Right whales (*Eubalaena glacialis*). *Mar. Mamm. Sci. 8(4): 397-405.*

Knowlton, A. R., S. D. Kraus, and R. D. Kenney. 1994. Reproduction in North Atlantic right whales (*Eubalaena glacialis*). *Can. J. Zool. 72: 1297-1305.*

Kraus, S. D. 1990. Rates and potential causes of mortality in North Atlantic right whales (*Eubalaena glacialis*). *Mar. Mamm. Sci. 6(4): 278-291.*

Malik, S. 1997. Assessment of genetic structuring and habitat philopatry in the North Atlantic right whale (*Eubalaena glacialis*). M.Sc. thesis, McMaster University, Hamilton, Ontario. 133 pp.

Mate, B. R., S. Nieukirk, R. Mesecar, and T. Martin. 1992. Application of remote sensing methods for tracking large cetaceans: North Atlantic right whales (*Eubalaena glacialis*). Final Report to the Minerals Management Service, Contract No. 14-12-0001-30411, U.S. Department of the Interior, Reston, Virginia. 167 pp.

Moore, J. C. and E. Clark. 1963. Discovery of right whales in the Gulf of Mexico. *Science 141(3577): 269.*

NMFS. 1991. Recovery plan for the northern right whale (*Eubalaena glacialis*). Prepared by the Right Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland, 86 pp.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Reeves, R. R. and E. Mitchell. 1987. Shore whaling for right whales in the northeastern United States. Contract Report No. NA85-WCC-06194, SEFSC/NMFS, Miami, FL, 108 pp.

Reeves, R. R., J. M. Breiwick, and E. Mitchell. 1992. Pre-exploitation abundance of right whales off the eastern United States. Pages 5-7. *In*: J. Hain (ed.), The right whale in the western North Atlantic: A science and management workshop, 14-15 April 1992, Silver Spring, Maryland. Northeast Fisheries Science Center Reference Document No. 92-05. NEFSC/NMFS, Woods Hole, Massachusetts, 88 pp.

Rosenbaum, H.C., Egan, M., Clapham, P.J., Brownell, R.L. Jr. & DeSalle, R. 1997. An effective method for isolating DNA from non-conventional museum specimens. *Mol. Ecol. 6: 677-681*.

Rosenbaum, H.C., Egam M.G., Clapham, P.J., Brownell, R.L. Jr., Malik, S., Brown, M., White, B. Walsh, P. and DeSalle, R. Submitted. Levels of historic genetic diversity and population structure in North Atlantic right whales detected by an effective technique to isolate DNA from museum specimens. *Rep. int. Whal. Commn*. (in review).

Schaeff, C.M., S.D. Kraus, M.W. Brown, J. Perkins, R. Payne and B.N. White. 1997. Comparison of genetic variability of North and South Atlantic right whales (*Eubalaena*) using DNA fingerprinting. *Can. J. Zool. 75: 1073-1080.*

Schaeff, C. M., S. D. Kraus, M. W. Brown, and B. N. White. 1993. Assessment of the population structure of the western North Atlantic right whales (*Eubalaena glacialis*) based on sighting and mtDNA data. *Can. J. Zool. 71: 339-345.*

Schmidly, D. J., C. O. Martin, and G. F. Collins. 1972. First occurrence of a black right whale (*Balaena glacialis*) along the Texas coast. *Southw. Nat. 17(2): 214-215.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop, April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-12. U.S. Dept. of Commerce, Washington, D.C. 93 pp.

HUMPBACK WHALE (*Megaptera novaeangliae*): North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the western North Atlantic, humpback whales feed during spring, summer and fall over a range which encompasses the eastern coast of the United States (including the Gulf of Maine), the Gulf of St Lawrence, Newfoundland/Labrador, and western Greenland (Katona and Beard, 1990). Other North Atlantic feeding grounds occur off Iceland and northern Norway, including off Bear Island and Jan Mayen (Christensen *et al.*, 1992; Palsbøll *et al.*, 1997). These six regions represent relatively discrete subpopulations, fidelity to which is determined matrilineally (Clapham and Mayo 1987). Recent genetic analysis of mitochondrial DNA (mtDNA) has indicated that this fidelity has persisted over an evolutionary timescale in at least the Icelandic and Norwegian feeding grounds (Palsbøll *et al.* 1995, Larsen *et al.* 1996). Genetic partitioning is not evident in the western North Atlantic, however; thus these four subpopulations (Gulf of Maine, Gulf of St Lawrence, Newfoundland/Labrador and western Greenland) are treated as a single stock in this report. However, given that fidelity to each feeding area is known to be high, it is possible that each of the four regions should be managed separately, an approach which requires further investigation.

In winter, whales from all six feeding areas mate and calve primarily in the West Indies, where spatial and genetic mixing among subpopulations occurs (Clapham *et al.* 1993; Katona and Beard, 1990; Palsbøll *et al.* 1997, Stevick *et al.* 1998). A few whales of unknown northern origin migrate to the Cape Verde Islands (Reiner *et al.*, 1996). In the West Indies, the majority of whales are found in the waters of the Dominican Republic, notably on Silver Bank, on Navidad Bank, and in Samana Bay (Balcomb and Nichols 1982, Whitehead and Moore 1982, Mattila *et al.* 1989, 1994). Humpback whales are also found at much lower densities throughout the remainder of the Antillean arc, from Puerto Rico to the coast of Venezuela (Winn *et al.* 1975, Levenson & Leapley 1978, Price 1985, Mattila and Clapham 1989).

It is apparent that not all whales migrate to the West Indies every winter, and that significant numbers of animals are found in mid- and high-latitude regions at this time (Swingle *et al.* 1993, Clapham *et al.* 1993). An increased number of sightings of young humpback whales in the vicinity of the Chesapeake and Delaware bays occurred in 1992 (Swingle *et al*. 1993). Wiley *et al*. (1995) reported 38 humpback whale strandings which occurred during 1985-1992 in the U.S. mid-Atlantic and southeastern states. Humpback whale strandings increased, particularly along the Virginia and North Carolina coasts, and most stranded animals were sexually immature; in addition, the small size of many of these whales strongly suggests that they had only recently separated from their mothers. Wiley *et al.* (1995) concluded that these areas are becoming an increasingly important habitat for juvenile humpback whales and that anthropogenic factors may negatively impact whales in this area. There have also been a number of wintertime humpback sightings in coastal waters of the southeastern U.S. (NMFS unpublished data; New England Aquarium unpublished data; Florida DEP, unpublished data). Whether the increased sightings represent a distributional change, or are simply due to an increase in sighting effort and/or whale abundance, is presently unknown.

Feeding is the principal activity of humpback whales in New England waters, and their distribution in New England waters has been largely correlated to prey species and abundance, although behavior and bottom topography are factors in foraging strategy (Payne *et al*. 1986, 1990). Humpback whales are frequently piscivorus when in these waters, feeding on herring (*Clupea harengus*), sand lance (*Ammodytes dubius*), and other small fishes. In the northern Gulf of Maine, euphausiids are also frequently taken (Paquet *et al.* 1997). Commercial depletion of herring and mackerel led to an increase in sand lance in the southwestern Gulf of Maine in the mid 1970s with a concurrent decrease in humpback whale abundance in the northern Gulf of Maine. Humpback whales were densest over the sandy shoals in the southwestern Gulf of Maine favored by the sand lance during much of the late 1970s and early 1980s, and humpback distribution appeared to have shifted to this area (Payne *et al*. 1986). An apparent reversal began in the mid 1980s, and herring and mackerel increased as sand lance again decreased (Fogarty *et al*. 1991). Humpback whale abundance in the northern Gulf of Maine increased dramatically during 1992-93 , along with a major influx of herring (P. Stevick, pers. comm.). Humpback whales were few in nearshore Massachusetts waters in the 1992-93 summer seasons. They were more abundant in the offshore waters of Cultivator Shoal and the Northeast Peak on Georges Bank, and on Jeffreys Ledge; these latter areas are more traditional locations of herring occurrence. In 1996 and 1997, sand lance, and thus humpback whales, were once again abundant in the Stellwagen Bank area. However, unlike previous cycles, where an increase in sand lance corresponded to a decrease in herring, herring remained relatively abundant in the northern Gulf of Maine, and humpbacks correspondingly continued to occupy this portion of the habitat, where they also fed on euphausiids (unpublished data, Center for Coastal Studies and College of the Atlantic).

In early 1992, a major research initiative known as the Years of the North Atlantic Humpback (YONAH) (Allen *et al*. 1993) was initiated. This project is a large-scale, intensive study of humpback whales throughout almost their entire North Atlantic range, from the West Indies to the Arctic. During two primary years of field work, photographs for individual identification and biopsy samples for genetic analysis were collected from summer feeding areas and from the breeding grounds in the West Indies. Additional samples were collected from certain areas in other years. Results pertaining to the estimation of abundance and to genetic population structure are summarized below.

POPULATION SIZE

The North Atlantic population was recently estimated from genetic tagging data collected by the YONAH project in the breeding range at 4,894 males (95% c.i. 3,374-7,123) and 2,804 females (95% c.i. 1,776-4,463) (Palsbøll *et al.* 1997). Since the sex ratio in this population is known to be even (Palsbøll *et al.* 1997), the excess of males is presumed to be a result of sampling bias, lower rates of migration among females or sex-specific habitat partitioning in the West Indies; whatever the reason, the combined total is an underestimate of overall population size in this ocean. Photographic mark-recapture analyses from the YONAH project gave an ocean-basin-wide estimate of 10,600 (95% c.i. 9,300 to 12,100), and an additional genotype-based analysis yielded a similar but less precise estimate of 10,400 (95% c.i. 8,000 to 13,600) (Smith *et al.* 1999). The estimate of 10,600 (CV = 0.067) is regarded as the best available estimate for the North Atlantic. In the northeastern North Atlantic, Øien (1990) estimated from sighting survey data that there were 1,100 humpback whales in the Barents Sea region.

A population size of 294 humpback whales (CV=0.45) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on an inverse variance weighted pooling of spring and summer data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate includes a dive-time scale-up correction of 3.6 but was not corrected for g(0), the probability of detecting an animal group on the track line. This estimate clearly does not reflect the current true population size because of its high degree of uncertainty (e.g., large CV), and its age. Furthermore, it is considerably smaller than the size of the existing catalog of identified individuals in the Gulf of Maine, and it was estimated just after cessation of extensive foreign fishing operations in the region.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for North Atlantic humpback whales is 10,600 (CV = 0.067, Smith *et al.* 1999). The minimum population estimate for this stock is 10,019 humpback whales (CV=0.067).

Table 1. Summary of abundance estimates for North Atlantic humpback whales. Period and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV). MR = Mark-recapture.

Month/Year	Area	Type	N_{best}	CV	Source
spring/summer 1978-82	Cape Hatteras, NC to Nova Scotia	Transect	294	0.45	CETAP 1982
1979-90	N. Atlantic Ocean W and SW of Iceland	Photo MR	5,543	0.16	Katona *et al.* 1994
1992-93	N. Atlantic Ocean	Photo MR	10,600	0.067	Smith *et al.* 1999

1992-93	N. Atlantic Ocean	Genotype MR	10,400	0.138	Smith *et al.* 1999
1992-93	West Indies	Genotype MR	4,894 males 2,804 females	0.180 0.218	Palsbøll *et al.* 1997

Current Population Trend

The rates of growth cited below, together with recent estimates of abundance that are larger than previous figures, appear to indicate that the humpback whale population in the North Atlantic is increasing. It is not known whether this increase is ocean-wide in nature or confined to specific feeding grounds. An increasing trend is apparent in the Gulf of Maine (Barlow and Clapham 1997); by contrast, the population which summers off western Greenland appears small and is perhaps static (F. Larsen, pers. comm.)

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Katona and Beard (1990) suggest an annual rate of increase of 9%; however, the lower 95% confidence level was less than zero. The difference between the estimates of abundance calculated by Katona and Beard (1990) and by Smith *et al.* (1999) were interpreted by the latter as probably being due to population growth in the years between the two estimates. This assumed growth rate would be very similar to the growth rate of 6.5% calculated using an interbirth interval model for humpback whales in the Gulf of Maine (Barlow and Clapham 1997).

Other life history parameters that could be used to estimate net productivity include the following: mean birth rate for identified humpbacks in the southwestern Gulf of Maine during 1979-87 was 8% (CV = 0.25), with no significant inter-annual differences; calving interval was 2.35 years (CV = 0.30); and the average age at attainment of sexual maturity for both males and females was five years (Clapham and Mayo 1990; Clapham 1992).

For purposes of this assessment, the maximum net productivity rate was set at 0.065, as calculated for the Gulf of Maine population by Barlow and Clapham (1997).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 10,019 (based on an estimate of abundance of 10,400 with a CV of 0.067). The maximum productivity rate is 0.065 from Barlow and Clapham (1997). The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because this stock is listed as an endangered species under the Endangered Species Act (ESA). PBR for the North Atlantic humpback whale stock is 32.6 whales.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 1991 through 199 6, the total estimated human-caused mortality and serious injury to humpback whales is estimated as 5.7 per year. This is derived from three components: 1) the 1992-1996 observed fishery, 0. 6; 2) additional fishery interaction records, 3.8; and 3) vessel collision records, 1.3. For the reasons described below, the additional records (from other than the observed fishery) cannot provide a quantitative estimate, but suggest that a number of additional serious injuries and mortalities do occur.

Background

As with right whales, human impacts (vessel collisions and entanglements) are factors which may be slowing recovery of the humpback whale population. There is an average of four to six entanglements of humpback whales a year in waters of the southern Gulf of Maine and additional reports of vessel-collision scars (unpublished data, Center for Coastal Studies). In addition, of 20 dead humpback whales, principally in the mid-Atlantic, where decomposition state did not preclude examination for human impacts, Wiley *et al*. (1995) reported that six (30%) had major injuries possibly attributable to ship strikes, and five (25%) had injuries consistent with possible entanglement in fishing gear. One whale displayed scars that may have been caused by both ship strike and entanglement. Thus, 60% of the whale carcasses which were suitable for examination showed signs that anthropogenic factors may have contributed to, or been responsible for, their death. Wiley *et al*. (1995) further reported that all stranded animals were sexually immature, suggesting a winter or migratory segregation and/or that juvenile animals are more susceptible to human impacts. Humpback whale entanglements also occur in relatively high numbers in Canadian waters. Reports of collisions with fixed fishing gear set for groundfish around Newfoundland averaged 365 annually from 1979 to 1987 (range 174-813). An average of 50 humpback whale entanglements (range 26-66) were reported annually between 1979 and 1988, and 12 of 66 humpback whales that were entangled in 1988 died (Lien *et al*. 1988). Volgenau *et al*. (1995) also summarized existing data and concluded that in Newfoundland and Labrador, cod traps caused the most entanglements and entanglement mortalities (21%) of humpbacks between 1979 and 1992. They also reported that gillnets are the gear that has been the primary cause of entanglements and entanglement mortalities (20%) of humpbacks in the Gulf of Maine between 1975 and 1990.

Fishery-Related Serious Injuries and Mortalities

Two mortalities were observed in the pelagic drift gillnet fishery since 1989. In winter 1993, a juvenile humpback was observed entangled dead in a pelagic drift gillnet along the 200 m isobath northeast of Cape Hatteras; in early summer 1995, a humpback was entangled and dead in a pelagic drift gillnet on southwestern Georges Bank (see below).

Additional reports of mortality and serious injury relevant to comparison to PBR, as well as description of total human impacts, are contained in records maintained by the Northeast Regional Office/NMFS. A number of these records (11 entanglements involving lobster gear) from the 1990-94 period were used in the 1997 List of Fisheries classification (62 FR 33, Jan. 2, 1997). For this report, the records of dead, injured, and/or entangled humpbacks (either found stranded or at sea) for the period 1991 to 199 6 were reviewed. . More than half of these records were eliminated from further consideration due to an absence of any evidence of human impact or, in the case of an entangled whale, it was documented that the animal had become disentangled. Of the remaining records, there were three mortalities where fishery interaction was possible or probable, and 20 records where serious injury attributable to fishery interaction was possible or probable—for a total of 23 records in the six-year period (Table 3). While these records are not statistically quantifiable in the same way as the observed fishery records, they are suggestive of the frequency of entanglements. If these records were considered in conjunction with Canadian and any mid-Atlantic entanglement reports, the total number of mortalities and serious injuries to humpbacks would be more than the 0.6 humpbacks per year estimated from observed fisheries alone.

Fishery Information

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras. By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic pair trawl, or other fisheries monitored by NMFS.

Pelagic Drift Gillnet

The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine vessels participated in this fishery between 1989 and 1993. In 1994, 1995, and 1996 there were 12, 11, and 10 vessels, respectively, in the fishery (Table 2). Observer coverage, percent of sets observed, was 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. The greatest concentrations of effort were located along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, from 1989 to 1993, were obtained using the aggregated catch rates, by strata (Northridge 1996). Estimates of the total annual bycatch for 1994, 1995, and 1996 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in logbooks. Variances were estimated using bootstrap resampling techniques. Estimated annual mortality (CV in parentheses), extrapolated from fishery observer data, was 0.7 (1.00) in 1991, 0.4 (1.00) in 1992, 1.5 in 1993 (0.34), 0 in 1994 (0), 1.0 in 1995 (0), and 0 in 1996 (0). The total average annual estimated fishery-related mortality and serious injury in fisheries monitored by NMFS in 1992-1996 was 0.6 humpback whale (CV = 0.22) (Table 2). The 1992-1996 period was used because it provides better characterization of this fishery.

In January 1997 (62 FR 33, Jan. 2, 1997), NMFS changed the classification of the Gulf of Maine and U.S. Mid-Atlantic lobster pot fisheries from Category III to Category I based on examination of stranding and entanglement records of large whales from 1990 to 1994 (including 11 serious injuries or mortalities of humpback whales).

Table 2. Summary of the incidental mortality of the humpback whale (*Megaptera novaeangliae*), by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels [1]	Data Type [2]	Observer Coverage [3]	Observed Mortality	Estimated Mortality [4]	Estimated CVs [4]	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	0, 1, 0, 1, 0	0.4, 1.5, 0, 1.0[5], 0	1.00, 0.34, 0, 0, 0	0.6 (.22)
TOTAL								0.6 (.22)

1 1994, 1995, and 1996 shown, other years not available on an annual basis.

2 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort, and the data are collected at the Southeast Fisheries Science Center (SEFSC).

3 The observer coverage and unit of effort for the Pelagic Drift Gillnet is a set.

4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). In 1994 and 1995, observer coverage increased substantially, and bycatch rates were not pooled for this period.

5 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.08 animals. However, the SEFSC mandatory logbook data were taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.01 animals

Table 3. Summarized records of mortality and serious injury likely to result in mortality, North Atlantic humpback whales, 1991- 1996. This listing includes only records related to U.S. commercial fisheries and/or U.S. waters. Cause of mortality or injury assigned based on records maintained by NMFS/NER.

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unknown uncertain	
5/31/91	mortality	"Silver" adult female length = 13.9m	Long Island, New York (40° 39' 73° 05')		P		line and/or cable from unknown gear; seen entangled several days before beaching, fresh scars, line through mouth, scars around pectorals, marks around mouth and jaw with exposed bone
8/1/91	serious injury	"Stalactite" sex unknown length (est.) = 12 m	4 mi NE of Plum Island, Mass. (42° 51' 70° 45')		P		gillnet and assorted lobster, tuna gear and grappling hook; trailing 50' netting, net around mouth and tail; emaciated and tired; disentangled 8/11/91; in poor condition
8/28/91	serious injury	"Manta" adult female born 1984	20 mi SE of Cape Elizabeth, Mass. (43° 15' 70° 03')		P		entangled around flukes with line, moving slowly, tired, gasping, hanging flesh between flukes, appears life threatening
2/14/92	mortality	8.6 m female	Chesapeake Bay mouth	P			floater; propeller wounds, fractured mandible and eye socket,; injuries may not have been immediately fatal, some signs of healing present; animal very thin; boat collision
4/17/92	mortality	8.9 m female	National Seashore, Assateague, Maryland	P			possible boat strike, blunt trauma to right side, advanced decomposition

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unknown uncertain	
5/13/92	serious injury	“Strait” sex unknown, juvenile born 1991	NW part Stellwagen Bank (42° 26' 70° 21')		P		gillnet line through mouth and around flipper, mouth lines anchored to bottom, animal worn out and in peril, open wounds on tail, disentangled
8/3/92	serious injury	unknown	14 mi NE of Province-town Mass (42° 16' 70° 05')		P		orange mesh netting and line wrapped over head and back with about 15-20' trailing, animal moving slowly and not fluking
8/9/92	serious injury	length (est.) = 13 m	10 mi SE of Bar Harbor, Maine (44° 16' 68° 03)'		P		monofilament net and poly lines across back and one flipper; gear may be trailing but not seen; bleeding, abrasions, labored breathing
9/17/92	serious injury	length (est.) = 13 m	25 mi E of Portsmouth, New Hampshire (43° 09' 70° 09')		P		½", 3-strand grey poly line w poly ball; poly ball removed; breathing labored
9/26/92	serious injury	length (est.) = 8 - 10 m	7 mi E of Montauk Point, New York (41° 00' 71° 50')		P		monofilament gillnet w/ 5/8" poly lines; mesh visible; gear wrapped around head, flippers, and bunched at tail region; labored breathing and trumpeting
10/8/92	serious injury	estimated to be adult size	Great South Channel (41° 08' 69° 11')		P		lobster or longline gear w/large orange buoy; whale entangled at dorsal fin; breathing labored

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unknown uncertain	
10/9/92	mortality	8.7 m female	Metompkin Island, Acomac, Virginia	P			fresh dead; external bruising and hemorrhage; boat collision
10/22/92	mortality	unknown	Virginia Beach, Virginia (36° 46' 75° 57')		P		line entanglement scars and cuts on leading edge of fluke and around caudal peduncle
4/22/93	serious injury	age and sex unknown	4 mi SE of Province-town, Mass. (42° 01' 70° 06')		P		line around tail region and flukes, whale thin; unknown if gear is trailing; thin and weak; healing around line
5/5/93	serious injury	age estimated 2-3 y.o.	NW part Stellwagen Bank (42° 26' 70° 27')		P		buoy warp wrapped around base of flipper; anchored and very fatigued; whale freed itself; unknown whether carrying gear
7/26/93	serious injury	unknown	30 mi SE of Bar Harbor, Maine (44° 00' 67° 38')		P		entangled; line wrapped around head and behind blowhole
8/8/93	serious injury	unknown	11 mi SE of Bar Harbor, Maine (44° 17' 68° 00')		P		net & buoys on head, dorsal fin, flippers; trailing gear; stressed behavior; cuts and blood reported, netting was removed, line remained on tail
10/7/93	serious injury	unknown	Atlantic City, New Jersey	P			boat collision with 33 ‘ sport fishing vessel; extent of injuries undetermined

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unknown uncertain	
7/14/94	serious injury	unknown	15 mi SE of Cape Elizabeth, Maine (43° 23' 68° 59')		P		CG helicopter crew reported animal with gillnet wrapped around head and swimming at surface
2/28/95	mortality	unknown	Cape Hatteras, North Carolina (35° 17' 75° 31')		P		stranded dead with gear wrapped around tail region
5/26/95	serious injury	length (est.) = 10 m	Great South Channel (41° 16' 69° 20')		P		net and monofilament around tail region; whale anchored; mesh visible and gear trailing
6/4/95	mortality	8.9 m male	Virginia Beach, Virginia	P			floater off inlet; lacerations along peduncle, probable ship strike
1/30/96	serious injury	juvenile	Northern Edge of Georges Bank (42° 26' 67° 30')		P		gear wrapped on body, some gear removed
2/22/96	serious injury	length (est.) = 8 m	Florida Keys		P		heavy line extending around maximum girth, pinning both pectorals; grooves/healed scars on dorsal ridge and on leading edge of both pectorals; fairly emaciated; disentangled
4/2/96	mortality	7.2 m female	Cape Story, Virginia Beach, Virginia	P			fresh dead; fractured left mandible; emaciated

Date	Report Type	Sex, age, ID	Location	Assigned Cause: P=primary, S=secondary			Notes
				Ship strike	Entang./ Fsh.inter	Unknown uncertain	
5/9/96	mortality	6.7 m female	mouth of Delaware Bay	P			propeller cuts behind blowhole, moderate decomposition; ship strike
7/18/96	serious injury	length (est.) = 10 m	25 mi S of Bar Harbor Maine (44° 01' 68° 00')		P		disentanglement unsuccessful; weighted gear wrapped around tail stock; whale swimming abnormally
7/28/96	serious injury	length (est.) = 10m	SW corner of Stellwagen Bank, MA		P		entanglement involved mouth or flipper and line over tail; recent entanglement; extent of trailing gear unknown
10/7/96	serious Injury	unknown	Great South Channel (41° 04' 69° 10')		P		gear wrapped around tail and trailing 30 m behind whale
10/18/96	serious injury	unknown	Great South Channel (41° 00' 69° 10')		P		Whale entangled in steel cable
11/3/96	mortality	8.4 m male	Carrituck, North Carolina	P			acute trauma to skull found by necropsy

Table notes:

1. The date sighted and location provided in the table are not necessarily when or where the serious injury or mortality occurred; rather, this information indicates when and where the whale was reported beached, entangled, or injured.
2. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (62 FR 33, Jan. 2, 1997) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.
3. Assigned cause based on best judgement of available data. Additional information may result in revisions.
4. Entanglements of juvenile whales may become more serious as whale grows.
5. There is no overlap between tables 2 and 3 (the two records from the observed fishery are not included in Table 3).

Other Mortality

Between November 1987 and January 1988, 14 humpback whales died after consuming Atlantic mackerel containing a dinoflagellate saxitoxin. The whales subsequently stranded or were recovered in the vicinity of Cape Cod Bay and Nantucket Sound, and it is highly likely that other mortalities occurred during this event which went unrecorded. During the first six months of 1990, seven dead juvenile (7.6 to 9.1 m long) humpback whales stranded between North Carolina and New Jersey. The significance of these strandings is unknown, but is a cause for some concern.

As reported by Wiley *et al*. (1995) injuries possibly attributable to ship strikes are more common and perhaps more serious than those from entanglements. In the NER/NMFS records examined, several contained notes about wounds or probable/possible vessel collision. While researchers often tend to attribute strikes to large vessels, the record of 7 October 1993 off Atlantic City, NJ, reports a collision (and subsequent injury) with a 33 ft sport-fishing vessel. To better assess human impacts (both vessel collision and net entanglement), and considering the number of decomposed and incompletely or unexamined animals in the records, there needs to be greater emphasis on the timely recovery of carcasses and complete necropsies.

While entangled animals are often released, on the other hand, some dead or injured animals likely go unobserved and unreported. The literature and review of records described above suggest that there are significant human impacts beyond those in the fishery observer data. Decomposed and/or unexamined animals (e.g., carcasses reported but not retrieved or necropsied) represent 'lost data', some of which may relate to human impacts. For these reasons, the human impacts listed in this report must be considered a minimum estimate.

STATUS OF STOCK

Although the most recent estimates of abundance indicate continued population growth, the size of the humpback whale stock is considered to be low relative to OSP in the U.S. Atlantic EEZ, and this species is listed as endangered under the ESA. A Recovery Plan has been published and is in effect (NMFS 1991). There are insufficient data to reliably determine population trends for humpback whales. The annual rate of population increase was estimated at 9% (Katona and Beard 1990, but with a lower 95% confidence level less than zero), and at 6.5% by Barlow and Clapham (1997). The total level of human-caused mortality and serious injury is unknown, but current data indicate that it is significant. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the humpback whale is listed as an endangered species under the ESA.

REFERENCES

Allen, J., P. Clapham, P. Hammond, S. Katona, F. Larsen, J. Lien, D. Mattila, N. Øien, P. Palsbøll, J. Sigurjonsson, and T. Smith. 1993. Years of the North Atlantic Humpback (YONAH): Progress Report. *Rep. int. Whal. Commn. SC/45/NA6.*

Balcomb, K.C. and G. Nichols. 1982. Humpback whale censuses in the West Indies. *Rep. int. Whal. Commn. 32: 401-406*.

Barlow, J., and P.J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. *Ecology 78 (2): 535-546*.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Christensen, I., T. Haug, and N. Øien. 1992. Seasonal distribution, exploitation and present abundance of stocks of large baleen whales (*Mysticeti*) and sperm whales (*Physeter macrocephalus*) in Norwegian and adjacent waters. *ICES Journal of Marine Science 49: 341-355*.

Clapham, P.J. & Mayo, C.A. 1987. Reproduction and recruitment of individually identified humpback whales, *Megaptera novaeangliae*, observed in Massachusetts Bay, 1979-1985. *Can.. J. of Zool. 65: 2853-2863.*

Clapham, P. J. and C. A. Mayo. 1990. Reproduction of humpback whales (*Megaptera novaeangliae*) observed in the Gulf of Maine. *Rep. int. Whal. Commn. Special Issue 12: 171-175*.

Clapham, P. J. 1992. Age at attainment of sexual maturity in humpback whales, *Megaptera novaeangliae*. *Can. J. Zool. 70: 1470-1472.*

Clapham, P. J., L. S. Baraff, C. A. Carlson, M. A. Christian, D. K. Mattila, C. A. Mayo, M. A. Murphy, and S. Pittman. 1993. Seasonal occurrence and annual return of humpback whales, *Megaptera novaeangliae*, in the southern Gulf of Maine. *Can. J. Zool. 71: 440-443.*

Fogarty, M. J., E. B. Cohen, W. L. Michaels, and W. W. Morse. 1991. Predation and the regulation of sand lance populations: An exploratory analysis. *ICES Mar. Sci. Symp. 193: 120-124.*

Katona, S. K., and J. A. Beard. 1990. Population size, migrations, and feeding aggregations of the humpback whale (*Megaptera novaeangliae*) in the western North Atlantic ocean. *Rep. int. Whal. Commn. Special Issue 12: 295-306.*

Katona, S. K., J. M. Allen, and P. Stevick. 1994. Maintaining the North Atlantic humpback whale catalog. Progress report to the Northeast Fisheries Science Center, Contract No. 50EANF-1-00056, May 1994, 26 pp.

Larsen, A. H., J. Sigurjónsson, N. Øien, G. Vikingsson, and P. J. Palsbøll. 1996. Population genetic analysis of mitochondrial and nuclear genetic loci in skin biopsies collected from central and northeastern North Atlantic humpback whales (*Megaptera novaeangliae*): population identity and migratory destinations. *Proceedings of the Royal Society of London B 263: 1611-1618.*

Levenson, C. and Leapley, W.T. 1978. Distribution of humpback whales (*Megaptera novaeangliae*) in the Caribbean determined by a rapid acoustic method. *J. Fish. Res. Bd. Can. 35: 1150-1152.*

Lien, J., W. Ledwell, and J. Naven. 1988. Incidental entrapment in inshore fishing gear during 1988: A preliminary report to the Newfoundland and Labrador Department of Fisheries and Oceans, 15 pp.

Mattila, D.K. & Clapham, P.J. 1989. Humpback whales and other cetaceans on Virgin Bank and in the northern Leeward Islands, 1985 and 1986. *Can. J. of Zool. 67: 2201-2211.*

Mattila, D.K., Clapham, P.J., Katona, S.K. and Stone, G.S. 1989. Population composition of humpback whales on Silver Bank. *Can. J. of Zool. 67: 281-285.*

NMFS. 1991. Recovery plan for the humpback whale (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland, 105 pp.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Øien, N. 1990. Sighting surveys in the northeast Atlantic in July 1988: distribution and abundance of cetaceans. *Rep. int. Whal. Commn. 40: 499-511.*

Paquet, D., C. Haycock and H. Whitehead. 1997. Numbers and seasonal occurrence of humpback whales (*Megaptera novaeangliae*) off Brier Island, Nova Scotia. *Can. Field Nat. 111: 548-552.*

Palsbøll, P.J., Allen, J., Bérubé, M., Clapham, P.J., Feddersen, T.P., Hammond, P., Jørgensen, H., Katona, S., Larsen, A.H., Larsen, F., Lien, J., Mattila, D.K., Sigurjónsson, J., Sears, R., Smith, T., Sponer, R., Stevick, P. & Øien, N. 1997. Genetic tagging of humpback whales. *Nature 388: 767-769.*

Palsbøll, P.J., Clapham, P.J., Mattila, D.K., Larsen, F., Sears, R., Siegismund, H.R., Sigurjónsson, J., Vásquez, O. and Arctander, P. 1995. Distribution of mtDNA haplotypes in North Atlantic humpback whales: the influence of behavior on population structure. *Marine Ecology Progress Series 116: 1-10.*

Payne, P. M., J. R. Nicholas, L. O'Brien, and K. D. Powers. 1986. The distribution of the humpback whale, *Megaptera novaeangliae*, on Georges Bank and in the Gulf of Maine in relation to densities of the sand eel, *Ammodytes americanus*. *Fish. Bull., U.S. 84: 271-277.*

Payne, P. M., D. N. Wiley, S. B. Young, S. Pittman, P. J. Clapham, and J. W. Jossi. 1990. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey. *Fish. Bull., U.S. 88(4): 687-696.*

Price, W.S. 1985. Whaling in the Caribbean: historical perspective and update. *Rep. int. Whal. Commn. 35: 413-420.*

Reiner, F., M. E. Dos Santos, and F. W. Wenzel. 1996. Cetaceans of the Cape Verde archipelago. *Mar. Mamm. Sci. 12: 434-443.*

Smith, T.D., J. Allen, P.J. Clapham, P.S. Hammond, S. Katona, F. Larsen, J. Lien, D. Mattila, P.J. Palsbøll, J. Sigurjónsson, P.T. Stevick and N. Øien. 1999. An ocean-basin-wide mark-recapture study of the North Atlantic humpback whale (*Megaptera novaeangliae*). *Mar. Mamm. Sci. 15 (1):1-32.*

Stevick, P., N. Øien and D.K. Mattila. 1998. Migration of a humpback whale between Norway and the West Indies. *Mar. Mamm. Sci. 14: 162-166.*

Swingle, W. M., S. G. Barco, T. D. Pitchford, W.A. McLellan and D.A. Pabst. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. *Mar. Mamm. Sci. 9: 309-315.*

Volgenau, L., S.D. Kraus, and J. Lien. 1995. The impact of entanglements on two substocks of the western North Atlantic humpback whale, *Megaptera novaeangliae*. *Can. J. Zool. 73: 1689-1698.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop, April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-12. U.S. Dept. of Commerce, Washington, D.C. 93 pp.

Whitehead, H. and M.J. Moore. 1982. Distribution and movements of West Indian humpback whales in winter. *Can. J. of Zool. 60: 2203-2211.*

Wiley, D. N., R. A. Asmutis, T. D. Pitchford, and D. P. Gannon. 1995. Stranding and mortality of humpback whales, *Megaptera novaeangliae*, in the mid-Atlantic and southeast United States, 1985-1992. *Fish. Bull., U.S. 93: 196-205.*

Winn, H.E., Edel, R.K. and Taruski, A.G. 1975. Population estimate of the humpback whale (*Megaptera novaeangliae*) in the West Indies by visual and acoustic techniques. *J. Fish. Res. Bd. Can. 32: 499-506.*

FIN WHALE (*Balaenoptera physalus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The Scientific Committee of the International Whaling Commission (IWC) has proposed stock boundaries for North Atlantic fin whales. Fin whales off the eastern U.S., north to Nova Scotia and on to the southeast coast of Newfoundland are believed to constitute a single stock under the present IWC scheme (Donovan 1991). However, the stock identity of North Atlantic fin whales has received relatively little attention, and whether the current stock boundaries define biologically isolated units has long been uncertain. The existence of a subpopulation structure was suggested by local depletions that resulted from commercial overharvesting (Mizroch *et al*. 1984).

A genetic study conducted by Bérubé *et al.* (1998) using both mitochondrial and nuclear DNA provided strong support for an earlier population model proposed by Kellogg (1929) and others. This postulates the existence of several subpopulations of fin whales in the North Atlantic and Mediterranean, with limited gene flow among them. Bérubé *et al.* (1998) also proposed that the North Atlantic population showed recent divergence due to climatic changes (i.e. postglacial expansion), as well as substructuring over even relatively short distances. The genetic data are consistent with the idea that different subpopulations use the same feeding ground, a hypothesis that was also originally proposed by Kellogg (1929).

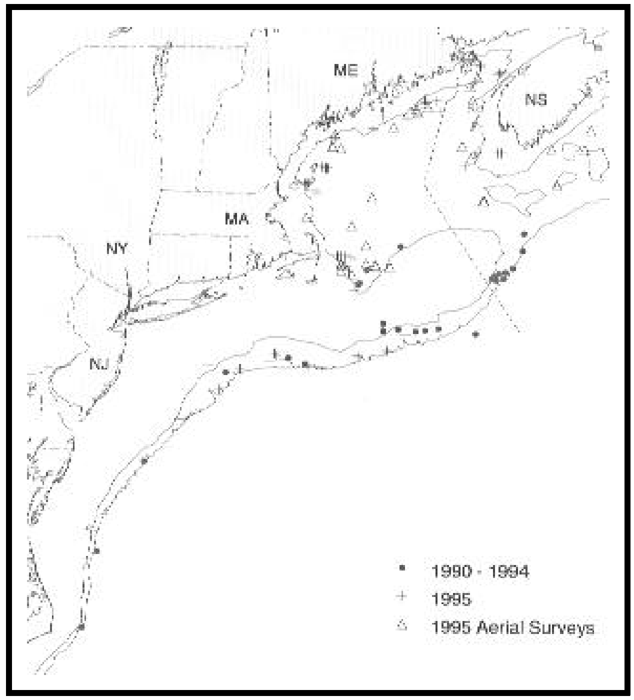

Figure 1. *Distribution of fin whale sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

Fin whales are common in waters of the U.S. Atlantic Exclusive Economic Zone (EEZ), principally from Cape Hatteras northward (Figure. 1). Fin whales accounted for 46% of the large whales and 24% of all cetaceans sighted over the continental shelf during aerial surveys (CETAP 1982) between Cape Hatteras and Nova Scotia during 1978-82. While a great deal remains unknown, the magnitude of the ecological role of the fin whale is impressive. In this region fin whales are the dominant large cetacean species in all seasons, with the largest standing stock, the largest food requirements, and therefore the largest impact on the ecosystem of any cetacean species (Hain *et al*. 1992).

There is little doubt that New England waters represent a major feeding ground for the fin whale. There is evidence of site fidelity by females, and perhaps some segregation by sexual, maturational or reproductive class on the feeding range (Agler *et al*. 1993). Seipt *et al*. (1990) reported that 49% of identified fin whales on Massachusetts Bay area feeding grounds were resighted within years, and 45% were resighted in multiple years. While recognizing localized as well as more extensive movements, these authors suggested that fin whales on these grounds exhibited patterns of seasonal occurrence and annual return that are in some respects similar to those shown for humpback whales. This was reinforced by Clapham and Seipt (1991), who showed maternally directed site fidelity by fin whales in the Gulf of Maine. Information on life history and vital rates is also available in data from the Canadian fishery, 1965-1971 (Mitchell 1974). In seven years, 3,528 fin whales were taken at three whaling stations. The station at Blandford, Nova Scotia, took 1,402.

Hain *et al*. (1992), based on an analysis of neonate stranding data, suggested that calving takes place during approximately four months from October-January in latitudes of the U.S. mid-Atlantic region; however, it is unknown where calving, mating, and wintering for most of the population occurs. Preliminary results from the Navy's IUSS program (Clark 1995) indicate a substantial deep-ocean component to fin whale distribution. It is likely that fin whales occurring in the U.S. Atlantic EEZ undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions.

POPULATION SIZE

Four seasonal abundance estimates for fin whales are available for portions of the northeastern U.S. Atlantic during spring and summer of 1978-82, June-July 1991, August-September 1991, and August-September 1991 and 1992 (Table 1; Figure 1).

A population size of 4,680 fin whales (CV=0.23) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on an inverse variance weighted pooling of spring and summer data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate includes a dive-time scale-up correction of 4.85 but does not correct for g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its old age and because it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 35 (CV=0.56) fin whales was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Table 1; Waring *et al*. 1992). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al*. 1993; Laake *et al*. 1993). Estimates include school size-bias, if applicable, but no corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 194 (CV=0.18) and 529 (CV=0.19) fin whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Table 1; Anon. 1991). The study area included that covered in the CETAP study plus several additional continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. The data were analyzed using DISTANCE (Buckland *et al*. 1993; Laake *et al*. 1993), where the CV was estimated using the bootstrap option. The abundance estimates do not include g(0) and were not pooled over platforms because the inter-platform calibration analysis has not been conducted.

A population size of 2,700 (CV=0.59) fin whales was estimated from two shipboard line transect surveys conducted during July to September 1991 and 1992 in the northern Gulf of Maine-lower Bay of Fundy region (Palka and Waring, unpublished data). This population size is a weighted-average of the 1991 and 1992 estimates, where each annual estimate was weighted by the inverse of its variance. The data were collected during surveys designed to estimate abundance of harbor porpoises (Palka 1995). Two independent teams of observers on the same ship surveyed using naked eye in non-closing mode. Using the product integral analytical method (Palka 1995) and DISTANCE (Buckland *et al*. 1993; Laake *et al*. 1993) the abundance includes an estimate of school size-bias, if applicable, an estimate of g(0), probability of detecting a group on the track line, but no correction for dive-time. Variability was estimated using bootstrap resampling techniques.

The best available current abundance estimate for the western North Atlantic fin whale is 2,700 (CV=0.59) from the 1991-92 northern Gulf of Maine-lower Bay of Fundy line transect surveys because it is relatively recent and covers the largest portion of the known habitat.

Table 1. Summary of abundance estimates for the western North Atlantic fin whale. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring & summer 1978-1982	Cape Hatteras, NC to Nova Scotia	4,680	0.23
Jun-Jul 1991	Cape Hatteras, NC to Georges Bank, shelf edge only	35	0.56
Aug-Sep 1991	Cape Hatteras, NC to Nova Scotia	194 and 529*	0.18 and 0.19*
Jul-Sep 1991 and 1992	N. Gulf of Maine and Bay of Fundy	2,700	0.59

* from data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for fin whales is 2,700 (CV=0.59). The minimum population estimate for the western North Atlantic fin whale is 1,704 (CV=0.59).

Current Population Trend

There are insufficient data to determine population trends for this species. Even at a conservatively estimated rate of increase, however, the numbers of fin whales may have increased substantially in recent years (Hain *et al*. 1992).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Based on photographically identified fin whales, Agler *et al*. (1993) estimated that the gross annual reproduction rate was at 8%, with a mean calving interval of 2.7 years.

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 1,704 (CV=0.59). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because the fin whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic fin whale is 3.4.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The number of fin whales taken at three whaling stations in Canada from 1965-71 totaled 3,528 whales (Mitchell 1974). Reports of non-directed takes of fin whales are fewer over the last two decades than for other endangered large whales such as right and humpback whales. There was no reported fishery-related mortality or serious injury to fin whales in fisheries observed by NMFS during 1991- 96. In a recent review of NER/NMFS fin whale mortality records from 1991-96, only one had sufficient evidence to confirm that the cause of death involved a fishery entanglement, and two records clearly involved vessel collisions. This translates into an estimated annual human-caused mortality and serious injury to fin whales of 0.5 per year. As noted in other species accounts, these anecdotal records can provide only the minimum level of human-caused mortality; and it is highly likely that additional serious injuries and mortalities go unreported.

Fishery-Related Serious Injury and Mortality

No fishery-related mortality or serious injury of fin whales was reported in the Sea Sampling by-catch database; therefore, no detailed fishery information is presented here.

A review of 26 records of stranded or floating (dead or injured) fin whales for the period 1992-1996 on file at NER/NMFS showed that three had fishery interactions. Two had net or rope marks, but the evidence on hand was not sufficient to confirm entanglement as the cause of death. The one confirmable record involved a whale that was found floating off Lubec, Maine, on 7/31/94. The whale had several wraps of line through the mouth, and about 30 wraps around the tail stock. This single entanglement mortality record suggests an annual mortality of 0.2 fin whales from fishery interactions. While these records are not statistically quantifiable in the same way as the observed fishery records, they give a minimum estimate of the frequency of entanglements for this species.

Other Mortality

After reviewing NER/NMFS records, two were found that had sufficient information to confirm the cause of death as collisions with vessels. On 3/12/94, a 16-meter fin whale was found on Virginia Beach with fresh, deep propeller wounds in the cuadal area. The animal's stomach was full. On 12/20/96, a fin whale was found floating near the shipping docks in Savannah, Georgia. The necropsy found bruising, coagulated blood, and broken ribs on the right side of the animal. NER/NMFS data holdings include seven additional records of fin whale mortalities that bore evidence of injury from collisions with vessels, but the available supporting documentation was not conclusive as to whether these constituted serious injury or were the proximal cause of the mortality.

STATUS OF STOCK

The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine the population trends for fin whales. The total fishery-related mortality and serious injury for this stock is less than 10% of the calculated PBR and can be considered insignificant and approaching zero mortality and serious injury rate. Any fishery-related mortality would be illegal because there is no recovery plan currently in place, although a draft plan is currently in review. This is a strategic stock because the fin whale is listed as an endangered species under the ESA.

REFERENCES

Agler, B. A., R. L. Schooley, S. E. Frohock, S. K. Katona, and I. E. Seipt. 1993. Reproduction of photographically identified fin whales, *Balaenoptera physalus*, from the Gulf of Maine. *J. Mamm. 74(3): 577-587.*

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA, NMFS, SEFSC & NEFSC, 4 pp. Available from NEFSC, Woods Hole Laboratory, Woods Hole, MA.

Barlow, J., S.L. Swartz, T. C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. NOAA Technical Memorandum NMFS-OPR-6. U.S. Department of Commerce, Washington, D.C. 73 pp.

Bérubé, M., A. Aguilar, D. Dendanto, F. Larsen, G. Notarbartolo di Sciara, R. Sears, J. Sigurjónsson, J. Urban-R. And P.J. Palsbøll. 1998. Population genetic structure of North Atlantic, Mediterranean and Sea of Cortez fin whales, *Balaenoptera physalus* (Linnaeus 1758): analysis of mitochondrial and nuclear loci. *Mol. Ecol*. (In press).

Buckland, S. T., D. R. Andersen, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. *Chapman and Hall*, New York, 446 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Clapham, P.J. & Seipt, I.E. 1991. Resightings of independent fin whales, *Balaenoptera physalus*, on maternal summer ranges. *Journal of Mammalogy 72: 788-790.*

Clark, C.W. 1995. Application of U.S. Navy underwater hydrophone arrays for scientific research on whales. *Rep. int. Whal. Commn. 45: 210-212.*

Donovan, G. P. 1991. A review of IWC stock boundaries. *Rep. int. Whal. Commn. Special Issue 13: 39-68.*

Hain, J. H. W., M. J. Ratnaswamy, R. D. Kenney, and H. E. Winn. 1992. The fin whale, *Balaenoptera physalus,* in waters of the northeastern United States continental shelf. *Rep. int. Whal. Commn. 42: 653-669*.

Kellogg, R. 1929. What is known of the migration of some of the whalebone whales. Ann. Rep. Smithsonian Inst. 1928: 467-494.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. DISTANCE user's guide, V2.0. 1993. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Mizroch, A. A., D. W. Rice, and J. M. Breiwick. 1984. The fin whale, *Balaenoptera physalus*. *Mar. Fisheries Rev*. *46: 20-24.*

Mitchell, E. 1974. Present status of Northwest Atlantic fin and other whale stocks. Pages 109-169, *in*: W. E. Schevill (editor), *The whale problem: A status report*. Harvard University Press, Cambridge, Massachusetts, 419 pp.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Pp. 27-50, *In*: A Bjørge and G.P. Donovan (eds). Biology of the Phocoenids, *Rep. int. Whal. Commn. Special Issue 16.*

Seipt, I. E., P. J. Clapham, C. A. Mayo, and M. P. Hawvermale. 1990. Population characteristics of individually identified fin whales, *Balaenoptera physalus*, in Massachusetts Bay. *Fish. Bull., U.S. 88(2): 271-278*

Sissenwine, M. P., W. J. Overholtz, and S. H. Clark. 1984. In search of density dependence. Pages 119-137 *in* Proceedings of the workshop on biological interactions among marine mammals and commercial fisheries in the southeastern Bering Sea. Alaska Sea Grant Report 84-1, Alaska Sea Grant College Program, University of Alaska, Fairbanks, Alaska.

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop, April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-12. U.S. Dept. of Commerce, Washington, D.C. 93 pp.

Waring, G.T., C.P. Fairfield, C.M. Ruhsam, and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES Marine Mammals Comm. CM 1992/N: 12. 29 pp.*

SEI WHALE (*Balaenoptera borealis*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Indications are that, at least during the feeding season, a major portion of the sei whale population is centered in northerly waters, perhaps on the Scotian Shelf (Mitchell and Chapman 1977). The southern portion of the species' range during spring and summer includes the northern portions of the U.S. Atlantic Exclusive Economic Zone (EEZ) — the Gulf of Maine and Georges Bank. The period of greatest abundance there is in spring, with sightings concentrated along the eastern margin of Georges Bank and into the Northeast Channel area, and along the southwestern edge of Georges Bank in the area of Hydrographer Canyon (CETAP 1982). The sei whale is generally found in the deeper waters characteristic of the continental shelf edge region (Hain *et al*. 1985). Mitchell (1975) similarly reported that sei whales off Nova Scotia were often distributed closer to the 2,000 m depth contour than were fin whales.

This general offshore pattern of sei whale distribution is disrupted during episodic incursions into more shallow and inshore waters. The sei whale, like the right whale, is largely planktivorous — feeding primarily on euphausiids and copepods. In years of reduced predation on copepods by other predators, and thus greater abundance of this prey source, sei whales are reported in more inshore locations, such as the Great South Channel (in 1987 and 1989) and Stellwagen Bank (in 1986) areas (R.D. Kenney, pers. comm.; Payne *et al*. 1990). An influx of sei whales into the southern Gulf of Maine occurred in the summer of 1986 (Schilling *et al*. 1992). Such episodes, often punctuated by years or even decades of absence from an area, have been reported for sei whales from various places worldwide.

Based on analysis of records from the Blandford, Nova Scotia, whaling station, where 825 sei whales were taken between 1965 and 1972, Mitchell (1975) described two "runs" of sei whales, in June-July and in September-October. He speculated that the sei whale population migrates from south of Cape Cod and along the coast of eastern Canada in June and July, and returns on a southward migration again in September and October; however, such a migration remains unverified.

Mitchell and Chapman (1977) reviewed the sparse evidence on stock identity of northwest Atlantic sei whales, and suggested two stocks — a Nova Scotia stock and a Labrador Sea stock. The Nova Scotian stock includes the continental shelf waters of the northeastern U.S., and extends northeastward to south of Newfoundland. The Scientific Committee of the IWC, while adopting these general boundaries, noted that the stock identity of sei whales (and indeed all North Atlantic whales) was a major research problem (Donovan 1991). In the absence of evidence to the contrary, the proposed IWC stock definition is provisionally adopted.

POPULATION SIZE

The total number of sei whales in the U.S. Atlantic EEZ is unknown. However, two abundance estimates are available for portions of the sei whale habitat (Table 1): from Nova Scotia during the 1970's, and in the U.S. Atlantic EEZ during the spring of 1978-82.

Mitchell and Chapman (1977), based on tag-recapture data, estimated the Nova Scotia, Canada, stock to contain between 1,393 and 2,248 sei whales (Table 1). Based on census data, they estimated a minimum Nova Scotian population of 870 sei whales.

A population size of 253 sei whales (CV=0.63) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on data collected during the spring when the greatest proportion of the population off the northeast U.S. coast appeared in the study area. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. The CETAP report suggested, however, that correcting the estimated abundance for dive time would increase the estimate to approximately the same as Mitchell and Chapman’s (1977) tag-recapture estimate. This estimate may not reflect the current true population size because of its high degree of uncertainty (e.g., large CV), its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region. There are no recent abundance estimates for the sei whale.

Table 1. Summary of abundance estimates for the western North Atlantic sei whale. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV). Unk=Unknown.

Month/Year	Area	N_{best}	CV
1966 - 1972	Nova Scotia, Canada	1,393 to 2,248	None reported
spring 1978-82	Cape Hatteras, NC to Nova Scotia	253	0.63

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). A current minimum population size cannot be estimated because there are no current abundance estimates (within the last 10 years).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because the sei whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic sei whale is unknown because the minimum population size is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

There are few if any data on fishery interactions or human impacts. There was no reported fishery-related mortality or serious injury to sei whales in fisheries observed by NMFS during 1991-1997. There are no reports of mortality, entanglement, or injury in the NEFSC or NE Regional Office databases; however, there is a report of a ship strike. The New England Aquarium documented a sei whale carcass hung on the bow of a container ship as it docked in Boston on November 17, 1994. The crew estimated that the whale had been hung on the bow for approximately four days prior to the ship's arriving in port.

Fishery Information

There have been no reported entanglements or other interactions between sei whales and commercial fishing activities; therefore there are no descriptions of fisheries.

STATUS OF STOCK

The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine the population trends for sei whales. The total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant and approaching a zero mortality and serious injury rate. Any fishery-related mortality would be unlawful because there is no recovery plan currently in place. This is a strategic stock because the sei whale is listed as an endangered species under the ESA.

REFERENCES

Barlow, J., S.L. Swartz, T. C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. NOAA Technical Memorandum NMFS-OPR-6. U.S. Department of Commerce, Washington, D.C. 73 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Donovan, G. P. 1991. A review of IWC stock boundaries. *Rep. int. Whal. Commn. Special Issue 13: 39-68.*

Hain, J. H. W., M. A. M. Hyman, R. D. Kenney, and H. E. Winn. 1985. The role of cetaceans in the shelf-edge region of the northeastern United States. *Mar. Fish. Rev. 47(1): 13-17.*

Mitchell, E. 1975. Preliminary report on Nova Scotia fishery for sei whales (*Balaenoptera borealis*). *Rep. int. Whal. Commn. 25: 218-225.*

Mitchell, E. and D. G. Chapman. 1977. Preliminary assessment of stocks of northwest Atlantic sei whales (*Balaenoptera borealis*). *Rep. int. Whal. Commn. Special Issue 1: 117-120.*

Payne, P. M., D. N. Wiley, S. B. Young, S. Pittman, P. J. Clapham, and J. W. Jossi. 1990. Recent fluctuations in the abundance of baleen whales in the southern Gulf of Maine in relation to changes in selected prey. *Fish. Bull., U.S. 88: 687-696.*

Schilling, M. R., I. Seipt, M. T. Weinrich, S. E. Frohock, A. E. Kuhlberg, and P. J. Clapham. 1992. Behavior of individually identified sei whales, *Balaenoptera borealis*, during an episodic influx into the southern Gulf of Maine in 1986. *Fish. Bull., U.S. 90(4): 749-755.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop, April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-12. U.S. Dept. of Commerce, Washington, D.C. 93 pp.

MINKE WHALE (*Balaenoptera acutorostrata*): Canadian East Coast Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Minke whales have a cosmopolitan distribution in polar, temperate and tropical waters. In the North Atlantic there are four recognized populations — Canadian east coast, west Greenland, central North Atlantic, and northeastern North Atlantic (Donovan 1991). These four population divisions were defined by examining segregation by sex and length, catch distributions, sightings, marking data and pre-existing ICES boundaries; however, there are very few data from the Canadian east coast population.

Minke whales off the eastern coast of the United States are considered to be part of the Canadian east coast population, which inhabits the area from the eastern half of Davis Strait out to 45°W and south to the Gulf of Mexico. The relationship between this and the other three populations is uncertain. It is also uncertain if there are separate stocks within the Canadian east coast population.

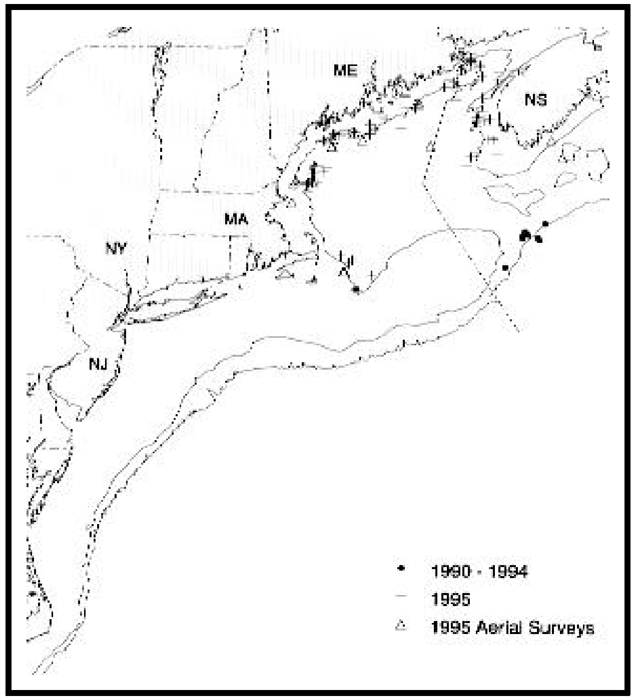

Figure 1. *Distribution of minke whale sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

The minke whale is common and widely distributed within the U.S. Atlantic Exclusive Economic Zone (EEZ) (CETAP 1982). There appears to be a strong seasonal component to minke whale distribution. Spring and summer are times of relatively widespread and common occurrence, and during this time they are most abundant in New England waters. During fall, in New England waters, there are fewer minke whales, while during winter, the species appears to be largely absent. Like most other baleen whales, the minke whale generally occupies the continental shelf proper, rather than the continental shelf edge region. Records summarized by Mitchell (1991) hint at a possible winter distribution in the West Indies and in mid-ocean south and east of Bermuda. As with several other cetacean species, the possibility of a deep-ocean component to distribution exists but remains unconfirmed.

POPULATION SIZE

The total number of minke whales in the Canadian East Coast population is unknown. However, four estimates are available for portions of the habitat — a 1978-1982 estimate, a shipboard survey estimate from the summers of 1991 and 1992, a shipboard estimate from June-July 1993, and an estimate made from a combination of a shipboard and aerial surveys conducted during July to September 1995 (Table 1; Figure 1).

A population size of 320 minke whales (CV=0.23) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on spring data because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during this season. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 2,650 (CV=0.31) minke whales was estimated from two shipboard line transect surveys conducted during July to September 1991 and 1992 in the northern Gulf of Maine-lower Bay of Fundy region (Table

1). This population size is a weighted-average of the 1991 and 1992 estimates, where each annual estimate was weighted by the inverse of its variance. The data were collected during surveys designed to estimate abundance of harbor porpoises (Palka 1995). Two independent teams of observers on the same ship surveyed using naked eye in non-closing mode. Using the product integral analytical method (Palka 1995) and DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993) the abundance included an estimate of school size-bias, if applicable, an estimate of g(0), probability of detecting a group on the track line, but no correction for dive-time or ship avoidance. Variability was estimated using bootstrap re-sampling techniques.

A population size of 330 minke whales (CV=0.66) was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap re-sampling techniques.

A population size of 2,790 (CV=0.32) minke whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS/NEFSC unpublished data). Total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom depth contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom depth contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. This survey included the same region covered during the above 1991 and 1992 sighting surveys. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey (Palka 1996). An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time or platform avoidance. Variability was estimated using bootstrap re-sampling techniques. Minke whales were only detected in the Georges Bank - Gulf of Maine - Bay of Fundy region by one of the ships and the plane, so this was the area included in this abundance estimate.

There are no estimates of abundance for this species in Canadian waters that lie farther north or east of the above survey's study area.

The best available current abundance estimate for minke whales is 2,790 (CV=0.32) as estimated from the July to September 1995 line transect surveys because this survey is recent and provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for Canadian East Coast minke whales. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring 1978-82	Cape Hatteras, NC to Nova Scotia	320	0.23
Jul -Sep 1991-92	N. Gulf of Maine and Bay of Fundy	2,650	0.31
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	330	0.66
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	2,790	0.32

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for minke whales is 2,790 (CV=0.32). The minimum population estimate for Canadian East Coast minke whale is 2,145 (CV=0.32).

Current Population Trend

There are insufficient data to determine population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: females mature when 6-8 years old; pregnancy rates are approximately 0.86 to 0.93; thus, the calving interval is between 1 and 2 years; calves are probably born during October to March, after 10 to 11 months gestation; nursing lasts for less than 6 months; maximum ages are not known, but for Southern Hemisphere minke whales the maximum age appears to be about 50 years (Katona *et al.* 1993; IWC 1991).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 2,145 (CV=0.32). The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the Canadian east coast minke whale is 21.

ANNUAL HUMAN-CAUSED MORTALITY AND INJURY

Fishery Information

Recent minke whale takes have been observed in U.S. waters in the New England multispecies sink gillnet, Atlantic pelagic drift gillnet, bluefin tuna purse seine fisheries, and in fish weirs; though all takes have not resulted in a mortality. The annual mortality estimate from these fisheries during 1992 to 1996 is 0.8 (CV=0) minke whales per year.

USA

Little information is available about fishery interactions that took place before the 1990's. Read (1994) reported that a minke whale was found dead in a Rhode Island fish trap in 1976. Prior to 1977, there was no documentation of marine mammal by-catch in distant-water fleet (DWF) activities off the northeast coast of the U.S. With implementation of the Magnuson Fisheries Conservation and Management Act in that year, an observer program was established which recorded fishery data and information of incidental by-catch of marine mammals. A minke whale was caught and released alive in the Japanese tuna longline fishery in 3,000 m of water, south of Lydonia Canyon on Georges Bank, in September 1986 (Waring *et al.* 1990). In 1982, there were 112 different foreign vessels; 16%, or 18, were Japanese tuna longline vessels operating along the U.S. east coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. Between 1983 and 1988, the number of Japanese longline vessels operating within the EEZ each year were 3, 5, 7, 6, 8, and 8, respectively. Observer coverage was 100%.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992, the SEFSC started observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) south of Cape Hatteras.

New England Multispecies Sink Gillnet

Two minke whales were taken in the New England multispecies sink gillnet fishery. The take in July 1991, south of Penobscot Bay, Maine resulted in a mortality, and the take in October 1992, off the coast of New Hampshire near Jeffreys Ledge was released alive (Table 3). There were approximately 349 vessels (full and part time) in the New England multispecies sink gillnet fishery in 1993 (Walden 1996). Observer coverage as a percentage of trips has been 1%, 6%, 7%, 5%, 7%, 5%, and 4% for years 1990 to 1996. Because no mortalities have been observed within the most recent five years (1992 to 1996), the annual estimated average New England multispecies sink gillnet fishery-related mortality for minke whales is zero (Table 2).

Pelagic Drift Gillnet

Four minke whale mortalities were observed in the Atlantic pelagic drift gillnet fishery during 1995 (Table 2). The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995 and 1996 were 233, 243, 232, 197, 164, and 149, respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. In 1994, 1995, and 1996 there were 12, 11 and 10 vessels, respectively, in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996 (Table 2). Observer coverage dropped during 1996 because some vessels were deemed too small or unsafe by the contractor that provided observer coverage. Fishing effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994, 1995, and 1996 were estimated separately for each year by summing the observed caught and the product of the average by-catch per haul and number of unobserved hauls as recorded in SEFSC logbooks. Variances were estimated using bootstrap re-sampling techniques. Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 0 for 1989 to 1994, 4.5 (0) for 1995, and 0 for 1996. Estimated average annual mortality and serious injury related to this fishery during 1992-1996 was 0.8 minke whales (CV=0.00) (Table 2).

Bluefin Tuna Purse Seine

In a bluefin tuna purse seine off Stellwagen Bank one minke whale was reported caught and released uninjured in 1991(D. Beach, NMFS NE Regional Office, pers. comm.) and in 1996. The minke caught during 1991 escaped after a crew member cut the rope that was wrapped around the tail. The minke whale caught during 1996 escaped by diving beneath the net. The tuna purse seine fishery occurring between Cape Hatteras and Cape Cod is directed at small and medium bluefin and skip jack for the canning industry, while the fishery north of Cape Cod is directed at large medium and giant bluefin tuna (NMFS 1995). The latter fisheries are entirely separate from any other Atlantic tuna purse seine fishery. Spotter aircraft are used to locate fish schools. The official start date, set by regulation, is August 15. Individual vessel quotas (IVQs) and a limited access system prevent a derby fishery situation. Catch rates for large mediums and giant tuna are high and consequently, the season usually only lasts a few weeks. The 1996 regulations allocated 250 MT (5 IVQs) with a minimum of 90% giants and 10% large mediums.

Limited observer data are available for the bluefin tuna purse seine fishery. Out of 45 total trips made in 1996, 43 trips (95.6%) were observed. Forty-four sets were made on the 43 observed trips and all sets were observed. A total of 136 days were covered.

Other Fisheries

A minke whale was trapped and released alive in a herring weir off northern Maine in 1990. In U.S. and Canadian waters the herring weir fishery occurs from May to September each year along the southwestern shore of the Bay of Fundy, and scattered along the western Nova Scotia and northern Maine coasts. In 1990 there were 180 active weirs in western Bay of Fundy, and 56 active weirs in Maine (Read 1994). It is unknown how many herring weirs currently exist in U.S. and Canadian waters.

For U.S. waters, an entanglement database maintained by NE Regional Office for 1975-1992 included 36 records of minke whales. The gear includes unspecified fishing net, unspecified cable or line, fish trap, weirs, seines, gillnets, and lobster gear. A review of these records is not complete, however, it was reported that an immature female minke whale, entangled with line around the tail stock, came ashore on the Jacksonville, Florida, jetty on 31 January 1990 (R. Bonde, USFWS, Gainesville, FL, pers. comm.). The 1997 List of Fisheries (62FR33, January 2, 1997) reported seven minke whale mortalities and serious injuries which have been attributed to the lobster fishery during 1990 to 1994.

The NE Regional Office entanglement/stranding database also contains records of minke whales entangled during 1993 to 1997. The records are currently be audited and summaries should be available in the next assessment report.

Total annual estimated average U.S. fishery-related mortality and serious injury to this minke whale stock in fisheries observed by NMFS during 1992-1996 was 0.8 minke whales (CV = 0), though the total from all fisheries is unknown. After U.S. stranding and entanglement records are audited an updated mortality and serious injury estimate will be made.

CANADA

In Canadian waters, information about minke whale interactions with fishing gear is not well quantified or recorded in most parts of Canada, though some records are available. Read (1994) reported interactions between minke whales and gillnets in Newfoundland and Labrador, cod traps in Newfoundland, and herring weirs in the Bay of Fundy.

Herring Weirs

During 1980 to 1990, 15 of 17 minke whales were released alive from herring weirs in the Bay of Fundy. In 1990, ten minke whales were trapped in the Bay of Fundy weirs, but all were released alive. More recent records of interactions are currently being audited and will be reported in the next assessment. In U.S. and Canadian waters the herring weir fishery occurs from May to September each year along the southwestern shore of the Bay of Fundy, and scattered along the western Nova Scotia and northern Maine coasts. In 1990 there were 180 active weirs in western Bay of Fundy, and 56 active weirs in Maine (Read 1994). It is unknown how many herring weirs currently exist in U.S. and Canadian waters. Due to the formation of a cooperative program between Canadian fishermen and biologists it is expected that in the future more minke whales will be able to be released alive (A. Westgate, pers. comm.).

Other Fisheries

Six minke whales were reported entangled during 1989 in the now non-operational groundfish gillnet fishery in the Newfoundland and Labrador (Read 1994). One of these animals escaped towing gear, the rest died.

Salmon gillnets in Canada, now no longer being used, had taken a few minke whales. In Newfoundland in 1979, one minke whale died in a salmon net. In Newfoundland and Labrador, between 1979 and 1990, it was estimated that 15% of the Canadian minke whale takes were in salmon gillnets, where a total of 124 minke whale interactions were documented in cod traps, groundfish gillnets, salmon gillnets, other gillnets and other traps. This fishery ended in 1993 as a result of an agreement between the fishermen and North Atlantic Salmon Fund (Read 1994). Five minke whales were entrapped and died in Newfoundland cod traps during 1989. The cod trap fishery in Newfoundland closed in 1993 due to the depleted groundfish resources (Read 1994).

Table 2. Summary of the incidental mortality of minke whales (*Balaenoptera acutorostrata*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CV) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
New England[3] Multispecies Sink Gillnet	92-96	1993=349	Obs. Data Weighout Trip logbook	.07, .05, .07, .05, .04	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0	0 (0)
Pelagic Drift Gillnet	92-96	1994=12[4] 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	0[5], 0[5], 0[5], 4[5], 0[5]	0[5], 0[5], 0[5],4.5[5,6], 0[5]	0	0.8 (0)
TOTAL								0.8 (0)

1 Observer data (Obs. Data) are used to estimate by-catch rates, and the data are collected by the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects Weighout (Weighout) landings data, which are used as a measure of total effort for the sink gillnet fishery. Mandatory trip logbook (Trip logbook) data are used to determine the spatial distribution of some fishing effort in the New England multispecies sink gillnet fishery. Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).

2 The observer coverage for the New England multispecies sink gillnet fishery is expressed as percentage of trips, and for the pelagic drift gillnet fishery, the unit of effort is expressed as percentage of sets.

[3] By-catch and fishery related information for this fishery remain in this table, despite no observed mortalities during 1992 to 1996 because there was one uninjured minke whale released from this fishery in 1992 (see Table 3).
[4] 1994-1996 shown, other years not available on an annual basis.
[5] For 1991-1993, pooled by-catch rates were used to estimate by-catch in months that had fishing effort but did not have observer coverage (Northridge 1996). In 1994, 1995, and 1996, observer coverage increased substantially, and by-catch rates were not pooled (Bisack 1997).
[6] One vessel, not observed during 1995, recorded in the SEFSC mandatory logbook 1 set in a 10 day trip. If it is assumed that the vessel fished 1.4 sets per day, as estimated from the 1995 Sea Sampling data, the point estimate increases by 0.42 animals. However, the SEFSC mandatory logbook data were taken at face value, and therefore it was assumed 1 set was fished within this trip; thus the point estimate increases by 0.03 animals.

Table 3. Summary of minke whales (*Balaenoptera acutorostrata*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured).

Fishery	Years	Ratio	Injured	Uninjured
New England multispecies sink gillnet	92-96	0/0, 0, 0, 0, 0	0, 0, 0, 0, 0	1[1], 0, 0, 0, 0
Tuna purse seine	96	0/0	0	1[2]

[1] The whale was wrapped up in the float rope where the rope was wrapped in front of and behind the dorsal fin and around the tail. The rope was cut by a crew member while the whale was in the water. It was believed that the whale was released without any rope around it, because all the rope was hauled in. There was no visible bleeding or tears in the skin.
[2] The minke whale escaped by diving beneath the net.

Other Mortality

Minke whales have been and are still being hunted in the North Atlantic. From the Canadian East Coast population, documented whaling occurred from 1948 to 1972 with a total kill of 1,103 animals (IWC 1992). Animals from other North Atlantic populations are presently still being harvested at low levels.

Minke whales inhabit coastal waters during much of the year and are subject to collision with vessels. According to the NE Regional Office marine mammal entanglement and stranding database, on 7 July 1974, a necropsy suggested a vessel collision; on 15 March 1992, a juvenile female minke whale with propeller scars was found floating east of the St. Johns channel entrance (R. Bonde, USFWS, Gainesville, FL, pers. comm.), and on 15 July 1996 the captain of a vessel reported they hit a minke whale offshore MA. Other reported minke whales that had injuries suggestive of a vessel collision are currently being audited and will be summarized in the next stock assessment report.

STATUS OF STOCK

The status of minke whales, relative to OSP, in the U.S. Atlantic EEZ is unknown. The minke whale is not listed as endangered under the Endangered Species Act (ESA). The total fishery-related mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because estimated fishery-related mortality and serious injury does not exceed PBR and the minke whale is not listed as a threatened or endangered species under the ESA.

REFERENCES

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine Mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA, 5 pp.

Barlow, J., S. L. Swartz, T. C. Eagle, and P. R. Wade. 1995. U.S. Marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. U.S.Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bisack, K.D. 1997. Marine mammal bycatch estimates and their sampling distributions in the U.S. New England sink gillnet, pair trawl, Atlantic pelagic drift gillnet and North Atlantic bottom trawl fisheries: 1994 to 1996. Working paper SC/49/SM35 submitted to the IWC Scientific Committee meeting in Bournemouth, UK, Aug/Sept 1997.

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance Sampling: Estimating abundance of biological populations. *Chapman & Hall*, New York, 446 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Donovan, G. P. 1991. A review of IWC stock boundaries. *Rep. int. Whal. Commn. Special Issue 13: 39-68.*

IWC [International Whaling Commission]. 1991. Appendix 11. Biological parameters of North Atlantic minke whales in Annex F Report of the sub-committee on North Atlantic Minke whales. *Rep. int. Whal. Commn. 41: 160.*

IWC [International Whaling Commission]. 1992. Annex K. Report of the working group on North Atlantic Minke trials. *Rep. int. Whal. Commn. 42: 246-251.*

Katona, S. K., V. Rough, and D. T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. *Smithsonian Institution Press*. Washington. 316 pp.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Mitchell, E. D. 1991. Winter records of the Minke whale (*Balaenoptera acutorostrata* Lacepede 1804) in the southern North Atlantic. *Rep. int. Whal. Commn. 41: 455-457.*

National Marine Fisheries Service (NMFS). 1995. Final environmental impact statement for a regulatory amendment for the western Atlantic bluefin tuna fishery. July 20, 1995.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna driftnet and pair trawl fisheries. Draft final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. Northeast Fish. Sci. Cent. Ref. Doc. 96-04; 37p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.) Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16*.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Walden, J. 1996. The New England gillnet effort study. NCAA, NFS, NEFSC Ref. Doc. No. 96-10, 38pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry, and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull., U.S. 88(2): 347-360.*

BLUE WHALE (*Balaenoptera musculus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of the blue whale, *Balaenoptera musculus*, in the western North Atlantic generally extends from the Arctic to at least mid-latitudes. Blue whales are most frequently sighted in the waters off eastern Canada, with the majority of recent records from the Gulf of St. Lawrence (Sears *et al*. 1987). The species was hunted around Newfoundland in the first half of the 20th century (Sergeant 1966). The present Canadian distribution, broadly described, is spring, summer, and fall in the Gulf of St. Lawrence, especially along the north shore from the St. Lawrence River estuary to the Strait of Belle Isle and off eastern Nova Scotia. The species occurs in winter off southern Newfoundland and also in summer in Davis Strait (Mansfield 1985). Individual identification has confirmed the movement of a blue whale between the Gulf of St Lawrence and western Greenland (R. Sears and F. Larsen, unpublished data), although the extent of exchange between these two areas remains unknown.

The blue whale is best considered as an occasional visitor in U.S. Atlantic Exclusive Economic Zone (EEZ) waters, which may represent the current southern limit of its feeding range (CETAP 1982; Wenzel *et al*. 1988). All of the five sightings described in the foregoing two references were in August. Yochem and Leatherwood (1985) summarized records that suggested an occurrence of this species south to Florida and the Gulf of Mexico, although the actual southern limit of the species' range is unknown.

Using the U.S. Navy's SOSUS program, blue whales have been detected and tracked acoustically in much of the North Atlantic, including in subtropical waters north of the West Indies and in deep water east of the U.S. EEZ (Clark 1995). Most of the acoustic detections were around the Grand Banks area of Newfoundland and west of the British Isles. Sigurjónsson and Gunnlaugsson (1990) note that North Atlantic blue whales appear to have been depleted by commercial whaling to such an extent that they remain rare in some formerly important habitats, notably in the northern and northeastern North Atlantic.

POPULATION SIZE

Little is known about the population size of blue whales except for in the Gulf of St. Lawrence area. Here, 308 individuals have been catalogued (Sears *et al*. 1987), but the data were deemed to be unusable for abundance estimation (Hammond *et al.* 1990). Mitchell (1974) estimated that the blue whale population in the western North Atlantic may number only in the low hundreds. R. Sears (pers. comm.) suggests that no present evidence exists to refute this estimate.

Minimum Population Estimate

The 308 recognizable individuals from the Gulf of St. Lawrence area which were catalogued by Sears *et al*. (1987) is considered to be a minimum population estimate for the western North Atlantic stock.

Current Population Trend

There are insufficient data to determine population trends for this species. Off western and southwestern Iceland, an increasing trend of 4.9% a year was reported for the period 1969-1988 (Sigurjónsson and Gunnlaugsson 1990), although this estimate should be treated with caution given the effort biases underlying the sightings data on which it was based.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 308 (CV=unknown). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because the blue whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic blue whale is 0.6.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

There are no confirmed records of mortality or serious injury to blue whales in the U.S. Atlantic EEZ. However, in March 1998 a dead 66-foot male blue whale was brought into Rhode Island waters on the bow of tanker. The cause of death was determined to be ship strike, although it was unclear whether the tanker concerned killed the whale or merely picked up the carcass after death. The location of the strike was also not determined. Given the known rarity of blue whales in U.S. Atlantic waters, and the vessel's port of origin (Antwerp), it seems reasonable to suppose that the whale died somewhere to the north of the U.S. EEZ.

Fishery Information

With one exception, no fishery information is presented because there are no observed fishery-related mortalities or serious injury. The exception concerns a blue whale observed in October 1986 on Stellwagen Bank, Massachusetts (Wenzel *et al.*. 1988) which had gear (possibly lobster line and a float)around its flipper. The gear type could not be confirmed, and its origin was unknown.

STATUS OF STOCK

The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine population trends for blue whales. The total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant and approaching a zero mortality and serious injury rate. Any fishery-related mortality would be unlawful because there is no recovery plan currently in place, although a draft plan is currently in review. This is a strategic stock because the blue whale is listed as an endangered species under the ESA.

REFERENCES

Barlow, J., S.L. Swartz, T. C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. NOAA Technical Memorandum NMFS-OPR-6. U.S. Department of Commerce, Washington, D.C. 73 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Clark, C.W. 1995. Application of U.S. Navy underwater hydrophone arrays for scientific research on whales. *Rep. int. Whal. Commn. 45: 210-212.*

Hammond, P.S., R. Sears and M. Bérubé. 1990. A note on problems in estimating the number of blue whales in the Gulf of St Lawrence from photo-identification data. *Rep. int. Whal. Commn., Special Issue 12: 141-142.*

Mansfield, A. W. 1985. Status of the blue whale, *Balaenoptera musculus*, in Canada. *Canadian Field Naturalist 99(3): 417-420.*

Mitchell, E. 1974. Present status of northwest Atlantic fin and other whale stocks. Pages 108-169 *in* W. E. Schevill (editor), The whale problem: A status report. *Harvard University Press*, Cambridge, Massachusetts, 419 pp.

Sears, R., F. Wenzel, and J. M. Williamson. 1987. The blue whale: a catalog of individuals from the western North Atlantic (Gulf of St. Lawrence). Mingan Island Cetacean Study, St. Lambert, Quebec, Canada, 27 pp.

Sergeant, D. E. 1966. Populations of large whale species in the western North Atlantic with special reference to the fin whale. *Fish. Res. Board. Canada Circular No. 9, 30 pp.*

Sigurjonsson, J. and T. Gunnlaugsson. 1990. Recent trends in abundance of blue (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) off west and southwest Iceland, with a note on occurrence of other cetacean species. *Rep. int. Whal. Commn. 40: 537-551.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop, April 3-5, 1996, Seattle, Washington. NOAA Technical Memorandum NMFS-OPR-12. U.S. Dept.of Commerce, Washington, D.C. 93 pp.

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

Yochem, P. K. and S. Leatherwood. 1985. Blue whale. Pages 193-240 *in:* S. H. Ridgeway and R. Harrison (eds), Handbook of Marine Mammals, Vol. 3: The Sirenians and Baleen Whales, *Academic Press*, New York.

SPERM WHALE (*Physeter macrocephalus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of the sperm whale in the U.S. EEZ occurs on the continental shelf edge, over the continental slope, and into mid-ocean regions (Figure 1). Waring *et al*. (1993) suggest that this offshore distribution is more commonly associated with the Gulf Stream edge and other features. However, the sperm whales that occur in the eastern U.S. EEZ likely represent only a fraction of the total stock. The nature of linkages of the U.S. habitat with those to the south, north, and offshore is unknown. Historical whaling records compiled by Schmidly (1981) suggested an offshore distribution off the southeast U.S., over the Blake Plateau, and into deep ocean. In the southeast Caribbean, both large and small adults, as well as calves and juveniles of different sizes are reported (Watkins *et al*. 1985). Whether the northwest Atlantic population is discrete from the northwestern or northeastern Atlantic is currently unresolved. There exists one tag return of a male tagged off Browns Bank (Nova Scotia) in 1966 and returned from Spain in 1973. In the U.S. EEZ waters, there appears to be a distinct seasonal cycle (CETAP 1982; Scott and Sadove 1997). In winter, sperm whales are concentrated east and northeast of Cape Hatteras. In spring, the center of distribution shifts northward to east of Delaware and Virginia, and is widespread throughout the central portion of the mid-Atlantic bight and the southern portion of Georges Bank. In summer, the distribution is similar but now also includes the area east and north of Georges Bank and into the Northeast Channel region, as well as the continental shelf (inshore of the 100m isobath) south of New England. In the fall, sperm whale occurrence south of New England on the continental shelf is at its highest level, and there remains a continental shelf edge occurrence in the mid-Atlantic bight. Similar inshore (<200m) observations have been made on the southwestern portion (Kenney pers. comm) and the eastern Scotian Shelf, particularly in the region of "the Gully" (Whitehead *et al*. 1991).

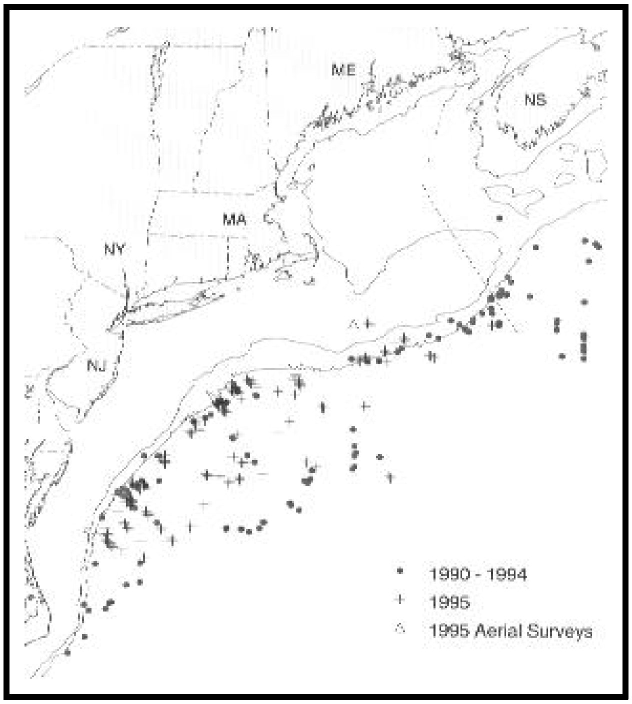

Figure 1. *Distribution of sperm whale sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

Geographic distribution of sperm whales may be linked to their social structure and their low reproductive rate and both of these factors have management implications. Several basic groupings or social units are generally recognized — nursery schools, harem or mixed schools, juvenile or immature schools, bachelor schools, bull schools or pairs, and solitary bulls (Best 1979; Whitehead *et al*. 1991). These groupings have a distinct geographical distribution, with females and juveniles generally based in tropical and subtropical waters, and males more wide-ranging and occurring in higher latitudes. However, CETAP and NMFS/NEFSC sightings in shelf-edge and off-shelf waters included many social groups with calves/juveniles (CETAP 1981; Waring *et al.*. 1992, 1993). The basic social unit of the sperm whale appears to be the mixed school of adult females plus their calves and some juveniles of both sexes, normally numbering 20-40 animals in all. There is evidence that some social bonds persist for many years.

POPULATION SIZE

Total number of sperm whales off the U.S. or Canadian Atlantic coast are unknown, although seven estimates from selected regions of the habitat do exist for select time periods (Table 1): spring and summer of 1978-82, August 1990, June-July 1991, August-September 1991, June-July 1993, August 1994, and July-September 1995. These surveys were conducted in continental shelf edge and/or deeper oceanic waters. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1).

A population size of 219 sperm whales (CV=0.36) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on an inverse variance weighted pooling of spring and summer data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate does not include corrections for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty, its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 338 (CV=0.31) sperm whales was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Table 1; Anon. 1990; Waring *et al.* 1992). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 736 (CV=0.33) sperm whales was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Table 1; Waring *et al.* 1992; Waring 1998). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but no corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 705 (CV=0.66) and 337 (CV=0.50) sperm whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Table 1; Anon. 1991). The study area included that covered in the CETAP study plus several additional continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. The data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993), where the CV was estimated using the bootstrap option. The abundance estimates do not include g(0) and were not pooled over platforms because the inter-platform calibration analysis has not been conducted.

A population size of 116 (CV=0.40) sperm whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 623 (CV=0.52) sperm whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (Table 1; Anon. 1994). Data were collected by two alternating teams that searched with 25x150 binoculars and an independent observer who searched by naked eye from a separate platform on the bow. Data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 2,698 (CV=0.67) sperm whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS, unpublished data). Total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques.

Because all the sperm whale estimates presented here were not corrected for dive-time, they are likely downwardly biased and an underestimate of actual abundance. Given that the average dive-time of sperm whales is approximately 45 min (Whitehead *et al*. 1991; Watkins *et al*. 1993), the bias may be substantial.

Although the stratification schemes used in the 1990-1995 surveys did not always sample the same areas or encompass the entire sperm whale habitat, they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The collective 1990-95 data suggest that, seasonally, at least several hundred sperm whales are occupying these waters. The 1995 estimate is nearly eight-fold greater than CETAP data from a decade previous. Sperm whale abundance may increase offshore, particularly in association with Gulf Stream and warm-core ring features; however, at present there is no reliable estimate of total sperm whale abundance in the western North Atlantic.

The best available current abundance estimate for the western North Atlantic sperm whale is 2,698 (CV=0.67) as estimated from the July to September 1995 line transect survey (NMFS, unpublished data) because this survey is recent and provided the most complete coverage of continental shelf edge and continental slope waters off the northeast U.S. coast.

Table 1. Summary of abundance estimates for the western North Atlantic sperm whale. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring & summer 1978-82	Cape Hatteras, NC to Nova Scotia	219	0.36
Aug 1990	Gulf Stream	338	0.31
Jun-Jul 1991	Cape Hatteras, NC to Georges Bank, shelf edge only	736	0.33
Aug-Sep 1991	Cape Hatteras, NC to Nova Scotia	705 and 337*	0.66 and 0.50*
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	116	0.40
Aug 1994	warm-core ring SE of Georges Bank	623	0.52
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	2,698	0.67

* from data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for sperm whales is 2,698 (CV=0.67). The minimum population estimate for the western North Atlantic sperm whale is 1,617 (CV=0.67).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. While more is probably known about sperm whale life history in other areas, some life history and vital rates information is available for the northwest Atlantic. These include: calving interval is 3-4 years, lactation period is 24 months, gestation period is 14.5-16.5 months, births occur mainly in July to November, length at birth is 405 cm, length at sexual maturity 11.0-12.0 m for males, and 8.3-9.2 m for females, mean age at sexual maturity is 19 years for males and 9 years for females, and mean age at physical maturity is 45 years for males and 30 years for females (Best 1974; Lockyer 1981).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 1,617 (CV=0.67). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because the sperm whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic sperm whale is 3.2.

ANNUAL HUMAN-CAUSED MORTALITY

Four hundred twenty-four sperm whales were harvested in the Newfoundland-Labrador area between 1904-1972 and 109 sperm whales were taken near Nova Scotia in 1964-1972 (Mitchell and Kozicki 1984) in a Canadian whaling fishery. There was also a well-documented sperm whale fishery based on the west coast of Iceland. Other sperm whale catches occurred near West Greenland, the Azores, Madeira, Spain, Spanish Morocco, Norway (coastal and pelagic), Faroes, and British coastal. At present, because of their general offshore distribution, sperm whales are less likely to be impacted by humans and those impacts that do occur are less likely to be recorded. There has been no complete analysis and reporting of existing data on this topic for the western North Atlantic.

Total annual estimated average fishery-related mortality or serious injury to this stock during 1992-1996 was zero sperm whales. Although, in 1995 one sperm whale was entangled in a pelagic drift gillnet and released alive with gear around several body parts. Presently, this injury has not been used to estimate mortality.

Fishery Information

Three sperm whale entanglements have been documented from August 1993 to May 1997. In August 1993, a dead sperm whale, with longline gear wound tightly around the jaw, was found floating about 20 miles off Mt Desert Rock. In October 1994, a sperm whale was successfully disentangled from a fine mesh gillnet in Birch Harbor, Maine. In May 1997, a sperm whale entangled in net with three buoys trailing was sighted 130 nm northwest of Bermuda. No information on the status of the animal was provided.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and currently provides observer coverage of vessels fishing south of Cape Hatteras.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, or North Atlantic bottom trawl observed fisheries.

Pelagic Drift Gillnet

Only two records exist in the present NEFSC by-catch database. In July 1990, a sperm whale was entangled and subsequently released (injured) from a pelagic drift gillnet near the continental shelf edge on southern Georges Bank. During June 1995, one sperm whale was entangled with "gear in/around several body parts" then released injured from a pelagic drift gillnet haul located on the shelf edge between Oceanographer and Hydrographer Canyons on Georges Bank.

The estimated total number of hauls in the pelagic drift net fishery increased from 714 in 1989 to 1144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine vessels participated in this fishery between 1989 and 1993. Since 1994, between 10 to 12 vessels have participated in the fishery . Observer coverage, percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. The greatest concentrations of effort were located along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of total by-catch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata, assuming the 1990 injury was a mortality (Northridge 1996). Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 2.2 sperm whales in 1989 (2.43), 4.4 in 1990 (1.77), 0 in 1991, 0 in 1992, 0 in 1993, 0 in 1994, 0 in 1995, and 0 in 1996. Estimated average annual mortality and serious injury related to this fishery during 1992-1996 was zero, assuming the 1995 injured sperm whale was not a serious injury. The 1992-1996 time period provides a better characterization of the current fishery. Table 2 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Table 2. Summary of sperm whales *(Physeter macrocephalus)* released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured)

Fishery	Years	Ratio	Injured[2]	Uninjured
Pelagic Drift Gillnet	92-96	0, 0, 0, 0, 0	0, 0, 0, 1[1],0	0, 0, 0, 0, 0

[1] The observer recorded this animal being released alive and having the "gear in/around several body parts".
[2] Annual mortality estimates do not include any animals injured and released alive.

Other mortality

Six sperm whale strandings have been documented along the U.S. Atlantic coast between Maine and Miami, Florida, during 1994-1996 (NMFS unpublished data).

STATUS OF STOCK

The status of this stock relative to OSP in U.S. Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine population trends. The current stock abundance estimate was based upon a small portion of the known stock range. Total fishery-related mortality and serious injury for this stock is less than 10% of the calculated PBR. This is a strategic stock because the species is listed as endangered under the ESA.

REFERENCES

Anon. 1990. Cruise results, NOAA Ship CHAPMAN, Cruise No. 90-05. Marine Mammal Sighting Survey. NOAA, NMFS, NEFSC, Woods Hole Laboratory, Woods Hole, MA 5pp.

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA, NMFS, SEFSC & NEFSC, 4 pp. Available from NEFSC, Woods Hole Laboratory, Woods Hole, MA.

Anon. 1993. Cruise results, NOAA Ship DELAWARE II, Cruise No. DEL 93-06, Marine Mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA 5 pp.

Anon. 1994. Cruise results, NOAA Ship RELENTLESS, Cruise No. RS 94-02, Marine Mammal Survey/Warm Core Ring Study. NOAA NMFS NEFSC Woods Hole Laboratory, Woods Hole, MA. 8pp

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Best, P. B. 1974. Biology of the sperm whale. Pages 53-81. *In:* W. E. Schevill (editor), The whale problem: A status report. *Harvard University Press,* Cambridge, Massachusetts, 419 pp.

Best, P. B. 1979. Social organization in sperm whales, *Physeter macrocephalus*. Pages 227-289. *In:* H. E. Winn and B. L. Olla (eds), Behavior of marine animals, Vol. 3: Cetaceans. *Plenum Press,* New York.

Buckland, S. T., D. R. Andersen, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. *Chapman and Hall*, New York, 442 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Lockyer, C. 1981. Estimates of growth and energy budget for the sperm whale. Pages 491-504 *in*: Mammals in the seas, III. *FAO Fish. Ser. No. 5. FAO, Rome, 504 pp.*

Mitchell, E. and V. M. Kozicki. 1984. Reproductive condition of male sperm whales, *Physeter macrocephalus*, taken off Nova Scotia. *Rep. int. Whal. Commn. Special Issue 6: 243-252.*

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500160.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.) Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16.*

Scott, T.M. and S.S. Sadove. 1997. Sperm whale, *Physeter macrocephalus*, sightings in the shallow shelf waters off Long Island, New York. *Mar. Mamm. Sci. 13(2): 317-321.*

Schmidly, D. J. 1981. Marine mammals of the southeastern United States and the Gulf of Mexico. Department of the Interior, U.S. Fish and Wildlife Service Publication FWS/OBS-80/41, Washington, DC, 166 pp.

Wade P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G.T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA NMFS NEFSC, Lab. Ref. Doc. No. 98-09, 21pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Waring, G.T., C.P. Fairfield, C.M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES. C.M. 1992/N:12. 29p.*

Waring, G.T., C.P. Fairfield, C.M. Ruhsam and M. Sano. 1993. Sperm whales associated with Gulf Stream features off the northeastern USA shelf. *Fish. Oceanogr. 2(2): 101-105*

Watkins, W. A., K. E. Moore, and P. Tyack. 1985. Sperm whale acoustic behavior in the southeast Caribbean. *Cetology 49: 1-15.*

Watkins, W.A., M.A. Daher, K.M. Fristrup, and T.J. Howald. 1993. Sperm whales tagged with transponders and tracked underwater by sonar. *Mar. Mamm. Sci. 9(1):55-67.*

Whitehead, H., S. Brennan, and D. Grover. 1991. Distribution and behavior of male sperm whales on the Scotian Shelf, Canada. *Can. J. Zool. 70: 912-918.*

December 1998

DWARF SPERM WHALE (*Kogia simus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The dwarf sperm whale (*Kogia simus*) and the pygmy sperm whale (*K. breviceps*) appear to be distributed worldwide in temperate to tropical waters (Caldwell and Caldwell 1989). Sightings of these animals in the northern Gulf of Mexico occur primarily along the continental shelf edge and over the deeper waters off the continental shelf (Mullin *et al*. 1991; NMFS unpublished data). Recent analyses of hemoglobin, morphometric and dietary data from Florida strandings of both species (Barros *et al.* 1998) suggests that habitat partitioning may exist between the two species, *K. simus* occupies more offshore and oceanic waters, whereas *K. breviceps* inhabits more mid-shelf waters. Interestingly, a recent analysis of South Africa stranding data indicates that in that region *K. simus* is the nearshore species (Plön *et al*. 1998). Pygmy sperm whales and dwarf sperm whales are difficult to distinguish and sightings of either species are often categorized as *Kogia* sp. There is no information on stock differentiation for the Atlantic population.

POPULATION SIZE

Estimates of abundance were derived through the application of distance sampling analysis (Buckland *et al*. 1993) and the computer program DISTANCE (Laake *et al*. 1993) to sighting data collected during a 1992 winter, visual sampling, line-transect vessel survey of the U.S. Atlantic Exclusive Economic Zone (EEZ) waters between Miami, Florida, and Cape Hatteras, North Carolina. Abundance was estimated for both species combined because the majority of sightings were not identified to species, and both species are known to occur in the area. The estimated abundance of dwarf sperm whales and pygmy sperm whales combined for the 1992 surveys was 420 animals (coefficient of variation, CV = 0.60) (Hansen *et al*. 1994). Dwarf sperm whale abundance alone cannot be estimated due to uncertainty of species identification of sightings.

Minimum Population Estimate

A best and minimum population size could not be estimated because of the uncertainty in species identification.

Current Population Trend

No information was available evaluate trends in population size.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic dwarf sperm whale is unknown because the minimum population size cannot be estimated.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1992-1996 was 0.2 dwarf sperm whales (CV = 0; Table 1).

Fishery Information

The level of past or current, direct, human-caused mortality of dwarf sperm whales in the U.S. Atlantic EEZ is unknown. Available information indicates there is likely little fisheries interaction with dwarf sperm whales in the U.S. Atlantic EEZ. Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory logbook system for large pelagic fisheries. The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993 the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and currently provides observer coverage of vessels fishing south of Cape Hatteras.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, and North Atlantic bottom trawl fisheries.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift net fishery increased from 714 in 1989 to 1144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine vessels participated in this fishery between 1989 and 1993. Since 1994, between 10 to12 vessels have participated in the fishery (Table 2). Observer coverage, percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. The greatest concentrations of effort were located along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of total by-catch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata, assuming the 1990 injury was a mortality (Northridge 1996). Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 0 dwarf sperm whales from 1991-1994, 1.0 in 1995 (CV = 0), and 0 in 1996. Estimated average annual mortality and serious injury related to this fishery during 1992-1996 was 0.2 dwarf sperm whales (CV = 0) (Table 1). The 1992-1996 time period provides a better characterization of the current fishery.

Table 1. Summary of the incidental mortality of the dwarf sperm whale (*Kogia simus*), by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels [1]	Data Type [2]	Observer Coverage [3]	Observed Mortality	Estimated Mortality [4]	Estimated CVs [4]	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	0, 0, 0, 1, 0	0, 0, 0, 1[5], 0	0	0.2 (0)
TOTAL								0.2 (0)

1 1994 to 1996 shown, other years not available on an annual basis.

2 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Logbook (Logbook) data are used to measure total effort, and the data are collected at the Southeast Fisheries Science Center (SEFSC).

3 The observer coverage and unit of effort for the Pelagic Drift Gillnet is a set.

4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). In 1994 and 1995, observer coverage increased substantially, and bycatch rates were not pooled for this period.

5 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.08 animals. However, the SEFSC mandatory logbook data were taken at face value, and therefore it was assumed that one set was fished within this trip, and the point estimate would then increase by 0.01 animals.

Other Mortality

At least 23 dwarf sperm whale strandings have been documented along the U.S. Atlantic coast between Cape Hatteras, North Carolina, and Miami, Florida, during 1987-1996). Three of the stranded animals had plastic, or a plastic bag or bags in their stomachs, and one of these three had possible propeller cuts on or near the flukes.

STATUS OF STOCK

The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown. This species is not listed as endangered or threatened under the Endangered Species Act. There is insufficient information with which to assess population trends. It is not known whether total fishery-related mortality and serious injury for this stock is less than 10% of PBR and therefore cannot be considered insignificant and approaching zero mortality and serious injury rate, because PBR cannot be calculated. Upon the advice of the Atlantic Scientific Review Group this stock has been designated a strategic stock because PBR cannot been determined and there is an unknown amount of possible human-caused mortality from the ingestion of marine debris such as plastic bags and from possible boat strikes.

REFERENCES

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Barros, N.B., D.A. Duffield, P.H. Ostrom, D.K. Odell and V.R. Cornish. 1998. Near-shore vs. off-shore ecotype differentiation of *Kogia breviceps* and *K. simus* based on hemoglobin, morphometric and dietary analyses. The World Marine Mammal Conference, 20-24 January 1998, Monaco (Abstract).

Buckland, S. T., D. R. Anderson, K. P. Burnham and J. L. Laake. 1993. Distance Sampling: estimating abundance of biological populations. *Chapman & Hall*, London, 446 pp.

Caldwell, D. K. and M. C. Caldwell. 1989. Pygmy sperm whale *Kogia breviceps* (de Blainville, 1838): dwarf sperm whale *Kogia simus* Owen, 1866. Pages 235-26. *In*: S. H. Ridgway and R. Harrison (eds.). Handbook of marine mammals, Vol. 4: river dolphins and the larger toothed whales. *Academic Press*, San Diego.

Hansen, L. J., K. D. Mullin and C. L. Roden. 1994. Preliminary estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-93/94-58.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Mullin, K., W. Hoggard, C. Roden, R. Lohoefener, C. Rogers and B. Taggart. 1991. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. OCS Study/MMS 91-0027. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, Louisiana, 108 pp.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No.40ENNF500045. 18p.

Plön, S.E.E., R.W. Harris, P.M. Illgner and V.G.C. Cockcroft. 1998. Analysis of pygmy *Kogia breviceps* and dwarf *Kogia simus* sperm whale strandings along the South African coastline using a geographic information system. The World Marine Mammal Conference, 20-24 January 1998, Monaco (Abstract).

Wade P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

PYGMY SPERM WHALE (*Kogia breviceps*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The dwarf sperm whale (*Kogia breviceps*) and the pygmy sperm whale (*K. simus*) appear to be distributed worldwide in temperate to tropical waters (Caldwell and Caldwell 1989). Sightings of these animals in the northern Gulf of Mexico occur primarily along the continental shelf edge and over the deeper waters off the continental shelf (Mullin *et al*. 1991; Southeast Fisheries Science Center unpublished data). Recent analyses of hemoglobin, morphometric and dietary data from Florida strandings of both species (Barros *et al.* 1998) suggests that habitat partitioning may exist between the two species, *K. simus* occupies more offshore and oceanic waters, whereas *K. breviceps* inhabits more mid-shelf waters. Interestingly, a recent analysis of South Africa stranding data indicates that in that region *K. simus* is the nearshore species (Plön *et al.* 1998). Pygmy sperm whales and dwarf sperm whales are difficult to distinguish and sightings of either species are often categorized as *Kogia* sp. There is no information on stock differentiation for the Atlantic population.

POPULATION SIZE

Estimates of abundance were derived through the application of distance sampling analysis (Buckland *et al*. 1993) and the computer program DISTANCE (Laake *et al*. 1993) to sighting data collected during a 1992 winter, visual sampling, line-transect vessel survey of the U.S. Atlantic Exclusive Economic Zone (EEZ) waters between Miami, Florida, and Cape Hatteras, North Carolina. Abundance was estimated for both species combined because the majority of sightings were not identified to species, and both species are known to occur in the area. The estimated abundance of dwarf sperm whales and pygmy sperm whales combined for the 1992 surveys was 420 animals (coefficient of variation, CV = 0.60) (Hansen *et al.* 1994). Pygmy sperm whale abundance alone cannot be estimated due to uncertainty of species identification of sightings.

Minimum Population Estimate

A best and minimum population size could not be estimated because of the uncertainty in species identification.

Current Population Trend

No information was available to evaluate trends in population size.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic pygmy sperm whale was unknown because the minimum population estimate cannot be estimated.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The level of past or current, direct, human-caused mortality of pygmy sperm whales in the U.S. Atlantic EEZ is unknown. Available information indicates there is likely little, if any, fisheries interaction with pygmy sperm whales in the U.S. Atlantic EEZ.

There were no documented strandings of pygmy sperm whales along the U.S. Atlantic coast during 1987-present which were classified as likely caused by fishery interactions. Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reporting fishery information system for large pelagic fisheries. The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and currently provides observer coverage of vessels fishing south of Cape Hatteras. There have been no observed mortalities or serious injuries by NMFS Sea Samplers in the pelagic drift gillnet, pelagic longline, pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, and North Atlantic bottom trawl fisheries.

Other Mortality

At least 174 (includes one unidentified in 1996 that was assigned by the SAR author to this species, because the pygmy sperm whales account for the majority of identified *Kogia* stranding) pygmy sperm whale strandings were documented along the U.S. Atlantic coast between Cape Hatteras, North Carolina, and Miami, Florida, during 1987-1996 (NMFS, unpubl. data). Two of the stranded animals had plastic, or a plastic bag or bags in their stomachs, and one additional animal had possible propeller cuts on it's flukes.

STATUS OF STOCK

The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown. This species is not listed as endangered or threatened under the Endangered Species Act. There is insufficient information with which to assess population trends. Because there are no observed mortalities or serious injuries between 1992 and 1996, total fishery-related mortality and serious injury for this stock is considered insignificant and approaching zero mortality and serious injury rate

REFERENCES

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Barros, N.B., D.A. Duffield, P.H. Ostrom, D.K. Odell and V.R. Cornish. 1998. Near-shore vs. off-shore ecotype differentiation of *Kogia breviceps* and *K. simus* based on hemoglobin, morphometric and dietary analyses. The World Marine Mammal Conference, 20-24 January 1998, Monaco (Abstract).

Buckland, S. T., D. R. Anderson, K. P. Burnham and J. L. Laake. 1993. Distance Sampling: estimating abundance of biological populations. *Chapman & Hall*, London, 446 pp.

Caldwell, D. K. and M. C. Caldwell 1989. Pygmy sperm whale *Kogia breviceps* (de Blainville 1838): dwarf sperm whale *Kogia simus* Owen, 1866. Pages 235-260. *In:* S. H. Ridgway and R. Harrison, Handbook of marine mammals, Vol. 4: river dolphins and the larger toothed whales. *Academic Press*, San Diego.

Hansen, L. J., K. D. Mullin and C. L. Roden. 1994. Preliminary estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-93/94-58.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Mullin, K., W. Hoggard, C. Roden, R. Lohoefener, C. Rogers and B. Taggart. 1991. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. OCS Study/MMS 91-0027. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, Louisiana, 108 pp.

Plön, S.E.E., R.W. Harris, P.M. Illgner and V.G.C. Cockcroft. 1998. Analysis of pygmy *Kogia breviceps* and dwarf *Kogia simus* sperm whale strandings along the South African coastline using a geographic information system. The World Marine Mammal Conference, 20-24 January 1998, Monaco (Abstract).

Wade P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

KILLER WHALE (*Orcinus orca*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales are characterized as uncommon or rare in waters of the U.S. Atlantic Exclusive Economic Zone (EEZ) (Katona *et al*. 1988). The 12 killer whale sightings constituted 0.1% of the 11,156 cetacean sightings in the 1978-81 CETAP surveys (CETAP 1982). The same is true for eastern Canadian waters, where the species has been described as relatively uncommon and numerically few (Mitchell and Reeves 1988). Their distribution, however, extends from the Arctic ice-edge to the West Indies. They are normally found in small groups, although 40 animals were reported from the southern Gulf of Maine in September 1979, and 29 animals in Massachusetts Bay in August 1986 (Katona *et al*. 1988). In the U.S. Atlantic EEZ, while their occurrence is unpredictable, they do occur in fishing areas, perhaps coincident with tuna, in warm seasons (Katona *et al*. 1988; NMFS unpublished data). In an extensive analysis of historical whaling records, Reeves and Mitchell (1988) plotted the distribution of killer whales in offshore and mid-ocean areas. Their results suggest that the offshore areas need to be considered in present-day distribution, movements, and stock relationships.

Stock definition is unknown. Results from other areas (e.g., the Pacific Northwest and Norway) suggest that social structure and territoriality may be important.

POPULATION SIZE

The total number of killer whales off the eastern U.S. coast is unknown.

Minimum Population Estimate

Present data are insufficient to calculate a minimum population estimate.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock. The maximum net productivity rate was assumed to be 0.04 for purposes of this assessment. This value is based on theoretical calculations showing that cetacean populations may not generally grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown. PBR for the western North Atlantic killer whale is unknown because the minimum population size cannot be determined.

ANNUAL HUMAN-CAUSED MORTALITY

In 1994, one killer whale was caught in the New England multispecies sink gillnet fishery but released alive. No takes were documented in a review of Canadian gillnet and trap fisheries (Read 1994).

Fishery Information

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling

Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

There have been no observed mortalities or serious injuries by NMFS Sea Samplers in the pelagic drift gillnet, pelagic longline, pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, and North Atlantic bottom trawl fisheries.

STATUS OF STOCK

The status of killer whales relative to OSP in U.S. Atlantic EEZ is unknown. Because there are no observed mortalities or serious injury between 1990 and 1995, the total fishery-related mortality and serious injury for this stock is considered insignificant and approaching zero mortality and serious injury rate. The species is not listed as threatened or endangered under the Endangered Species Act. In Canada, the Cetacean Protection Regulations of 1982, promulgated under the standing Fisheries Act, prohibit the catching or harassment of all cetacean species. There are insufficient data to determine the population trends for this species. This is not a strategic stock because, although PBR could not be calculated, there is no evidence of human-induced mortality.

REFERENCES

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Katona, S. K., J. A. Beard, P. E. Girton, and F. Wenzel. 1988. Killer whales (*Orcinus orca*) from the Bay of Fundy to the Equator, including the Gulf of Mexico. *Rit. Fiskideild*. 9: 205-224.

Mitchell, E. and R. R. Reeves. 1988. Records of killer whales in the western North Atlantic, with emphasis on eastern Canadian waters. *Rit. Fiskideild*. 9: 161-193.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the Northwest Atlantic. Rep. int. Whal. Commn. Special Issue 15: 133-147.

Reeves, R. R. and E. Mitchell. 1988. Killer whale sightings and takes by American pelagic whalers in the North Atlantic. *Rit. Fiskideild*. 9: 7-23

Wade P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

July 1995

PYGMY KILLER WHALE (*Feresa attenuata*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The pygmy killer whale is distributed worldwide in tropical and subtropical waters (Ross and Leatherwood 1994). Sightings of these animals in the northern Gulf of Mexico occur primarily over the deeper waters off the continental shelf (NMFS unpublished data). There is no information on stock differentiation for the Atlantic population.

POPULATION SIZE

A single sighting of this species was made during a 1992 winter, visual sampling, line-transect vessel survey of the U.S. Atlantic Exclusive Economic Zone (EEZ) from Miami, Florida, to Cape Hatteras, North Carolina (Hansen *et al*. 1994). This sighting, of a herd of six animals, was not made during visual sampling effort; therefore, the sighting could not be used to estimate abundance of pygmy killer whales, but it does confirm the presence of this species in the U.S. Atlantic EEZ.

Minimum Population Estimate

The minimum population estimate based on the count of animals in the single sighting, was six pygmy killer whales (Hansen *et al*. 1994).

Current Population Trend

No information was available to evaluate trends in population size.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (Wade and Angliss 1997). The minimum population size is six (6). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic pygmy killer whale is 0.1.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of pygmy killer whales in the U.S. Atlantic EEZ is unknown; however, there has historically been some take of this species in small cetacean fisheries in the Caribbean (Caldwell and Caldwell 1971). Available information indicates there likely is little, if any, fisheries interaction with pygmy killer whales in the U.S. Atlantic EEZ. There have been no logbook reports of fishery-related mortality or serious injury and no observed fishery-related mortality or serious injury has been observed.

There have been no documented strandings of pygmy killer whales in the along the U.S. Atlantic coast during 1987-present which have been classified as likely caused by fishery interactions or other human-related causes. Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the dolphins which die or are seriously injured in fishery interactions wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

Fishery Information

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

There have been no observed mortalities or serious injuries by NMFS Sea Samplers in the pelagic drift gillnet, pelagic longline, pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, and North Atlantic bottom trawl fisheries.

Other Mortality

This stock may be subjected to human-induced mortality caused by habitat degradation (e.g., industrial and agricultural pollution) and indirect effects of fisheries on prey. There have been, however, no studies to date which have determined the amount, if any, of indirect human-induced mortality resulting from habitat degradation or competition for prey.

STATUS OF STOCK

The status of pygmy killer whales relative to OSP in U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. The total known fishery-related mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered insignificant and approaching zero mortality and serious injury rate. The western North Atlantic pygmy killer whale is considered a non-strategic stock.

REFERENCES

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Caldwell, D. K. and M. C. Caldwell. 1971. The pygmy killer whale, *Feresa attenuata*, in the western Atlantic, with a summary of world records. *J. Mamm. 52:206-209*.

Hansen, L. J., K. D. Mullin and C. L. Roden. 1994. Preliminary estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys, and of selected cetacean species in the U.S. Atlantic Exclusive Economic Zone from vessel surveys from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-93/94-58

Ross, G. J. B. and S. Leatherwood. 1994. Pygmy killer whale *Feresa attenuata* (Gray 1874). Pages 387-404 *in* S. H. Ridgway and R. Harrison (eds), Handbook of marine mammals, Vol. 5: The first book of dolphins. *Academic Press*, *San Diego*, 418 pp.

Wade P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

NORTHERN BOTTLENOSE WHALE (*Hyperoodon ampullatus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Northern bottlenose whales are characterized as extremely uncommon or rare in waters of the U.S. Atlantic Exclusive Economic Zone. The two sightings of three individuals constituted less than 0.1% of the 11,156 cetacean sightings in the 1978-82 CETAP surveys. Both sightings were in the spring, along the 2,000 m isobath (CETAP 1982). In 1993 and 1996, two sightings of single animals, and in 1996, a single sighting of six animals (one juvenile), were made during summer shipboard surveys conducted along the southern edge of Georges Bank (Anon. 1993; Anon. 1996).

Northern bottlenose whales are distributed in the North Atlantic from Nova Scotia to about 70° in the Davis Strait, along the east coast of Greenland to 77° and from England to the west coast of Spitzbergen. It is largely a deep-water species and is very seldom found in waters less than 2,000 m deep (Mead 1989).

There are two main centers of bottlenose whale distribution in the western north Atlantic, one in the area called "The Gully" just north of Sable Island, Nova Scotia, and the other in Davis Strait off northern Labrador (Reeves *et al*. 1993). Studies at the entrance to the Gully from 1988-1995 identified 237 individuals and estimated the local population size at about 230 animals (95% C.I. 160-360) (Whitehead *et al*. 1997). These individuals are believed to be year-round residents and all age and sex classes are present (Gowans and Whitehead 1998). Mitchell and Kozicki (1975) documented stranding records in the Bay of Fundy and as far south as Rhode Island. Stock definition is unknown.

POPULATION SIZE

The total number of northern bottlenose whales off the eastern U.S. coast is unknown.

Minimum Population Estimate

Present data are insufficient to calculate a minimum population estimate.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic northern bottlenose whale is unknown because the minimum population size cannot be determined.

ANNUAL HUMAN-CAUSED MORTALITY

No mortalities have been reported in U.S. waters. A fishery for northern bottlenose whales existed in Canadian waters during both the 1800s and 1900s. Its development was due to the discovery that bottlenose whales contained spermaceti. A Norwegian fishery expanded from east to west (Labrador and Newfoundland) in several episodes. The fishery peaked in 1965. Decreasing catches led to the cessation of the fishery in the 1970s, and provided evidence that the population was depleted. A small fishery operated by Canadian whalers from Nova Scotia operated in the Gully, and took 87 animals from 1962 to 1967 (Mead 1989; Mitchell 1977).

Fishery Information

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

There have been no observed mortalities or serious injuries by NMFS Sea Samplers in the pelagic drift gillnet, pelagic longline, pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, and North Atlantic bottom trawl fisheries.

STATUS OF STOCK

The status of northern bottlenose whales relative to OSP in U.S. Atlantic EEZ is unknown; however, a depletion in Canadian waters in the 1970's may have impacted U.S. distribution and may be relevant to current status in U.S. waters. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. Because there are no observed mortalities or serious injury, the total fishery-related mortality and serious injury for this stock is considered to be approaching zero mortality and serious injury rate. This is not a strategic stock because there are no recent records of fishery-related mortality or serious injury.

REFERENCES

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine Mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA 5 pp.

Anon. 1996. Cruise results, R/V ABEL-J, Cruise No. AJ-9601, Part III, Marine Mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA 7 pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Gowans, S. and H. Whitehead. 1998. Social organization of northern bottlenose whales. The World Marine Mammal Science Conference, Monaco, January 1998 (Abstract).

Mead, J. G. 1989. Bottlenose whales. Pages 321-348. *In:* S. H. Ridgway and R. Harrison (eds), Handbook of marine mammals, Volume 4: River dolphins and the larger toothed whales. *Academic Press*, New York.

Mitchell, E. D. 1977. Evidence that the northern bottlenose whale is depleted. *Rep. int. Whal. Commn. 27: 195-203.*

Mitchell, E. D. and V. M. Kozicki. 1975. Autumn stranding of a northern bottlenose whale (*Hyperoodon ampullatus)* in the Bay of Fundy. *J. Fish. Res. Bd. Can. 32: 1019-1040.*

Reeves, R.R., E. Mitchell and H. Whitehead. 1993. Status of the northern bottlenose whale, *Hyperoodon ampullatus*. *Can. Fld. Nat. 107:490-508.*

Whitehead, H., S. Gowans, A. Faucher, and S.W. McCarrey. 1997. Population analysis of northern bottlenose whales in the Gully, Nova Scotia. *Mar. Mamm. Sci. 13(2): 173-185.*

Wade P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of Cuvier's beaked whales is poorly known, and is based mainly on stranding records (Leatherwood *et al*. 1976). Strandings have been reported from Nova Scotia along the eastern U.S. coast south to Florida, around the Gulf of Mexico, and within the Caribbean (Leatherwood *et al*. 1976; CETAP 1982; Heyning 1989; Houston 1990). Stock structure in the western North Atlantic is unknown.

Cuvier's beaked whale sightings have occurred principally along the continental shelf edge in the mid-Atlantic region off the northeast U.S. coast (CETAP 1982; Waring *et al*. 1992; NMFS unpubl. data). Most sightings were in late spring or summer. Based on sighting data, this species is a rare inhabitant of waters off the northeast U.S. coast (CETAP 1982).

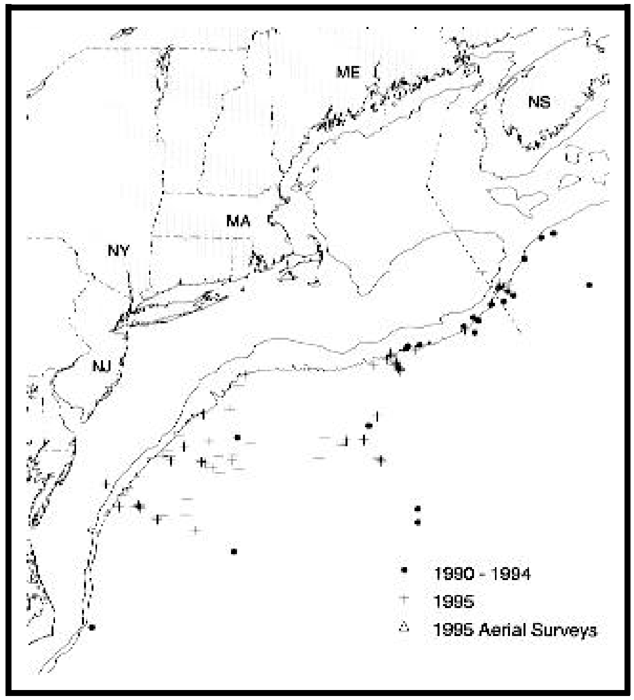

Figure 1. *Distribution of beaked whale sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

POPULATION SIZE

The total number of Cuvier's beaked whales off the eastern U.S. coast is unknown. However, seven estimates of the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) are available from select regions of the habitat during summer 1978-82, August 1990, June-July 1991, August-September 1991, June-July 1993, August 1994, and July to September 1995 (Table 1; Figure 1).

A population size of 120 undifferentiated beaked whales (CV=0.71) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on summer data because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during this season. This estimate does not include corrections for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty (e.g., large CV), its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 442 (CV=0.51) undifferentiated beaked whales was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Table 1; Waring *et al.* 1992). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 262 (CV=0.99) undifferentiated beaked whales was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Table 1; Waring *et al.* 1992; Waring 1998). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but no corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 370 (CV=0.65) and 612 (CV=0.73) undifferentiated beaked whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Table

1; Anon. 1991). The study area included that covered in the CETAP study plus several additional continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. The data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993), where the CV was estimated using the bootstrap option. The abundance estimates do not include g(0) and were not pooled over platforms because the inter-platform calibration analysis has not been conducted.

A population size of 330 (CV=0.66) undifferentiated beaked whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000 m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 99 (CV=0.64) undifferentiated beaked whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (Table 1; Anon. 1994). Data were collected by two alternating teams that searched with 25x150 binoculars and an independent observer who searched by naked eye from a separate platform on the bow. Data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 1,519 (CV=0.69) undifferentiated beaked whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS unpubl. data). Total track line length of this survey was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques. Because the number of beaked whale sightings in each strata were extremely low (3 to 10), and their sightability and behavior preclude pooling with other cetaceans, the abundance estimates are based on small sample sizes. Therefore, the above abundance estimates should be viewed with caution.

Because the estimates presented here were not dive-time corrected, they are likely negatively biased and probably underestimate actual abundance. Given that *Mesoplodon* spp. prefers deep-water habitats (Mead 1989) the bias may be substantial.

The best available current abundance estimate for the undifferentiated complex of beaked whales is 1,519 (CV=0.69) as estimated from the July to September 1995 line transect survey (NMFS unpubl. data) because this survey provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for the undifferentiated complex of beaked whales which include *Ziphius* and *Mesoplodon* spp. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
summer 1978-82	Cape Hatteras, NC to Nova Scotia	120	0.71
Aug 1990	Gulf Stream	442	0.51
Jun-Jul 1991	Cape Hatteras, NC to Georges Bank, shelf edge only	262	0.99
Aug-Sep 1991	Cape Hatteras, NC to Nova Scotia	370 and 612*	0.65 and 0.73*
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	330	0.66
Aug 1994	warm-core ring SE of Georges Bank	99	0.64
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	1,519	0.69

* from data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for undifferentiated beaked whales is 1,519 (CV=0.69). The minimum population estimate for the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 895 (CV=0.69). It is not possible to determine the minimum population estimate of only Cuvier's beaked whales.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: length at birth is 2 to 3 m, length at sexual maturity 6.1 m for females, and 5.5 m for males, maximum age for females were 30 growth layer groups (GLG's) and for males was 36 GLG's, which may be annual layers (Mitchell 1975; Mead 1984; Houston 1990).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for the undifferentiated complex of beaked whales is 895 (CV=0.69). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for all species in the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 8.9. It is not possible to determine the PBR for only Cuvier's beaked whales.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 1992-1996 total average estimated annual fishery-related mortality of beaked whales in the U.S. EEZ was 9.7 (CV = 0.07).

Fishery Information

There is no historical information available that documents incidental mortality in either U.S. or Canadian Atlantic coast fisheries (Read 1994).

Current data on incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at Southeast Fisheries Science Center (SEFSC). In late 1992 and in 1993 the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and currently provides observer coverage of vessels fishing south of Cape Hatteras.

Total fishery-related mortality and serious injury cannot be estimated separately for each beaked whale species because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that any beaked whale stock which occurred in the U.S. Atlantic EEZ might have been subject to the observed fishery-related mortality and serious injury.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, or North Atlantic bottom trawl observed fisheries.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 143, respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fishery information. Variances were estimated using bootstrap re-sampling techniques. By-catch of beaked whales has only occurred from Georges Canyon to Hydrographer Canyon along the continental shelf break and continental slope during July to October. Thirty-five fishery-related beaked whale mortalities were observed between 1989 and 1995. The estimated annual fishery-related mortality (CV in parentheses) was 60 in 1989 (0.21), 76 in 1990 (0.26), 13 in 1991 (0.21), 9.7 in 1992 (0.24), 12 in 1993 (0.16) 4.8 in 1994 (0.08), 9.1 in 1995 (0), and 13 in 1996 (0.12) (Table 2). Annual mortality estimates do not include any animals injured and released alive. The 1992-1996 total average estimated annual fishery-related mortality of beaked whales in the U.S. EEZ was 9.7 (CV = 0.07) (Table 2). The 1992-1996 period provides a better characterization of the current pelagic drift gillnet fishery. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Table 2. Summary of the incidental mortality for the undifferentiated complex of beaked whales which include Cuvier's beaked whale (*Ziphius cavirostris*), and *Mesoplodon* beaked whale, by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels [1]	Data Type [2]	Observer Coverage [3]	Observed Mortality	Estimated Mortality [4]	Estimated CVs [4]	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	1, 5, 4, 9, 8	9.7, 12, 4.8, 9.1[5] 13	.24, .16, .08, 0, .12	9.7 (.07)
TOTAL								9.7 (.07)

1 1994 - 1996 shown, other years not available on an annual basis.
2 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort, and the data are collected at the Southeast Fisheries Science Center (SEFSC).
3 The observer coverage and unit of effort for the Pelagic Drift Gillnet is a set.
4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). Because observer coverage increased substantially from 1994-1996, bycatch rates for this period are single year estimates.
5 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.8 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.1 animals.

Table 3. Summary for the undifferentiated complex of beaked whales which include Cuvier's Beak Whales (*Ziphius cavirostris*) and Mesoplodon beaked whales released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured)

Fishery	Years	Ratio	Injured[1]	Uninjured
Pelagic Drift Gillnet	92-96	1/9.7, 5/12, 4/4.8, 9/9.1, 8/13	0, 0, 0, 1[2] 0	0, 0, 0, 0, 0

1 Injured and released alive animals are not included in the Table 2 mortality estimates.
2 The observer recorded this animal being released alive and having the "gear in/around a single body part".

Other Mortality

From 1992-1996, 21 beaked whales (11(includes one tentative identification) -Gervais's beaked whales;2 -True's beaked whale; 1- Blainville's beaked whale; 6 -Cuvier's beaked whale- one 1996 animal showed signs of human interactions propeller marks) stranded along the U.S. Atlantic coast between Florida and Massachusetts (NMFS unpublished data).

STATUS OF STOCK

The status of Cuvier's beaked whale relative to OSP in U.S. Atlantic EEZ is unknown. This species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine population trends and the level of human-caused mortality and serious injury is unknown because of uncertainty regarding species identification in observed fisheries. If one were to assume that the incidental fisheries mortality of the four *Mesoplodon* spp. and *Z. cavirostris* was random with respect to species (i.e., in proportion to their relative abundance), then the minimum population estimate for all of those stocks would need to sum to at least 970 in order for an annual mortality of 9.7 animals not to exceed the PBR of any one of these species. Because an assumption of unselective incidental fishing mortality is probably overly optimistic and represents a best case situation, it is likely that a combined minimum population estimate of substantially greater than 970 would be necessary for an annual mortality of 9.7 to not exceed the PBR of any one of these five stocks. The largest recent abundance estimate available for beaked whales in the western North Atlantic was 1,519 (CV = 0.69) which would result in a minimum population estimate of 895 beaked whales; however, this estimate does not include a correction factor for submerged animals which may be substantial. Although a species specific PBR cannot be determined, the total fishery mortality and serious injury for this group is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because of uncertainty regarding stock size and evidence of fishery-related mortality and serious injury.

REFERENCES

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA, NMFS, SEFSC & NEFSC, 4 pp. Available from NEFSC, Woods Hole Laboratory, Woods Hole, MA.

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA. 5pp.

Anon. 1994. Cruise results, NOAA Ship RELENTLESS, Cruise No. RS 94-02, Marine Mammal Survey/Warm Core Ring Study. NOAA NMFS NEFSC Woods Hole Laboratory, Woods Hole, MA. 8pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S.T., D.R. Anderson, K.P. Burnham and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. *Chapman and Hall*, New York, NY, 442 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Heyning, J. E. 1989. Cuvier's beaked whale, *Ziphius cavirostris* G. Cuvier, 1823. Pages 289-308. *In*: S. H. Ridgway and R. Harrison (eds), *Handbook of Marine Mammals, Vol. 4: River dolphins and larger toothed whales*. *Academic Press*, London, 442 pp.

Houston, J. 1990. Status of Cuvier's Beaked Whale, *Ziphius cavirostris*, in Canada. *Can. Fld. Nat. 105(2): 215-218.*

Laake, J.L., S.T. Buckland, D.R. Anderson and K.P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado. 72pp.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Mead, J. G. 1984. Survey of reproductive data for the beaked whales (*Ziphiidae*). *Rep. int. Whal. Commn. Special Issue 6: 91-96.*

Mitchell, E. D. (editor). 1975. Review of the biology and fisheries for smaller cetaceans. Report of the meeting on smaller cetaceans. Int. Whal. Commn. *J. Fish. Res. Bd. Can. 32(7): 875-1240.*

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.) Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16*.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the Northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G.T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA NMFS NEFSC, Lab. Ref. Doc. No. 98-09, 21pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Waring, G.T., C.P. Fairfield, C.M. Ruhsam, and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES C.M. 1992/N:12 29 pp.*

MESOPLODON BEAKED WHALES (*Mesoplodon* spp.): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Within the genus Mesoplodon, there are four species of beaked whales that reside in the northwest Atlantic. These include True's beaked whale, *Mesoplodon mirus*; Gervais' beaked whale, *M. europaeus*; Blainville's beaked whale, *M. densirostris*; and Sowerby's beaked whale, *M. bidens*. These species are difficult to identify to the species level at sea; therefore, much of the available characterization for beaked whales is to genus level only. Stock structure for each species is unknown.

The distribution of *Mesoplodon* spp. in the northwest Atlantic is known principally from stranding records (Mead 1989). Off the northeast U.S. coast, beaked whale (*Mesoplodon* spp.) sightings have occurred principally along the southern edge of Georges Bank (CETAP, 1982; Waring *et al*. 1992; NMFS unpubl. data). Most sightings were in late spring and summer. In addition, beaked whales were also sighted in Gulf Stream features during NEFSC 1990-1995 surveys (Waring *et al*. 1992; Anon 1994; Tove 1995; NMFS unpubl. data).

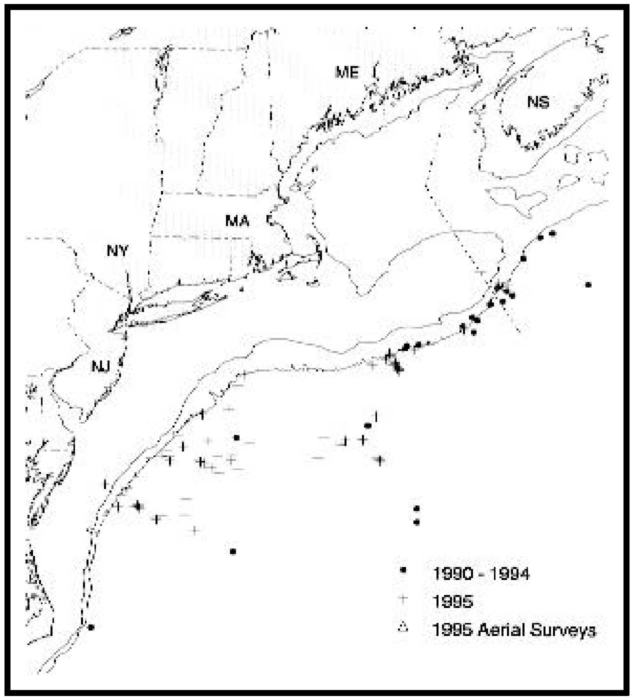

Figure 1. *Distribution of beaked whale sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

True's beaked whale is a temperate-water species that has been reported from Cape Breton Island, Nova Scotia, to the Bahamas (Leatherwood *et al*. 1976, Mead 1989). It is considered rare in Canadian waters (Houston 1990).

Gervais's beaked whales are believed to be principally oceanic, and strandings have been reported from the mid-Atlantic Bight to Florida, into the Caribbean and the Gulf of Mexico (Leatherwood *et al*. 1976; Mead 1989). This is the commonest species of *Mesoplodon* stranded along the U.S. Atlantic coast. The northernmost stranding was off New York (Mead 1989).

Blainville's beaked whales have been reported from southwestern Nova Scotia to Florida, and are believed to be widely but sparsely distributed in tropical to warm-temperate waters (Leatherwood *et al*. 1976; Mead 1989). There are two records of standings in Nova Scotia which probably represent strays from the Gulf Stream (Mead 1989). They are considered rare in Canadian waters (Houston 1990).

Sowerby's beaked whales have been reported from New England waters north to the ice pack, and individuals are seen along the Newfoundland coast in summer (Leatherwood *et al*. 1976; Mead 1989). Furthermore, a single stranding occurred off the Florida west coast (Mead 1989). This species is considered rare in Canadian waters (Lien *et al*. 1990).

POPULATION SIZE

The total number of *Mesoplodon* spp. beaked whales off the eastern U.S. coast is unknown. However, seven estimates of the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) are available from select regions of the habitat during summer 1978-82, August 1990, June-July 1991, August-September 1991, June-July 1993, August 1994, and July to September 1995 (Table 1; Figure 1).

A population size of 120 undifferentiated beaked whales (CV=0.71) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on summer data because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during this season. This estimate does not include corrections for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty (e.g., large CV), its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 442 (CV=0.51) undifferentiated beaked whales was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Table 1; Waring *et al.* 1992). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 262 (CV=0.99) undifferentiated beaked whales was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Table 1; Waring *et al.* 1992; Waring 1998). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but no corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 370 (CV=0.65) and 612 (CV=0.73) undifferentiated beaked whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Table 1; Anon. 1991). The study area included that covered in the CETAP study plus several additional continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. The data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993), where the CV was estimated using the bootstrap option. The abundance estimates do not include g(0) and were not pooled over platforms because the inter-platform calibration analysis has not been conducted.

A population size of 330 (CV=0.66) undifferentiated beaked whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 99 (CV=0.64) undifferentiated beaked whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (Table 1; Anon. 1994). Data were collected by two alternating teams that searched with 25x150 binoculars and an independent observer who searched by naked eye from a separate platform on the bow. Data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 1,519 (CV=0.69) undifferentiated beaked whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS unpubl. data). Total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques. Because the number of beaked whale sightings in each survey were extremely low (3 to 10), and their sightability and behavior preclude pooling with other cetaceans, the abundance estimates are based on small sample sizes. Therefore, the above abundance estimates should be viewed with caution.

Although the 1990-1995 surveys did not sample exactly the same areas or encompass the entire beaked whale habitat, they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The collective 1990-95 data suggest that, seasonally, at least several hundred beaked whales are occupying these waters, highest levels of abundance in the Georges Bank region. This is consistent with the earlier CETAP results. Recent results suggest that beaked whale abundance may be highest in association with Gulf Stream and warm-core ring features.

Because the estimates presented here were not dive-time corrected, they are likely negatively biased and probably underestimate actual abundance. Given that *Mesoplodon* spp. prefers deep-water habitats (Mead 1989) the bias may be substantial.

The best available current abundance estimate for the undifferentiated complex of beaked whales is 1,519 (CV=0.69) as estimated from the July to September 1995 line transect survey (NMFS unpubl. data) because this survey provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for the undifferentiated complex of beaked whales which include *Ziphius* and *Mesoplodon* spp. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
summer 1978-82	Cape Hatteras, NC to Nova Scotia	120	0.71
Aug 1990	Gulf Stream	442	0.51
Jun-Jul 1991	Cape Hatteras, NC to Georges Bank, shelf edge only	262	0.99
Aug-Sep 1991	Cape Hatteras, NC to Nova Scotia	370 and 612*	0.65 and 0.73*
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	330	0.66
Aug 1994	warm-core ring SE of Georges Bank	99	0.64
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	1,519	0.69

* from data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for undifferentiated beaked whales is 1,519 (CV=0.69). The minimum population estimate for the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 895 (CV=0.69). It is not possible to determine the minimum population estimate of only Mesoplodont beaked whales.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: length at birth is 2 to 3 m, length at sexual maturity 6.1 m for females, and

5.5 m for males, maximum age for females were 30 growth layer groups (GLG's) and for males was 36 GLG's, which may be annual layers (Mead 1984).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for the undifferentiated complex of beaked whales is 895 (CV=0.69). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for all species in the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 8.9. It is not possible to determine the PBR for only Mesoplodon beaked whales.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 1992-1996 total average estimated annual fishery-related mortality of beaked whales in the U.S. EEZ was 9.7 (CV = 0.07).

Fishery Information

There is no historical information available that documents incidental mortality in either U.S. or Canadian Atlantic coast fisheries (Read 1994).

Current data on incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993 the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and currently provides observer coverage of vessels fishing south of Cape Hatteras.

Total fishery-related mortality and serious injury cannot be estimated separately for each beaked whale species because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that any beaked whale stock which occurred in the U.S. Atlantic EEZ might have been subject to the observed fishery-related mortality and serious injury.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic trawl, New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, or North Atlantic bottom trawl observed fisheries.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 143, respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fishery information. Variances were estimated using bootstrap re-sampling techniques. By-catch of beaked whales has only occurred from Georges Canyon to Hydrographer Canyon along the continental shelf break and continental slope during July to October. Thirty-five fishery-related beaked whale mortalities were observed between 1989 and 1995. The estimated annual fishery-related mortality (CV in parentheses) was 60 in 1989 (0.21), 76 in 1990 (0.26), 13 in 1991 (0.21), 9.7 in 1992 (0.24), 12 in 1993 (0.16) 4.8 in 1994 (0.08), 9.1 in 1995 (0), and 13 in 1996 (0.12) (Table 2). Annual mortality estimates do not include any animals injured and released alive. The 1992-1996 total average estimated annual fishery-related mortality of beaked whales in the U.S. EEZ was 9.7 (CV = 0.07) (Table 2). The 1992-1996 period provides a better characterization of the current pelagic drift gillnet fishery. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Table 2. Summary of the incidental mortality for the undifferentiated complex of beaked whales which include Cuvier's beaked whale (*Ziphius cavirostris*), and *Mesoplodon* beaked whale, by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels [1]	Data Type [2]	Observer Coverage [3]	Observed Mortality	Estimated Mortality [4]	Estimated CVs [4]	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	1, 5, 4, 9, 8	9.7, 12, 4.8, 9.1[5] 13	.24, .16, .08, 0, .12	9.7 (.07)
TOTAL								9.7 (.07)

1 1994 - 1996 shown, other years not available on an annual basis.
2 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort, and the data are collected at the Southeast Fisheries Science Center (SEFSC).
3 The observer coverage and unit of effort for the Pelagic Drift Gillnet is a set.
4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). Because observer coverage increased substantially from 1994-1996, bycatch rates for this period are single year estimates.
5 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.8 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.1 animals.

Table 3. Summary for the undifferentiated complex of beaked whales which include Cuvier's Beak Whales (*Ziphius cavirostris*) and Mesoplodon beaked whales released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured)

Fishery	Years	Ratio	Injured[1]	Uninjured
Pelagic Drift Gillnet	92-96	1/9.7, 5/12, 4/4.8, 9/9.1, 8/13	0, 0, 0, 1[2] 0	0, 0, 0, 0, 0

1 Injured and released alive animals are not included in the Table 2 mortality estimates.
2 The observer recorded this animal being released alive and having the "gear in/around a single body part".

Other Mortality

From 1992-1996, 21 beaked whales (11(includes one tentative identification) -Gervais's beaked whales;2 -True's beaked whale; 1- Blainville's beaked whale; 6 -Cuvier's beaked whale- one 1996 animal showed signs of human interactions propeller marks) stranded along the U.S. Atlantic coast between Florida and Massachusetts (NMFS unpublished data).

STATUS OF STOCK

The status of Mesoplodont beaked whales relative to OSP in U.S. Atlantic EEZ is unknown. These species are not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine population trends and the level of human-caused mortality and serious injury is unknown because of uncertainty regarding species identification in observed fisheries. If one were to assume that the incidental fisheries mortality of the four *Mesoplodon* spp. and *Z. cavirostris* was random with respect to species (i.e., in proportion to their relative abundance), then the minimum population estimate for all of those stocks would need to sum to at least 970 in order for an annual mortality of 9.7 animals not to exceed the PBR of any one of these species. Because an assumption of unselective incidental fishing mortality is probably overly optimistic and represents a best case situation, it is likely that a combined minimum population estimate of substantially greater than 970 would be necessary for an annual mortality of 9.7 to not exceed the PBR of any one of these five stocks. The largest recent abundance estimate available for beaked whales in the western North Atlantic was 1,519 (CV = 0.69), which would result in a minimum population estimate of 895 beaked whales; however, this estimate does not include a correction factor for submerged animals which may be substantial. Although a species specific PBR cannot be determined, the total fishery mortality and serious injury for this group is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because of uncertainty regarding stock size and evidence of fishery-related mortality and serious injury.

REFERENCES

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA, NMFS, SEFSC & NEFSC, 4 pp. Available from NEFSC, Woods Hole Laboratory, Woods Hole, MA.

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA. 5 pp.

Anon. 1994. Cruise results, NOAA ship RELENTLESS, Cruise No. RS 9402, Marine Mammal Survey/Warm Core Ring Study. NOAA NMFS NEFSC Woods Hole Laboratory, Woods Hole, MA. 8pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S. T., D. R. Andersen, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. *Chapman and Hall*, New York, 446 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Houston, J. 1990. Status of Blainville's beaked whale, *Mesoplodon densirostris*, in Canada. *Can. Fld. Nat. 104(1): 117-120.*

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Lien J., F. Barry, K. Breeck, and U. Zuschlag. 1990. Status of Sowerby's Beaked Whale, *Mesoplodon bidens*, in Canada. *Can. Fld. Nat. 104(1): 125-130.*

Mead, J.G. 1984. Survey of reproductive data for the beaked whales (*Ziphiidae*). *Rep. int. Whal. Commn. Special Issue 6:91-96.*

Mead, J. G. 1989. Beaked whales of the genus *Mesoplodon*. Pages 349-430. *In:* S. H., Ridgway and R. Harrison (eds), Handbook of marine mammals, Vol. 4: River Dolphins and toothed whales. *Academic press*, San Diego, 442 pp.

Nicolas, J., A. Williams, G. Repucci. 1993. Observations of beaked whales (*Mesoplodon* spp.) in the western North Atlantic Ocean. Proceedings of the Tenth Biennial Conference on the Biology of Marine Mammals, Nov. 11-15, 1993, Galveston, TX (Abstract).

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.). Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16*.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the Northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Trove, M. 1995. Live sighting of *Mesoplodon* CF. *M. Mirus*, True's Beaked Whale. *Mar. Mamm. Sci. 11(1): 80-85.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G.T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA NMFS NEFSC, Lab. Ref. Doc. No. 98-09, 21pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Waring, G.T., C.P. Fairfield, C.M. Ruhsam, and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES C.M. 1992/N:12 29 pp.*

RISSO'S DOLPHIN (*Grampus griseus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Risso's dolphin is distributed worldwide in tropical and temperate seas. Risso's dolphins generally have an oceanic range, and occur along the Atlantic coast of North America from Florida to eastern Newfoundland (Leatherwood *et al*. 1976; Baird and Stacey 1990). Off the northeast U.S. coast, Risso's dolphin is distributed along the continental shelf edge from Cape Hatteras northward to Georges Bank during the spring, summer, and autumn (CETAP 1982; Payne *et al*. 1984). In winter, the range begins at the mid-Atlantic bight and extends further into oceanic waters (Payne *et al*. 1984). In general, the population occupies the mid-Atlantic continental shelf edge year round, and is rarely seen in the Gulf of Maine (Payne *et al*. 1984). During 1990, 1991 and 1993, spring/summer surveys conducted in continental shelf edge and deeper oceanic waters had sightings of Risso's dolphins associated with strong bathymetric features, Gulf Stream warm-core rings, and the Gulf Stream north wall (Waring *et al*. 1992; Waring 1993). There is no information on stock differentiation of Risso's dolphin in the western North Atlantic.

POPULATION SIZE

The total number of Risso's dolphins off the eastern U.S. and Canadian Atlantic coast is unknown, although four estimates are available from selected regions during spring and summer 1978-82, June-July 1991, August-September 1991, and June-July 1993.

A population size of 4,980 (CV = 0.34) Risso's dolphins was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on an inverse variance weighted pooling of spring and summer data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

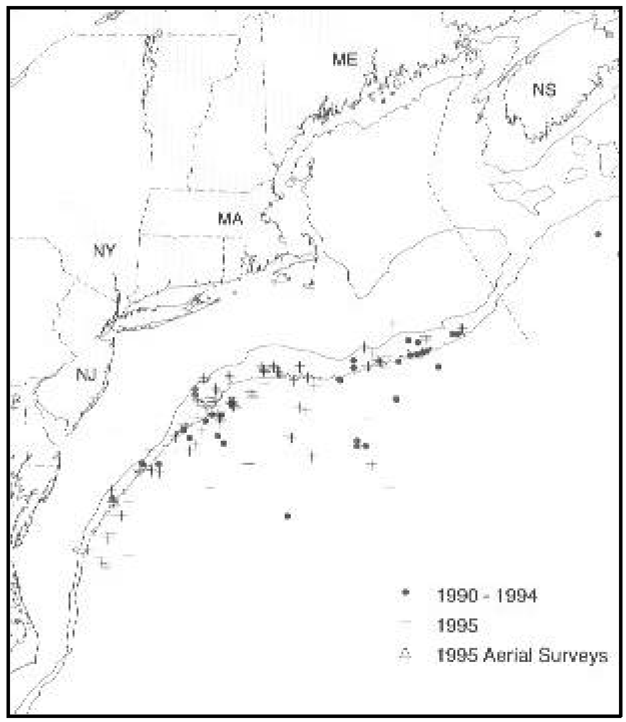

Figure 2. Distribution of Risso's dolphin sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100m and 1,000 m.

A population size of 11,017 (CV=0.58) Risso's dolphins was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000m isobaths from Cape Hatteras to Georges Bank (Table 1; Waring *et al.* 1992; Waring 1998). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but no corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 6,496 (CV=0.74) and 16,818 (CV=0.52) Risso's dolphins was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Table 1; Anon. 1991). The study area included that covered in the CETAP study plus several additional continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. The data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993), where the CV was estimated using the bootstrap option. The abundance estimates do not include g(0) and were not pooled over platforms because the inter-platform calibration analysis has not been conducted.

A population size of 212 (CV=0.62) Risso's dolphins was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

The few Risso's dolphin sightings made during August 1990 and 1994 were widely scattered, and therefore were not used to obtain abundance estimates. It should be noted, however, that nearly all of the sightings in these two years were in deeper oceanic waters (Waring 1993; Anon. 1994).

A population size of 5,587 (CV=1.16) Risso's dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS unpublished data). Total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques.

Although the 1991, 1993, and 1995 surveys did not sample exactly the same areas or encompass the entire Risso's dolphin habitat, they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The collective data suggest that at least several thousand Risso's dolphins occupy these waters seasonally; however, survey coverage to date was not judged adequate to provide a definitive estimate of Risso's dolphin abundance in the western North Atlantic.

The best available current abundance estimate for Risso's dolphins is 16,818 (CV=0.52) as estimated from the August to September 1991 aerial line transect survey in the AT-11 because this survey provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for the western North Atlantic Risso's dolphin. Month, year, and area covered during each abundance survey, resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring & summer 1978-82	Cape Hatteras, NC to Nova Scotia	4,980	0.34
Jun-Jul 1991	Cape Hatteras, NC to Georges Bank, shelf edge only	11,017	0.58
Aug-Sep 1991	Cape Hatteras, NC to Nova Scotia	6,496 and 16,818*	0.74 and 0.52*
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	212	0.62
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	5587	1.16

* from data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for Risso's dolphins is 16,818 (CV=0.52). The minimum population estimate for the western North Atlantic Risso's dolphin is 11,140 (CV=0.52).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 11,140 (CV=0.52). The maximum productivity rate is 0.04 , the default value for cetaceans (Barlow *et al*. 1995). The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic Risso's dolphin is 111.

ANNUAL HUMAN-CAUSED MORTALITY

Total annual estimated average fishery-related mortality to this stock during 1992-1996 was 18 Risso's dolphins (CV = 0.17; Table 2).

Fishery Information

Prior to 1977, there was no documentation of marine mammal by-catch in distant-water fleet (DWF) activities off the northeast coast of the U.S. With implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) in that year, an observer program was established which has recorded fishery data and information of incidental by-catch of marine mammals. DWF effort in the U.S. Atlantic Exclusive Economic Zone (EEZ) under MFCMA has been directed primarily towards Atlantic mackerel and squid. From 1977 through 1982, an average of 120 different foreign vessels per year (range 102-161) operated within the U.S. Atlantic EEZ. In 1982, there were 112 different foreign vessels; 16%, or 18, were Japanese tuna longline vessels operating along the U.S. east coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. Between 1983 and 1991, the numbers of foreign vessels operating within U.S. Atlantic EEZ each year were 67, 52, 62, 33, 27, 26, 14, 13, and 9, respectively. Between 1983 and 1988, the numbers of DWF vessels included 3, 5, 7, 6, 8, and 8, respectively, Japanese longline vessels. Observer coverage on DWF vessels was 25-35% during 1977-82, and increased to 58%, 86%, 95%, and 98%, respectively, in 1983-86. From 1987-91, 100% observer coverage was maintained. Foreign fishing operations for squid and mackerel ceased at the end of the 1986 and 1991 fishing seasons, respectively. NMFS foreign-fishery observers have reported four deaths of Risso's dolphins incidental to squid and mackerel fishing activities in the continental shelf and continental slope waters between March 1977 and December 1991 (Waring *et al*. 1990; NMFS unpublished data). Three animals were taken by squid trawlers and a single animal was killed in longline fishing operations.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, pelagic pair trawl fishery, and pelagic longline fishery, but no mortalities or serious injuries have been documented in the New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, or North Atlantic bottom trawl observed fisheries.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10 and 12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fishery information. Variances were estimated using bootstrap re-sampling techniques. Forty two Risso's dolphin mortalities were observed between 1989 and 1996. One animal was entangled and released alive. By-catch occurred during July, September and October along continental shelf edge canyons off the southern New England coast. Estimated annual mortality and serious injury (CV in parentheses) attributable to the drift gillnet fishery was 87 in 1989 (0.52), 144 in 1990 (0.46), 21 in 1991 (0.55), 31 in 1992 (0.27), 14 in 1993 (0.42), 1.5 in 1994 (0.16), 6 in 1995 (0), and 0 in 1996. The 1992-1996 total average estimated annual fishery-related mortality of Risso's dolphins in the U.S. EEZ was 10.5 (CV = 0.20) (Table 2). The 1992-1996 period provides a better characterization of the current pelagic drift gillnet fishery. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Pelagic Pair Trawl

Effort in the pelagic pair trawl fishery increased during the period 1989 to 1993, from zero hauls in 1989 and 1990, to an estimated 171 hauls in 1991, and then to an estimated 536 hauls in 1992, 586 in 1993, 407 in 1994, and 440 in 1995, respectively. This fishery ceased operations in 1996, when NMFS rejected a petition to consider pair trawl gear as an authorized gear type in Atlantic tunas fishery. The fishery operated from August-November in 1991, from June-November in 1992, from June-October in 1993 (Northridge 1996), and from mid-summer to November in 1994 and 1995. Sea sampling began in October 1992 (Gerrior *et al*. 1994), and 48 sets (9% of the total) were sampled in that season, 102 hauls (17% of the total) were sampled in 1993. In 1994 and 1995, 52% (212) and 55% (238), respectively, of the sets were observed. Nineteen vessels have operated in this fishery. The fishery extends from 35ºN to 41ºN, and from 69°W to 72°W. Approximately 50% of the total effort was within a one degree square at 39ºN, 72ºW, around Hudson Canyon. Examination of the locations and species composition of the by-catch, showed little seasonal change for the six months of operation and did not warrant any seasonal or areal stratification of this fishery (Northridge 1996). One mortality was observed in 1992. Estimated annual fishery-related mortality (CV in parentheses) was 0.6 dolphins in 1991 (1.0), 4.3 in 1992 (0.76), 3.2 in 1993 (1.0), 0 in 1994 and 3.7 in 1995 (0.45). The 1992-1995 estimated mean annual Risso's dolphin mortality attributable to this fishery is 2.8 (CV= 0.44) (Table 2). Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

During the 1994 and 1995 experimental fishing seasons, fishing gear experiments were conducted to collect data on environmental parameters, gear behavior, and gear handling practices to evaluate factors affecting catch and bycatch (Goudy 1995, 1996). Results of these studies were inconclusive in identifying factors responsible for marine mammal bycatch.

Pelagic Longline

Total effort for the pelagic longline fishery, based on mandatory self-reported fishery information, was 11,279 sets in 1991, 10,605 sets in 1992, 11,538 sets in 1993 11,231 sets in 1994, and 12,713 in 1995 (Cramer 1994; Scott and Brown 1997). The fishery has been observed from January to March off Cape Hatteras, in May and June in the entire Mid-Atlantic, and in July through December in the Mid-Atlantic Bight and off Nova Scotia. This fishery has been monitored with about 5% observer coverage, in terms of trips observed, since 1992. Most of the estimated marine mammal by-catch was from EEZ waters between South Carolina and Cape Cod. From 1992-1995 two mortalities were observed, one each in 1993 and 1994 (Cramer 1994; Scott and Brown 1997) (Table 2). Estimated annual fishery-related mortality (CV in parentheses) was 0 in 1992 (0), 13 in 1993 (0.19), 7 in 1994 (1.0) and 0 in 1995 (0). The 1992-1995 estimated mean annual Risso's dolphin mortality attributable to this fishery is 5.0 (CV= 0.37) (Table 2). Injured and released alive animals are not included in the Table 2 mortality estimates. Total average annual total fishery-related mortality is 18.3 Risso's dolphins (CV = 0.17).

Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Table 2. Summary of the incidental mortality of Risso's dolphin (*Grampus griseus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated[5] Mortality	Estimated CVs	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12[3] 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	15, 1, 1, 6, 0	31, 14, 1.5 6[4], 0	.27, .42, .16, 0, 0	10.5 (.20)
Pelagic Pair Trawl	92-95	12	Obs. Data Logbook	.10, .18, .52, .54	1, 0, 0, 2	4.3, 3.2, 0, 3.7	.76, 1.0, 0, .45	2.8 (.44)
Longline	92-95		Obs. Data Logbook	.05	0, 1, 1, 0	0, 13, 7, 0	0, .19, 1.0, 0	5.0 (.37)
TOTAL								18.3 (.17)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects weighout (Weighout) landings data, and total landings are used as a measure of total effort for the coastal gillnet fishery and days fished are used as total effort for the North Atlantic bottom trawl fishery. Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).

2 The observer coverage for the pelagic drift gillnet and pair trawl fishery is measured in terms of sets, and the North Atlantic bottom trawl fishery is in days fished. Assessments for the coastal gillnet fishery have not been completed. The number of trips sampled by the NEFSC Sea Sampling Program are reported here.

3 1994 -1996 shown, other years not available on an annual basis.

4 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.42 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.03 animals.

[5] Injured and released alive animals are not included in the Table 2 mortality estimates.

Table 3. Summary of Risso's dolphin (*Grampus griseus*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured)

Fishery	Years	Ratio	Injured[2]	Uninjured
Pelagic Longline	92-95	0, 1/13, 1/7, 0	0, 0, 6 [1], 2[1]	0, 0, 0, 2[1]

1 Summary of observer comments for each animal as reported in Scott and Brown (1997): 1994 Trip A44004 (2 animals)- released alive, hooked in dorsal fin; mainline wrapped around body immediately adjacent to flukes; #2 released alive, hooked in tail fluke and mainline; gear cut to release animal, swam away with mainline and leader around tail; TripA53037 - released alive; gear wrapped around animal, cut loose by crew, swam away quickly; Trip A62002 (3 animals)- a good amount of mainline was tangled around animal, released with a fair amount of mainline around fluke, some blood noticed around caudal peduncle; #2 hooked in mouth, animal released with hook in mouth and approximately 7 fathoms of 400 lb test line trailing from mouth; #3 apparently hooked in mouth, appeared to be wound up the midsection of the body with line, animal swam off quite sluggishly. 1995 Trip A411031 - hooked in mouth, gangion cut to free animal, alive; Trip #A44040 - alive, mainline and gangion wrapped around tail, all gear cut before animal released; Trip 62058 - gear cut from animal, alive; Trip A41032 - mouth hooked, line snapped and animal swam off; Trip A44043 - #1 mainline cut from around tail flukes and pulled from mouth, animal swam sway quickly; #2 mainline cut from around tail flukes, animal swam off slowly after blowing.

2 Injured and released alive animals are not included in the Table 2 mortality estimates.

Other mortality

From 1995-1996, three Risso's dolphins stranding were recorded along the Atlantic coast (NMFS unpublished data).

STATUS OF STOCK

The status of Risso's dolphins relative to OSP in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. The total fishery mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate. The 1992-1996 average annual fishery-related mortality did not exceed PBR; therefore, this is not a strategic stock.

REFERENCES

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA, NMFS, SEFSC & NEFSC, 4 pp. Available from NEFSC, Woods Hole Laboratory, Woods Hole, MA.

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA. 5 pp.

Anon. 1994. Cruise results, NOAA ship RELENTLESS, Cruise No. RS 9402, Marine Mammal Survey/Warm Core Ring Study. NOAA NMFS NEFSC Woods Hole Laboratory, Woods Hole, MA. 8 pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Baird, R. W. and P. J. Stacey. 1990. Status of Risso's dolphin, *Grampus griseus*, in Canada. *Can. Fld. Nat. 105:233-242*.

Buckland, S.T., D.R. Anderson, K.P. Burnham and S.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. *Chapman and Hall,* New York, NY, 446 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Gerrior, P., A.S. Williams, and D.J. Christensen. 1994. Observations of the 1992 U.S. pelagic pair trawl fishery in the northwest Atlantic. *U.S. Mar. Fish. Rev. 56(3): 24-27.*

Goudy, C.A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic, MITSG 95-6,Cambridge, MA. 10 pp.

Goudy, C.A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic, MITSG 95-6, Cambridge, MA. 13 pp.

Laake, J.L., S.T. Buckland, D.R. Anderson and K.P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado. 72pp.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.). Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16.*

Payne, P. M., L. A. Selzer and A. R. Knowlton. 1984. Distribution and density of cetaceans, marine turtles, and seabirds in the shelf waters of the northeastern United States, June 1980-December 1983, based on shipboard observations. NOAA/NMFS Contract No. NA-81-FA-C-00023.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Scott, G.P. and C.A. Brown. 1997. Estimates of marine mammal and marine turtle catch by the US Atlantic pelagic longline fleet in 1994-1995. Miami Laboratory Contribution MIA-96/97-28

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G.T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA NMFS NEFSC, Lab. Ref. Doc. No. 98-09, 21pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Waring, G. T. 1993. Spatial patterns of six cetaceans along a linear habitat. Proceedings of the Tenth Biennial Conference on the Biology of Marine Mammals, Nov. 11-15, 1993, Galveston, TX (Abstract).

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES Marine Mammals Comm. CM 1992/N:12, 29 pp.*

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988, *Fish. Bull., U.S., 88:347-360.*

LONG-FINNED PILOT WHALE (*Globicephala melas*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two species of pilot whales in the Western Atlantic — the Atlantic or long-finned pilot whale, *Globicephala melas*, and the short-finned pilot whale, *G. macrorhynchus*. These species are difficult to identify to the species level at sea; therefore, some of the descriptive material below refers to *Globicephala* sp., and is identified as such. The species boundary is considered to be in the New Jersey to Cape Hatteras area. Sightings north of this area are likely *G. melas*.

Pilot whales (*Globicephala* sp.) are distributed principally along the continental shelf edge in the winter and early spring off the northeast U.S. coast, (CETAP 1982; Payne and Heinemann 1993). In late spring, pilot whales move onto Georges Bank and into the Gulf of Maine and more northern waters, and remain in these areas through late autumn (CETAP 1982; Payne and Heinemann 1993). In general, pilot whales generally occupy areas of high relief or submerged banks. They are also associated with the Gulf Stream north wall and thermal fronts along the continental shelf edge (Waring *et al.* 1992; NMFS unpubl. data).

The long-finned pilot whale is distributed from North Carolina to Iceland and possibly the Baltic Sea (Sergeant 1962; Leatherwood *et al*. 1976; Abend 1993). The stock structure of the North Atlantic population is currently unknown (Anon. 1993a); however, several recently initiated genetic studies and proposed North Atlantic sighting surveys will likely provide information required to delineate stock boundaries.

POPULATION SIZE

The total number of long-finned pilot whales off the eastern U.S. and Canadian Atlantic coast is unknown, however, eight estimates are available (Table 1; Figure 1). Two estimates were derived from catch data and population models that estimated the abundance of the entire stock. Six seasonal estimates are available from selected regions in U.S. waters during spring, summer and autumn 1978-82, August 1990, June-July 1991, August-September 1991, June-July 1993, and July-September 1995. Because long-finned and short-finned pilot whales are difficult to identify at sea, seasonal abundance estimates were reported for *Globicephala* sp., both long-finned and short-finned pilot whales.

Mitchell (1974) used cumulative catch data from the 1951-61 drive fishery off Newfoundland to estimate the initial population size (ca. 50,000 animals).

Mercer (1975), used population models to estimate a population in the same region of between 43,000-96,000 long-finned pilot whales, with a range of 50,000-60,000 being considered the best estimate.

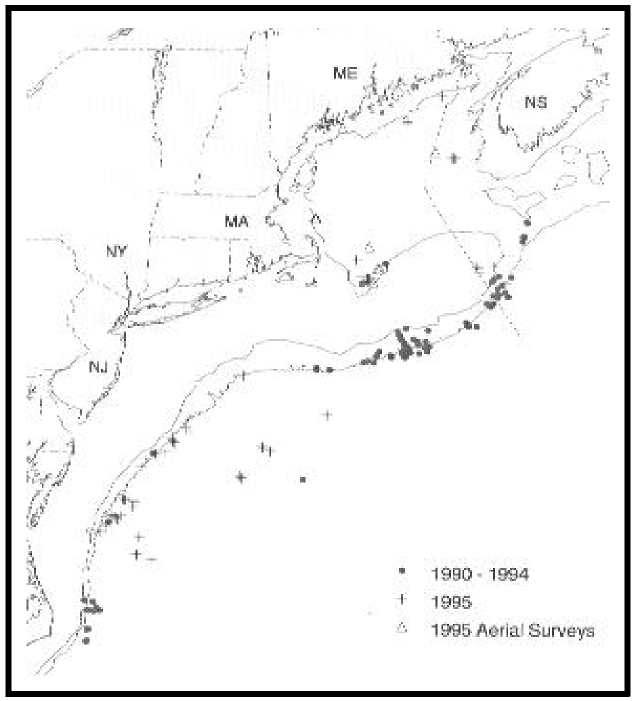

Figure 1. *Distribution of pilot whale sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

A population size of 11,120 (CV=0.29) *Globicephala* sp. was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on an inverse variance weighted pooling of spring, summer and autumn data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty , its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 1,043 (CV=0.78) *Globicephala* sp. was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Table 1; Waring *et al.* 1992). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 3,636 (CV = 0.36) *Globicephala* sp. was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000 m isobaths from Cape Hatteras to Georges Bank (Table 1; Waring *et al.* 1992; Waring 1998). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but no corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 3,668 (CV=0.28) and 5,377 (CV=0.53) *Globicephala* sp. was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Table 1; Anon. 1991). The study area included that covered in the CETAP study plus several additional continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. The data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993), where the CV was estimated using the bootstrap option. The abundance estimates do not include g(0) and were not pooled over platforms because the inter-platform calibration analysis has not been conducted.

A population size of 668 (CV=0.55) *Globicephala* sp. was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000 m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993b). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 8,176 (CV=0.65) *Globicephala* sp. was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS unpubl. data.). Total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques.

Although the 1990-1995 surveys did not sample the same areas or encompass the entire pilot whale habitat, they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The collective 1990-95 data suggest that, seasonally, at least several thousand pilot whales are occupying these waters; however, survey coverage to date is not judged adequate to provide a definitive estimate of pilot whale abundance in the western North Atlantic.

The best available current abundance estimate for *Globicephala* sp. is 8,176 (CV=0.65) as estimated from the July to September 1995 line transect survey (NMFS unpubl. data.) because this survey is recent and provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for the western North Atlantic *Globicephala* sp. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV). Unk=unknown.

Month/Year	Area	N_{best}	CV
1951-1961	Newfoundland	50,000	None reported
1951-1961	Newfoundland	50,000-60,000	None reported
spring, summer & autumn 1978-82	Cape Hatteras, NC to Nova Scotia	11,120	0.29
Aug 1990	Gulf Stream	1,043	0.78
Jun-Jul 1991	Cape Hatteras, NC to Georges Bank, shelf edge only	3,636	0.36
Aug-Sep 1991	Cape Hatteras, NC to Nova Scotia	3,668 and 5,377*	0.28 and 0.53*
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	668	0.55
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	8,176	0.65

* from data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for *Globicephala* sp. is 8,176 (CV=0.65). The minimum population estimate for *Globicephala* sp. is 4,968 (CV=0.65).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include those from animals taken in the Newfoundland drive fishery: calving interval 3.3 years; lactation period about 21-22 months; gestation period 12 months; births mainly from June to November; length at birth is 177 cm; mean length at sexual maturity, 490 cm, males; and 356 cm, females; age at sexual maturity is 12 years for males and 6 years for females, and mean adult length is 557 cm for males and 448 cm for females; and maximum age was 40 for males, and 50 for females (Sergeant 1962; Kasuya *et al*. 1988). Analysis of data recently collected from animals taken in the Faroe Islands drive fishery produced higher values for all parameters (Bloch *et al*. 1993; Desportes *et al*. 1993; Martin and Rothery 1993). These differences are likely related, at least in part, to larger sample sizes and newer analytical techniques.

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for *Globicephala* sp. is 4,968 (CV=0.65). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is 0.50 because this stock is of unknown status (Wade and Angliss 1997). PBR for the western North Atlantic *Globicephala* sp. is 50.

ANNUAL HUMAN-CAUSED MORTALITY

Total annual estimated average fishery-related mortality to this stock during 1992-1996 was 32 pilot whales (CV = 0.09; Table 2).

Fishery Information

USA

Prior to 1977, there was no documentation of marine mammal by-catch in distant-water fleet (DWF) activities off the northeast coast of the U.S. A fishery observer program, which has collected fishery data and information on incidental by-catch of marine mammals, was established in 1977 with the implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA). DWF effort in the Atlantic coast EEZ under MFCMA has been directed primarily towards Atlantic mackerel and squid. An average of 120 different foreign vessels per year (range 102-161) operated within the Atlantic coast EEZ during 1977 through 1982. In 1982, there were 112 different foreign vessels; 18 (16%) were Japanese tuna longline vessels operating along the U.S. Atlantic coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. The number of foreign vessels operating within the U.S. Atlantic EEZ each year between 1983 and 1991 averaged 33 and ranged from nine to 67. The number of Japanese longline vessels included among the DWF vessels averaged six and ranged from three to eight between 1983 and 1988. MFCMA observer coverage on DWF vessels was 25-35% during 1977-82, increased to 58%, 86%, 95%, and 98%, respectively, during 1983-86, and 100% observer coverage was maintained from 1987-91. Foreign fishing operations for squid ceased at the end of the 1986 fishing season and, for mackerel, at the end of the 1991 fishing season.

During 1977-1991, observers in this program recorded 436 pilot whale mortalities in foreign-fishing activities (Waring *et al*. 1990; Waring 1995). A total of 391 (90%) were taken in the mackerel fishery, and 41 (9%) occurred during *Loligo* and *Illex* squid-fishing operations. This total includes 48 documented takes by U.S. vessels involved in joint venture fishing operations in which U.S. captains transfer their catches to foreign processing vessels. Due to temporal fishing restrictions, the by-catch occurred during winter/spring (December to May) in continental shelf and continental shelf edge waters (Fairfield *et al*. 1993; Waring 1995); however, the majority of the takes occurred in late spring along the 100 m isobath. Two animals were also caught in both the hake fishery and tuna longline fisheries (Waring *et al*. 1990).

The distribution of long-finned pilot whale, a northern species, overlaps with that of the short-finned pilot whale, a predominantly southern species, between 35°30'N to 38°00'N (Leatherwood *et al*. 1976). Although long-finned pilot whales are most likely taken in the waters north of Delaware Bay, many of the pilot whale takes are not identified to species and by-catch does occur in the overlap area. In this summary, therefore, long-finned pilot whales (*Globicephala melas*) and unidentified pilot whales (*Globicephala* sp.) are considered together.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet, pelagic longline, and pelagic pair trawl fisheries, but no mortalities or serious injuries have documented in the New England multispecies sink gillnet or mid-Atlantic coastal sink gillnet.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fishery information. Variances were estimated using bootstrap re-sampling techniques. Between 1989 and 1995, sixty -eight mortalities were observed in the large pelagic drift gillnet fishery. The annual fishery-related mortality (CV in parentheses) was 77 in 1989 (0.24), 132 in 1990 (0.24), 30 in 1991 (0.26), 33 in 1992 (0.16), 31 in 1993 (0.19), 20 in 1994 (0.06), 9.1 in 1995 (0), and 11 in 1996 (.17); average annual mortality between 1992-1996 was 20.8 pilot whales (0.08) (Table 2). The 1992-1996 period provides a better characterization of this fishery (i.e., fewer vessels and increased observer coverage). Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery. Because animals released alive may have subsequently died due to injuries received during entanglement, pilot whales that were released were included in the mortality estimates. Pilot whales were taken along the continental shelf edge, northeast of Cape Hatteras in January and February. Takes were recorded at the continental shelf edge east of Cape Charles, Virginia, in June. Pilot whales were taken from Hydrographer Canyon along the Great South Channel to Georges Bank from July-November. Takes occurred at the Oceanographer Canyon continental shelf break and along the continental shelf northeast of Cape Hatteras in October-November.

Pelagic Pair Trawl

Effort in the pelagic pair trawl fishery has increased during the period 1989 to 1993, from zero hauls in 1989 and 1990, to an estimated 171 hauls in 1991, and then to an estimated 536 hauls in 1992, 586 in 1993, 407 in 1994, and 440 in 1995, respectively. This fishery ceased operations in 1996, when NMFS rejected a petition to consider pair trawl gear as an authorized gear type in Atlantic tunas fishery. The fishery operated from August-November in 1991, from June-November in 1992, from June-October in 1993, and from mid-summer to November in 1994 and 1995. Sea sampling began in October 1992 (Gerrior *et al*. 1994), and 48 sets (9% of the total) were sampled in that season, 102 hauls (17% of the total) were sampled in 1993. In 1994 and 1995, 52% (212) and 54% (238), respectively, of the sets were observed. Twelve vessels have operated in this fishery. The fishery extends from 35ºN to 41ºN, and from 69°W to 72°W. Approximately 50% of the total effort was within a one degree square at 39ºN, 72ºW, around Hudson Canyon. Examination of the locations and species composition of the by-catch, showed little seasonal change for the six months of operation and did not warrant any seasonal or areal stratification of this fishery (Northridge 1996). Five pilot whale (*Globicephala* sp.) mortalities were reported in the self-reported fishery information in 1993. In 1994 and 1995 observers reported one and twelve mortalities, respectively (Table 2). The estimated fishery-related mortality to pilot whales in the U.S. Atlantic attributable to this fishery in 1994 was 2.0 (CV=0.49) and 22 (CV=0.33) in 1995. The average mortality between 1992 and 1995 was 6 (CV=0.31) for this fishery. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

During the 1994 and 1995 experimental fishing seasons, fishing gear experiments were conducted to collect data on environmental parameters, gear behavior, and gear handling practices to evaluate factors affecting catch and bycatch (Goudy 1995, 1996). Results of these studies were inconclusive in identifying factors responsible for marine mammal bycatch.

Pelagic Longline

The pelagic longline fishery operates in the U.S. Atlantic (including Caribbean) and Gulf of Mexico EEZ (SEFSC unpublished data). Interactions between the pelagic longline fishery and pilot whales have been reported; however, a vessel may fish in more than one statistical reporting area and it is not possible to separate estimates of fishing effort other than to subtract Gulf of Mexico effort from Atlantic fishing effort, which includes the Caribbean Sea. This fishery has been monitored with about 5% observer coverage, in terms of trips observed, since 1992. Total effort for the pelagic longline fishery (Atlantic, including the Caribbean), based on mandatory self-reported fishery information, was 11,279 sets in 1991, 10,605 sets in 1992, 11,538 in 1993, 11,231 sets in 1994, and 12,713 in 1995 (Cramer 1994; Scott and Brown 1997). The fishery has been observed nearly year round within every statistical reporting area within the EEZ and beyond. Most of the estimated marine mammal by-catch was from EEZ waters between South Carolina and Cape Cod. Pilot whales are frequently observed to feed on hooked fish, particularly big-eye tuna (NMFS unpublished data). Between 1990-1995 fifty-four pilot whales (including one identified as a short-fin pilot whale) were released alive, and one mortality was observed. January-March by-catch was concentrated on the continental shelf edge northeast of Cape Hatteras. By-catch was recorded in this area during April-June, and takes also occurred north of Hydrographer Canyon off the continental shelf in water over 1,000 fathoms during April-June. During the July-September period, takes occurred on the continental shelf edge east of Cape Charles, Virginia, and on Block Canyon slope in over 1,000 fathoms of water. October-December by-catch occurred along the 20 to 50 fathom contour lines between Barnegat Bay and Cape Hatteras. The 1990-1993, estimated take was based on a generalized linear model (Poisson error assumption) fit to the available observed incidental take and self-reported incidental take and effort data for the fishery (SEFSC unpublished data). The 1994-1995 estimates were based on the Delta-lognormal method (details in Scott and Brown 1997). The estimated fishery-related mortality to pilot whales in the U.S. Atlantic attributable to this fishery was: 22 in 1992 (CV = 0.23), and zero in 1993-1995; average annual mortality between 1992-1995 was 5.5 pilot whales (0.23) (Table 2). Injured and released alive animals are not included in the Table 2 mortality estimates. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Bluefin Tuna Purse Seine

The tuna purse seine fishery between Cape Hatteras and Cape Cod is directed at small and medium bluefin and skip jack for the canning industry, while north of Cape Cod purse seine vessels are directed at large medium and giant bluefin tuna (NMFS, 1995). The latter fishery is entirely separate from any other Atlantic tuna purse seine fishery. Spotter aircraft are used to locate fish schools. The official start date is August 15, set by regulation. Individual vessel quotas (IVQs) and a limited access system prevent a derby fishery situation. Catch rates are high with this gear and consequently, the season usually only lasts a few weeks for large mediums and giants. The 1996 regulations allocated 250 MT (5 IVQs) with a minimum of 90% giants and 10% large mediums. Limited observer data are available for the bluefin tuna purse seine fishery. Out of 45 total trips made in 1996, 43 trips (95.6%) were observed. Forty-four sets were made on the 43 observed trips and all sets were observed. A total of 136 days were covered. Two interactions with pilot whales were observed in 1996. In one interaction, the net was actually pursed around one pilot whale, the rings were released and the animal escaped alive, condition unknown. This set occurred east of the Great South Channel and just north of the Cultivator Shoals region on Georges Bank. In a second interaction, five pilot whales were encircled in a set. The net was opened prior to pursing to let the whales swim free, apparently uninjured. This set occurred on the Cultivator Shoals region on Georges Bank.

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under the MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 (CV = 0.04) vessels (full and part time) participated annually in the fishery during 1989-1993. The fishery is active in New England in all seasons. One mortality was documented in 1990 and one animal was released alive and uninjured in 1993. In 1997 one decomposed pilot whale was taken in the mid-Atlantic region. The animal was clearly dead prior to being taken by the trawl, because it was severely decomposed and the tow duration of 3.3. hours was insufficient to allow extensive decomposition; therefore, there is no estimated bycatch for this fishery. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Atlantic Squid, Mackerel, Butterfish Trawl

The mid-Atlantic mackerel and squid trawl fisheries were combined into the Atlantic mid-water trawl fishery in the revised proposed list of fisheries in 1995. The fishery occurs along the U.S. mid-Atlantic continental shelf region between New Brunswick, Canada, and Cape Hatteras year around. The mackerel trawl fishery was classified as a

Category II fishery since 1990 and the squid fishery was originally classified as a Category II fishery in 1990, but was reclassified as a Category III fishery in 1992. The combined fishery was reclassified as a Category II fishery in 1995. In 1996, mackerel, squid, and butterfish trawl fisheries were combined into the Atlantic squid, mackerel, butterfish trawl fishery, and maintained a Category II classification. Three fishery-related mortality of pilot whales were reported in self-reported fishery information from the mackerel trawl fishery between 1990-1992. One mortality was observed in the 1996 *Illex* squid fishery. The effort data for this fishery are currently under review. Total fishery-related mortality and serious injury cannot be estimated separately for the two species of pilot whales in the U.S. Atlantic EEZ because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that either species might have been subject to the observed fishery-related mortality and serious injury. Total estimated annual fishery-related mortality of pilot whales from NMFS-observed fisheries was the sum of integer-rounded annual mortality estimates across the pelagic longline (1992-1995), pelagic drift gillnet (1992-1996), pelagic pair trawl (1992-1995), and was 32 pilot whales, *Globicephala* sp. (CV = 0.32) (Table 2).

CANADA

An unknown number of pilot whales have also been taken in Newfoundland and Labrador, and Bay of Fundy, groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, and Atlantic Canada cod traps (Read 1994). The Atlantic Canadian and Greenland salmon gillnet fishery is seasonal, with the peak from June to September, depending on location. In southern and eastern Newfoundland, and Labrador during 1989, 2,196 nets 91 m long were used. There are no effort data available for the Greenland fishery; however, the fishery was terminated in 1993 under an agreement between Canada and North Atlantic Salmon Fund (Read 1994).

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

Between January 1993 and December 1994, 36 Spanish deep water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211sets), were observed in NAFO Fishing Area 3 (off the Grand Bank) (Lens 1997). A total of 47 incidental catches were recorded, which included one long-finned pilot whale. The incidental mortality rate for pilot whales was (0.007/set).

Table 2. Summary of the incidental mortality of pilot whales (*Globicephala sp*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type[1]	Observer Coverage[2]	Observed Mortality	Estimated[7] Mortality	Estimated CVs	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12[3] 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	14, 11[4], 17, 9, 7	33, 31, 20, 9.1[5], 11	.16, .19, .06, 0, .17	20.8 (.08)
Pelagic Pair Trawl	92-95	12	Obs. Data Logbook	.09, .17, .52, .54	0, 0[6], 1, 12	0, 0, 2, 22	0, 0, .49, .33	6.0 (.31)
Atlantic squid, mackerel, butterfish trawl	96	NA	Obs. Data Logbook	.007	1	NA	NA	NA
Longline	92-95		Obs. Data Logbook	.05	1, 0, 0, 0	22, 0, 0, 0	.23, 0, 0, 0	5.5 (.23)
TOTAL								32 (.09)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet and longline fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).

2 Observer coverage for the pelagic drift gillnet, pair trawl and longline fishery are in terms of sets.

3 1994 and 1995 shown, other years not available on an annual basis.

4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). In 1994 and 1995, observer coverage increased substantially, and bycatch rates were not pooled for this period.

5 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.84 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.06 animals.

6 In 1993, 5 pilot whales were taken on a tow without an observer. An estimate could not be made based on unobserved tows.

7 Annual mortality estimates do not include any animals injured and released alive.

Table 3. Summary of pilot whales (*Globicephala sp*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured).

Fishery	Years	Ratio	Injured[5]	Uninjured
Pelagic Drift Gillnet	92-96	14/33, 11/31, 17/20,9/9.1,7/11	1[1], 1[2], 0, 0, 0	0
Pelagic Long Line	92-95	1/22, 0, 0, 0	NA, NA, 5[3], 4[4]	NA, NA, 9[3],11[4]
North Atlantic Bottom Trawl	92-96	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 1, 0, 0

1 Released alive with moderate injury (observers's comments).

2 Released alive with condition unknown.

3 1994: Trip A02 - alive, cut from gear, condition unknown; Trip A28030 - #1 alive, mainline wrapped around fluke, one end of line cut and the other pulled free, animal swam away; #2 hooked in pectoral fine, gangion cut and animal swam away; Trip A32006 - #1-#5 alive, gangion cut, animal swam away; #6 tangled in mainline, cut free, animal swam away; Trip A44004 - #1 alive, hooked in dorsal fin, mainline cut to release animal with gangion still attached; #2 animal cut from mainline several wraps of mainline and part of gangion around base of flukes/tail, animal swam off slowly; #3 hooked in mouth, broke gangion from mainline, swam away strongly trailing 50 fathoms of mainline from its mouth; Trip A54005 - #1 alive, gear around flipper; #2 alive, gear around body Trip A44043 - hooked in flipper; gangion broke off as it was hauled.

4 1995: Trip A53034 - animal cut free, swam away quickly; Trip A41031 - cut loose with leader still attached, line parted as it neared the vessel, 'mouth hooked'; Trip A25041 - alive, animal hooked or maybe wrapped in mono, condition unknown; Trip A44040 - alive, hooked in flipper, cut from gangion ;Trip A62058 -#1 animal extensively wrapped in mainline around caudal peduncle, most of the line cut away, animal released with the remaining line trailing; #2 alive, gear cut from animal; Trip A41032 - mouth hooked, line snapped and animal swam off; Trip A44043 - hooked in flipper, gangion broke off as it was hauled; Trip A62071 - hooked imbedded in caudal peduncle, one or tow wraps of the gangion along with the hook were left in the animal, sluggishly swam away, (shortfin pilot whale)- hooked in mouth, gangion clipped as close to the mouth as possible, released with hook in mouth; Trip A41034 - #1 animal swam away after breaking line, condition unknown; #2 hooked in mouth, leader cut to free animal, condition unknown; #3 leader cut to free animal, condition unknown; #4 same as #3, but animal swam towards a small pod; Trip A44048 -hooked in mouth, cut from mainline, swam away trailing gangion and 100 ft of mainline; Trip T12 - alive, entangled in mainline, mono cut away.

5 Injured and released alive animals are not included in the Table 2 mortality estimates.

Other Mortality

Pilot whales have a propensity to mass strand throughout their range, but the role of human activity in these events is unknown. Between two and 120 pilot whales have stranded annually either individually or in groups in the NMFS Northeast Region (Anon. 1993b) since 1980. From 1992-1996, 60 long-finned pilot whale stranded between South Carolina and Maine, including 22 animals that mass stranded in 1992 along the Massachusetts coast (NMFS unpublished data).

A potential human-caused source of mortality is from polychlorinated biphenyls (PCBs) and DDT, moderate levels of which have been found in pilot whale blubber (Taruski 1975; Muir *et al*. 1988). The effect of the observed levels of such contaminants is unknown.

STATUS OF STOCK

The status of long-finned pilot whales relative to OSP in U.S. Atlantic EEZ is unknown, but stock abundance may have been affected by reduction in foreign fishing, curtailment of the Newfoundland drive fishery for pilot whales in

1971, and increased abundance of herring, mackerel, and squid stocks. There are insufficient data to determine the population trends for this species. The species is not listed under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because the 1992-1996 estimated average annual fishery-related mortality to pilot whales, *Globicephala* sp., does not exceed PBR.

REFERENCES

Abend, A. 1993. Long-finned pilot whale distribution and diet as determined from stable carbon and nitrogen ratio isotope tracers. M.S. Thesis, University of Massachusetts, Amherst.

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA, NMFS, SEFSC & NEFSC. Available from NEFSC, Woods Hole Laboratory, Woods Hole, MA. 4 pp.

Anon. 1993a. Status of fishery resources off the northeastern United States for 1993. NOAA Tech. Mem. NMFS-F/NEC-101, 140 pp.

Anon. 1993b. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA. 5 pp.

Anon. 1994. Cruise results, NOAA ship RELENTLESS, Cruise No. RS 9402, Marine Mammal Survey/Warm Core Ring Study. NOAA NMFS NEFSC Woods Hole Laboratory, Woods Hole, MA. 8 pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bloch, D., M. Zachariassen and P. Zachariassen. 1993. Some external characters of the long-finned pilot whale off Faroe Island and a comparison with the short-finned pilot whale. *Rep. int. Whal. Commn. Special Issue 14:117-135.*

Buckland, S.T., D.R. Anderson, K.P. Burnham and S.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. *Chapman and Hall*, New York, NY, 446 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC. 538 pp.

Cramer J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.

Desportes, G., M. Saboureau and A. Lacroix. 1993. Reproductive maturity and seasonality of male pilot long-finned whales off the Faroe Islands. *Rep. int. Whal. Commn. Special Issue 14: 233-262.*

Fairfield, C. P., G. T. Waring and M. H. Sano. 1993. Pilot whales incidentally taken during the distant water fleet Atlantic mackerel fishery in the mid-Atlantic Bight, 1984-88. *Rep. int. Whal. Commn. Special Issue 14: 107-116.*

Gerrior, P., A.S. Williams, and D.J. Christensen. 1994. Observations of the 1992 U.S. pelagic pair trawl fishery in the Northwest Atlantic. *Mar. Fish. Rev. 56(3): 24-27.*

Goudy, C.A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic, MITSG 95-6, Cambridge, MA. 10 pp.

Goudy, C.A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic, MITSG 95-6, Cambridge, MA. 13 pp.

Kasuya, T., D. E. Sergeant and K. Tanaka. 1988. Re-examination of life history parameters of long-finned pilot whales in the Newfoundland waters. *Sci. Rep. Whales Res. Inst. No. 39: 103-119.*

Laake, J.L., S.T. Buckland, D.R. Anderson and K.P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado. 72 pp.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES CM 1997/Q:8. 10 pp.*

Martin, A. R. and P. Rothery. 1993. Reproductive parameters of female long-finned pilot whales (*Globicephala melas*) around the Faroe Islands. *Rep. int. Whal. Commn. Special Issue 14: 263-304.*

Mercer, M. C. 1975. Modified Leslie-DeLury population models of the long-finned pilot whale (*Globicephala melaena*) and annual production of the short-finned squid (*Illex illecebrosus*) based upon their interactions at Newfoundland. *J. Fish. Res. Bd. Can. 32(7): 1145-54.*

Mitchell, E. 1974. Present status of northwest Atlantic fin and other whale stocks. Pages 108-169. *In:* W. E. Schevill (ed.), The whale problem: A status report. *Harvard University Press*, Cambridge, Massachusetts, 419 pp.

Muir, D. C. G., R. Wagermann, N. P. Grift, R. J. Norstrom, M. Simon, and J. Lien. 1988. Organochlorine chemical and heavy metal contaminants in white-beaked dolphins (*Lagenorhynchus albirostris*) and pilot whales (*Globicephala melaena*) from the coast of Newfoundland. Canada. Arch. Environ. Contam. *Toxicol. 17: 613-29.*

National Marine Fisheries Service. 1995. Final environmental impact statement for a regulatory amendment for the western Atlantic bluefin tuna fishery. July 20, 1995. Available from NOAA, NMFS, Office of Protected Species, Silver Springs, MD.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.) Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16.*

Payne, P. M. and D. W. Heinemann. 1993. The distribution of pilot whales (*Globicephala* sp.) in shelf/shelf edge and slope waters of the northeastern United States, 1978-1988. *Rep. int. Whal. Commn. Special Issue 14: 51-68.*

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Scott, G.P. and C.A. Brown. 1997. Estimates of marine mammal and marine turtle catch by the US Atlantic pelagic longline fleet in 1994-1995. Miami Laboratory Contribution MIA-96/97-28.

Sergeant D. E. 1962. The biology of the pilot or pothead whale (*Globicephala melaena* (Traill) in Newfoundland waters. *Bull. Fish. Res. Bd. Can. 132: 1-84.*

Taruski, A. G., C. E. Olney, and H. E. Winn. 1975. Chlorinated hydrocarbons in cetaceans. *J. Fish. Res. Bd. Can. 32(11): 2205-9.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull., U.S. 88(2): 347-360*.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES Marine Mammals Comm. CM 1992/N:12, 29 pp.*

Waring, G.T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA NMFS NEFSC, Lab. Ref. Doc. No. 98-09, 21pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Waring, G. T. 1995. Fishery and ecological interactions for selected cetaceans off the northeast USA. Ph.D. dissertation, University of Massachusetts, Amherst, 260 pp.

December 1998

SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two species of pilot whales in the Western Atlantic: the Atlantic or long-finned pilot whale, *Globicephala melas*, and the short-finned pilot whale, *G. macrorhynchus*. These species are difficult to identify to the species level at sea; therefore, some of the descriptive material below refers to *Globicephala* sp. and is identified as such. The species boundary is considered to be in the New Jersey to Cape Hatteras area. Sightings north of this area are likely *G. melas*.

The short-finned pilot whale is distributed worldwide in tropical to warm temperate waters (Leatherwood and Reeves 1983). The northern extent of the range of this species within the U.S. Atlantic Exclusive Economic Zone (EEZ) is generally thought to be Cape Hatteras, North Carolina (Leatherwood and Reeves 1983). Sightings of these animals in U.S. Atlantic EEZ occur primarily within the Gulf Stream [Southeast Fisheries Science Center (SEFSC) unpublished data], and primarily along the continental shelf and continental slope in the northern Gulf of Mexico (Mullin *et al*. 1991; SEFSC unpublished data). There is no information on stock differentiation for the Atlantic population.

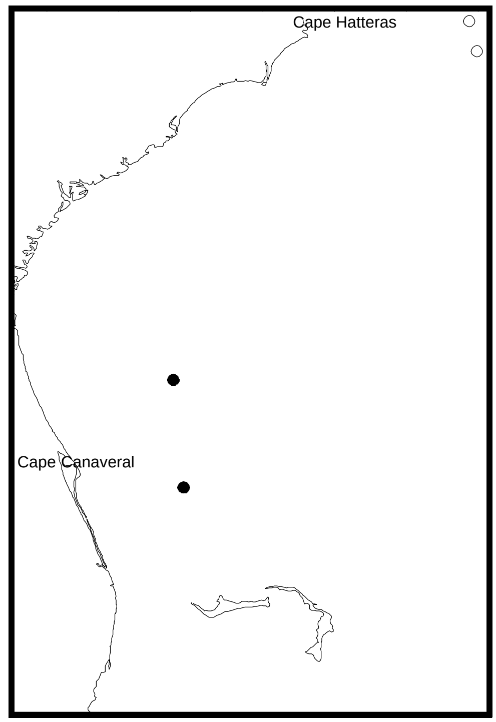

Figure 1. *Sightings of short-finned pilot whales (filled circles) and unidentified pilot whales (unfilled circles) during NOAA Ship Oregon II marine mammal survey cruise in winter 1992.*

POPULATION SIZE

Estimates of abundance were derived through the application of distance sampling analysis (Buckland *et al*. 1993) and the computer program DISTANCE (Laake *et al*. 1993) to sighting data collected during a 1992 winter, visual sampling, line-transect vessel survey of the U.S. Atlantic EEZ waters between Miami, Florida, and Cape Hatteras, North Carolina. The estimated abundance of short-finned pilot whales for the 1992 survey was 749 (coefficient of variation, CV = 0.64) (Hansen *et al*. 1994).

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for short-finned pilot whales is 749 (CV=0.64). The minimum population estimate for the western North Atlantic short-finned pilot whale is 457 (CV=0.64).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 457 (CV=0.64). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is 0.50 because this stock is of unknown status (Wade and Angliss 1997). PBR for the western North Atlantic short-finned pilot whales is 4.6.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality to this stock during 1992-1996 was 32 pilot whales (CV = 0.09; Table 2).

Fishery Information

USA

The level of past or current, direct, human-caused mortality of short-finned pilot whales in the U.S. Atlantic EEZ is unknown. The short-finned pilot whale has been taken in the pelagic longline fishery in Atlantic waters off the southeastern U.S. (Lee *et al*. 1994; SEFSC unpublished data).

Prior to 1977, there was no documentation of marine mammal by-catch in distant-water fleet (DWF) activities off the northeast coast of the U.S. A fishery observer program, which has collected fishery data and information on incidental by-catch of marine mammals, was established in 1977 with the implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA). DWF effort in the Atlantic coast EEZ under MFCMA has been directed primarily towards Atlantic mackerel and squid. An average of 120 different foreign vessels per year (range 102-161) operated within the Atlantic coast EEZ during 1977 through 1982. In 1982, there were 112 different foreign vessels; 18 (16%) were Japanese tuna longline vessels operating along the U.S. Atlantic coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. The number of foreign vessels operating within the U.S. Atlantic EEZ each year between 1983 and 1991 averaged 33 and ranged from nine to 67. The number of Japanese longline vessels included among the DWF vessels averaged six and ranged from three to eight between 1983 and 1988. MFCMA observer coverage on DWF vessels was 25-35% during 1977-82, increased to 58%, 86%, 95%, and 98%, respectively, during 1983-86, and 100% observer coverage was maintained from 1987-91. Foreign fishing operations for squid ceased at the end of the 1986 fishing season and, for mackerel, at the end of the 1991 fishing season.

During 1977-1991, observers in this program recorded 436 pilot whale mortalities in foreign-fishing activities (Waring *et al*. 1990; Waring 1995). A total of 391 (90%) were taken in the mackerel fishery, and 41 (9%) occurred during *Loligo* and *Illex* squid-fishing operations. This total includes 48 documented takes by U.S. vessels involved in joint venture fishing operations in which U.S. captains transfer their catches to foreign processing vessels. Due to temporal fishing restrictions, the by-catch occurred during winter/spring (December to May) in continental shelf and continental shelf edge waters (Fairfield *et al*. 1993; Waring 1995); however, the majority of the takes occurred in late spring along the 100 m isobath. Two animals were also caught in both the hake fishery and tuna longline fisheries (Waring *et al*. 1990).

The distribution of long-finned pilot whale, a northern species, overlaps with that of the short-finned pilot whale, a predominantly southern species, between 35°30'N to 38°00'N (Leatherwood *et al*. 1976). Although long-finned pilot whales are most likely taken in the waters north of Delaware Bay, many of the pilot whale takes are not identified to species and by-catch does occur in the overlap area. In this summary, therefore, long-finned pilot whales (*Globicephala melas*) and unidentified pilot whales (*Globicephala* sp.) are considered together.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet, pelagic longline, and pelagic pair trawl fisheries, but no mortalities or serious injuries have been documented in the New England multispecies sink gillnet or mid-Atlantic coastal sink gillnet.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fishery information. Variances were estimated using bootstrap re-sampling techniques. Between 1989 and 1995, sixty -eight mortalities were observed in the large pelagic drift gillnet fishery. The annual fishery-related mortality (CV in parentheses) was 77 in 1989 (0.24), 132 in 1990 (0.24), 30 in 1991 (0.26), 33 in 1992 (0.16), 31 in 1993 (0.19), 20 in 1994 (0.06), 9.1 in 1995 (0), and 11 in 1996 (.17); average annual mortality between 1992-1996 was 20.8 pilot whales (0.08) (Table 2). The 1992-1996 period provides a better characterization of this fishery (i.e., fewer vessels and increased observer coverage). Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery. Because animals released alive may have subsequently died due to injuries received during entanglement, pilot whales that were released were included in the mortality estimates. Pilot whales were taken along the continental shelf edge, northeast of Cape Hatteras in January and February. Takes were recorded at the continental shelf edge east of Cape Charles, Virginia, in June. Pilot whales were taken from Hydrographer Canyon along the Great South Channel to Georges Bank from July-November. Takes occurred at the Oceanographer Canyon continental shelf break and along the continental shelf northeast of Cape Hatteras in October-November.

Pelagic Pair Trawl

Effort in the pelagic pair trawl fishery has increased during the period 1989 to 1993, from zero hauls in 1989 and 1990, to an estimated 171 hauls in 1991, and then to an estimated 536 hauls in 1992, 586 in 1993, 407 in 1994, and 440 in 1995, respectively. This fishery ceased operations in 1996, when NMFS rejected a petition to consider pair trawl gear as an authorized gear type in Atlantic tunas fishery. The fishery operated from August-November in 1991, from June-November in 1992, from June-October in 1993, and from mid-summer to November in 1994 and 1995. Sea sampling began in October 1992 (Gerrior *et al*. 1994), and 48 sets (9% of the total) were sampled in that season, 102 hauls (17% of the total) were sampled in 1993. In 1994 and 1995, 52% (212) and 54% (238), respectively, of the sets were observed. Twelve vessels have operated in this fishery. The fishery extends from 35ºN to 41ºN, and from 69°W to 72°W. Approximately 50% of the total effort was within a one degree square at 39ºN, 72ºW, around Hudson Canyon. Examination of the locations and species composition of the by-catch, showed little seasonal change for the six months of operation and did not warrant any seasonal or areal stratification of this fishery (Northridge 1996). Five pilot whale (*Globicephala* sp.) mortalities were reported in the self-reported fishery information in 1993. In 1994 and 1995 observers reported one and twelve mortalities, respectively (Table 2). The estimated fishery-related mortality to pilot whales in the U.S. Atlantic attributable to this fishery in 1994 was 2.0 (CV=0.49) and 22 (CV=0.33) in 1995. The average mortality between 1992 and 1995 was 6 (CV=0.31) for this fishery. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

During the 1994 and 1995 experimental fishing seasons, fishing gear experiments were conducted to collect data on environmental parameters, gear behavior, and gear handling practices to evaluate factors affecting catch and bycatch (Goudey 1995, 1996). Results of these studies were inconclusive in identifying factors responsible for marine mammal bycatch.

Pelagic Longline

The pelagic longline fishery operates in the U.S. Atlantic (including Caribbean) and Gulf of Mexico EEZ (SEFSC unpublished data). Interactions between the pelagic longline fishery and pilot whales have been reported; however, a vessel may fish in more than one statistical reporting area and it is not possible to separate estimates of fishing effort other than to subtract Gulf of Mexico effort from Atlantic fishing effort, which includes the Caribbean Sea. This fishery has been monitored with about 5% observer coverage, in terms of trips observed, since 1992. Total effort for the pelagic longline fishery (Atlantic, including the Caribbean), based on mandatory self-reported fishery information, was 11,279 sets in 1991, 10,605 sets in 1992, 11,538 in 1993, 11,231 sets in 1994, and 12,713 in 1995 (Cramer 1994; Scott and Brown 1997). The fishery has been observed nearly year round within every statistical reporting area within the EEZ and beyond. Most of the estimated marine mammal by-catch was from EEZ waters between South Carolina and Cape Cod. Pilot whales are frequently observed to feed on hooked fish, particularly big-eye tuna (NMFS unpublished data). Between 1990-1995 fifty-four pilot whales (including one identified as a short-fin pilot whale) were released alive, and one mortality was observed. January-March by-catch was concentrated on the continental shelf edge northeast of Cape Hatteras. By-catch was recorded in this area during April-June, and takes also occurred north of Hydrographer Canyon off the continental shelf in water over 1,000 fathoms during April-June. During the July-September period, takes occurred on the continental shelf edge east of Cape Charles, Virginia, and on Block Canyon slope in over 1,000 fathoms of water. October-December by-catch occurred along the 20 to 50 fathom contour lines between Barnegat Bay and Cape Hatteras. The 1990-1993, estimated take was based on a generalized linear model (Poisson error assumption) fit to the available observed incidental take and self-reported incidental take and effort data for the fishery (SEFSC unpublished data). The 1994-1995 estimates were based on the Delta-lognormal method (details in Scott and Brown 1997). The estimated fishery-related mortality to pilot whales in the U.S. Atlantic attributable to this fishery was: 22 in 1992 (CV = 0.23), and zero in 1993-1995; average annual mortality between 1992-1995 was 5.5 pilot whales (0.23) (Table 2). Injured and released alive animals are not included in the Table 2 mortality estimates. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Bluefin Tuna Purse Seine

The tuna purse seine fishery between Cape Hatteras and Cape Cod is directed at small and medium bluefin and skip jack for the canning industry, while north of Cape Cod purse seine vessels are directed at large medium and giant bluefin tuna (NMFS, 1995). The latter fishery is entirely separate from any other Atlantic tuna purse seine fishery. Spotter aircraft are used to locate fish schools. The official start date is August 15, set by regulation. Individual vessel quotas (IVQs) and a limited access system prevent a derby fishery situation. Catch rates are high with this gear and consequently, the season usually only lasts a few weeks for large mediums and giants. The 1996 regulations allocated 250 MT (5 IVQs) with a minimum of 90% giants and 10% large mediums. Limited observer data are available for the bluefin tuna purse seine fishery. Out of 45 total trips made in 1996, 43 trips (95.6%) were observed. Forty-four sets were made on the 43 observed trips and all sets were observed. A total of 136 days were covered. Two interactions with pilot whales were observed in 1996. In one interaction, the net was actually pursed around one pilot whale, the rings were released and the animal escaped alive, condition unknown. This set occurred east of the Great South Channel and just north of the Cultivator Shoals region on Georges Bank. In a second interaction, five pilot whales were encircled in a set. The net was opened prior to pursing to let the whales swim free, apparently uninjured. This set occurred on the Cultivator Shoals region on Georges Bank.

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under the MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 (CV = 0.04) vessels (full and part time) participated annually in the fishery during 1989-1993. The fishery is active in New England in all seasons. One mortality was documented in 1990 and one animal was released alive and uninjured in 1993. In 1997 one decomposed pilot whale was taken in the mid-Atlantic region. The animal was clearly dead prior to being taken by the trawl, because it was severely decomposed and the tow duration of 3.3. hours was insufficient to allow extensive decomposition; therefore, there is no estimated bycatch for this fishery. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Atlantic Squid, Mackerel, Butterfish Trawl

The mid-Atlantic mackerel and squid trawl fisheries were combined into the Atlantic mid-water trawl fishery in the revised proposed list of fisheries in 1995. The fishery occurs along the U.S. mid-Atlantic continental shelf region between New Brunswick, Canada, and Cape Hatteras year around. The mackerel trawl fishery was classified as a Category II fishery since 1990 and the squid fishery was originally classified as a Category II fishery in 1990, but was reclassified as a Category III fishery in 1992. The combined fishery was reclassified as a Category II fishery in 1995. In 1996, mackerel, squid, and butterfish trawl fisheries were combined into the Atlantic squid, mackerel, butterfish trawl fishery, and maintained a Category II classification. Three fishery-related mortality of pilot whales were reported in self-reported fishery information from the mackerel trawl fishery between 1990-1992. One mortality was observed in the 1996 *Illex* squid fishery. The effort data for this fishery are currently under review, therefore the estimated fishery-related mortality has not been determined.

Total fishery-related mortality and serious injury cannot be estimated separately for the two species of pilot whales in the U.S. Atlantic EEZ because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that either species might have been subject to the observed fishery-related mortality and serious injury. Total estimated annual fishery-related mortality of pilot whales from NMFS-observed fisheries was the sum of integer-rounded annual mortality estimates across the pelagic longline (1992-1995), pelagic drift gillnet (1992-1996), and pelagic pair trawl (1992-1995), and was 32 pilot whales, *Globicephala* sp. (CV = 0.09) (Table 2).

CANADA

An unknown number of pilot whales have also been taken in Newfoundland and Labrador, and Bay of Fundy, groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, and Atlantic Canada cod traps (Read 1994). The Atlantic Canadian and Greenland salmon gillnet fishery is seasonal, with the peak from June to September, depending on location. In southern and eastern Newfoundland, and Labrador during 1989, 2,196 nets 91 m long were used. There are no effort data available for the Greenland fishery; however, the fishery was terminated in 1993 under an agreement between Canada and North Atlantic Salmon Fund (Read 1994).

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

Between January 1993 and December 1994, 36 Spanish deep water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211sets), were observed in NAFO Fishing Area 3 (off the Grand Bank) (Lens 1997). A total of 47 incidental catches were recorded, which included one long-finned pilot whale. The incidental mortality rate for long-finned pilot whales was (0.007/set).

Table 2. Summary of the incidental mortality of pilot whales (*Globicephala sp*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated[7] Mortality	Estimate d CVs	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12[3] 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	14, 11[4], 17, 9, 7	33, 31, 20, 9.1[5], 11	.16, .19, .06, 0, .17	20.8 (.08)
Pelagic Pair Trawl	92-95	12	Obs. Data Logbook	.09, .17, .52, .54	0, 0[6], 1, 12	0, 0, 2, 22	0, 0, .49, .33	6.0 (.31)
Atlantic squid, mackerel, butterfish trawl	96	NA	Obs. Data Logbook	0.007	1	NA	NA	NA
Longline	92-95		Obs. Data Logbook	.05	1, 0, 0, 0	22, 0, 0, 0	.23, 0, 0, 0	5.5 (.23)
TOTAL								32 (.09)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet and longline fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).

2 Observer coverage for the pelagic drift gillnet, pair trawl and longline fishery are in terms of sets.

3 1994 and 1995 shown, other years not available on an annual basis.

4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). In 1994 and 1995, observer coverage increased substantially, and bycatch rates were not pooled for this period.

5 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.84 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.06 animals.

6 In 1993, 5 pilot whales were taken on a tow without an observer. An estimate could not be made based on unobserved tows.

7 Annual mortality estimates do not include any animals injured and released alive.

Table 3. Summary of pilot whales (*Globicephala sp*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured).

Fishery	Years	Ratio	Injured[5]	Uninjured
Pelagic Drift Gillnet	92-96	14/33, 11/31, 17/20,9/9.1,7/11	1[1], 1[2], 0, 0, 0	0
Pelagic Long Line	92-95	1/22, 0, 0, 0	NA, NA, 5[3], 4[4]	NA, NA, 9[3],11[4]
North Atlantic Bottom Trawl	92-96	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 1, 0, 0

1 Released alive with moderate injury (observer's comments).

2 Released alive with condition unknown.

3 1994: Trip A02 - alive, cut from gear, condition unknown; Trip A28030 - #1 alive, mainline wrapped around fluke, one end of line cut and the other pulled free, animal swam away; #2 hooked in pectoral fine, gangion cut and animal swam away; Trip A32006 - #1-#5 alive, gangion cut, animal swam away; #6 tangled in mainline, cut free, animal swam away; Trip A44004 - #1 alive, hooked in dorsal fin, mainline cut to release animal with gangion still attached; #2 animal cut from mainline several wraps of mainline and part of gangion around base of flukes/tail, animal swam off slowly; #3 hooked in mouth, broke gangion from mainline, swam away strongly trailing 50 fathoms of mainline from its mouth; Trip A54005 - #1 alive, gear around flipper; #2 alive, gear around body Trip A44043 - hooked in flipper; gangion broke off as it was hauled.

4 1995: Trip A53034 - animal cut free, swam away quickly; Trip A41031 - cut loose with leader still attached, line parted as it neared the vessel, 'mouth hooked'; Trip A25041 - alive, animal hooked or maybe wrapped in mono, condition unknown; Trip A44040 - alive, hooked in flipper, cut from gangion ;Trip A62058 -#1 animal extensively wrapped in mainline around caudal peduncle, most of the line cut away, animal released with the remaining line trailing; #2 alive, gear cut from animal; Trip A41032 - mouth hooked, line snapped and animal swam off; Trip A44043 - hooked in flipper, gangion broke off as it was hauled; Trip A62071 - hooked imbedded in caudal peduncle, one or tow wraps of the gangion along with the hook were left in the animal, sluggishly swam away, (shortfin pilot whale)- hooked in mouth, gangion clipped as close to the mouth as possible, released with hook in mouth; Trip A41034 - #1 animal swam away after breaking line, condition unknown; #2 hooked in mouth, leader cut to free animal, condition unknown; #3 leader cut to free animal, condition unknown; #4 same as #3, but animal swam towards a small pod; Trip A44048 -hooked in mouth, cut from mainline, swam away trailing gangion and 100 ft of mainline; Trip T12 - alive, entangled in mainline, mono cut away.

5 Injured and released alive animals are not included in the Table 2 mortality estimates.

Other Mortality

There were 190 short-finned pilot whale strandings documented during 1987- August 1996 along the U.S. Atlantic coast between Cape Hatteras, North Carolina, and Miami, Florida; four of these were classified as likely caused by fishery interactions. From 1992-1995, eight short-finned pilot whales stranded along beaches north of Cape Hatteras (Virginia to New Jersey) (NMFS unpublished data).

STATUS OF STOCK

The status of the short-finned pilot whale relative to OSP in U.S. Atlantic EEZ is unknown. There are insufficient data to determine the population trends for this stock. They are not listed under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because the 1992-96 estimated average annual fishery-related mortality to pilot whales, *Globicephala* sp., exceeds PBR.

REFERENCES

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S. T., D. R. Anderson, K. P. Burnham and J. L. Laake. 1993. Distance Sampling: estimating abundance of biological populations. *Chapman & Hall*, London, 446 pp.

Cramer J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.

Gerrior, P., A.S. Williams, and D.J. Christensen. 1994. Observations of the 1992 U.S. pelagic pair trawl fishery in the Northwest Atlantic. *Mar. Fish. Rev. 56(3): 24-27.*

Goudy, C.A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic, MITSG 95-6, Cambridge, MA. 10 pp.

Goudy, C.A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic, MITSG 95-6, Cambridge, MA. 13 pp.

Hansen, L. J., K. D. Mullin and C. L. Roden. 1994. Preliminary estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys, and of selected cetacean species in the U.S. Atlantic Exclusive Economic Zone from vessel surveys from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-93/94-58.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Leatherwood, S. and R. R. Reeves. 1983. The Sierra Club handbook of whales and dolphins. *Sierra Club Books*, San Francisco, 302 pp.

Lee, D. W., C. J. Brown, A. J. Catalano, J. R. Grubich, T. W. Greig, R. J. Miller and M. T. Judge. 1994. SEFSC pelagic longline observer program data summary for 1992-1993. NOAA Tech. Mem. NMFS-SEFSC-347. 19 pp.

Mullin, K., W. Hoggard, C. Roden, R. Lohoefener, C. Rogers and B. Taggart. 1991. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. OCS Study/MMS 91-0027. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, Louisiana, 108 pp.

National Marine Fisheries Service. 1995. Final environmental impact statement for a regulatory amendment for the western Atlantic bluefin tuna fishery. July 20, 1995. Available from NOAA, NMFS, Office of Protected Species, Silver Springs, MD.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull., U.S. 88(2): 347-360.*

Waring, G. T. 1995. Fishery and ecological interactions for selected cetaceans off the northeast USA. Ph.D. dissertation, University of Massachusetts, Amherst, 260 pp.

WHITE-BEAKED DOLPHIN (*Lagenorhynchus albirostris*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

White-beaked dolphins are the more northerly of the two species of *Lagenorhynchus* in the Northwest Atlantic (Leatherwood *et al.* 1976). The species is found in waters from southern New England, north to western and southern Greenland and Davis Straits (Leatherwood *et al.* 1976; CETAP 1982), in the Barents Sea and south to at least Portugal (Reeves *et al.*, in press). Differences in skull features indicate that there are at least two separate stocks, one in the eastern and one in the western North Atlantic (Mikkelsen and Lund 1994). No genetic analyzes have been conducted to distinguish the stock structure.

In waters off the northeastern U.S. coast, white-beaked dolphin sightings have been concentrated in the western Gulf of Maine and around Cape Cod (CETAP 1982). The limited distribution of this species in U.S. waters has been attributed to opportunistic feeding (CETAP 1982). Prior to the 1970's, white-sided dolphins (*L. acutus*) in U.S. waters were found primarily offshore on the continental slope, while white-beaked dolphins were found on the continental shelf. During the 1970's, there was an apparent switch in habitat use between these two species. This shift may have been a result of the increase in sand lance in the continental shelf waters (Katona *et al.* 1993; Kenny *et al.* 1996).

POPULATION SIZE

The total number of white-beaked dolphins in U.S. and Canadian waters is unknown, although one abundance estimate is available for part of the known habitat in U.S. waters, and two estimates are from Canadian waters (Table 1).

A population size of 573 white-beaked dolphins (CV=0.69) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on spring data because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during this season. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty (e.g., large CV), its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 5,500 white-beaked dolphins was based on an aerial survey off eastern Newfoundland and southeastern Labrador (Table 1; Alling and Whitehead 1987).

A population size of 3,486 white-beaked dolphins [95% confidence interval (CI) = 2,001-4,971]was estimated from a ship-based survey of a small segment of the Labrador Shelf in August 1982 (Table 1; Alling and Whitehead 1987). A CV was not given, but, assuming a symmetric CI, it would be 0.22.

There are no abundance estimates for this species in waters between the Gulf of Maine and the Newfoundland/Labrador region.

Table 1. Summary of abundance estimates for western North Atlantic white-beaked dolphins. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV). Unk=unknown.

Month/Year	Area	N_{best}	CV
spring 1978-82	Cape Hatteras, NC to Nova Scotia	573	0.69
1980's	E. Newfoundland and SE Labrador	5,500	None reported
August 1982	Labrador shelf	3,486	0.22

Minimum Population Estimate

Present data are insufficient to calculate a minimum population estimate in U.S. Exclusive Economic Zone (EEZ) waters.

Current Population Trend

There are insufficient data to determine population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (Wade and Angliss 1997). The minimum population size of white-beaked dolphins is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic white-beaked dolphin is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

White-beaked dolphins have been taken in cod traps and the Canadian groundfish gillnet fisheries off Newfoundland and Labrador and in the Gulf of St. Lawrence (Alling and Whitehead 1987; Read 1994; Hai *et al.* 1996); however, the total number of animals taken is not known.

There are no documented reports of fishery-related mortality or serious injury to this stock in the U.S. EEZ.

Fishery Information

Because of the absence of observed fishery-related mortality and serious injury to this stock in the U.S. EEZ, no U.S. fishery information is provided.

The Canadian Atlantic groundfish gillnet fishery is important and widespread. Many fisherman hold groundfish gillnet licenses but the number of active fishermen is unknown. In 1989, approximately 6,800 licenses were issued to fishermen along the southern coast of Labrador, and northeast and southern coast of Newfoundland. About 3,900 licenses were issued in 1989 in the Gulf of St. Lawrence and 659 licenses were issued in the Bay of Fundy and southwestern Nova Scotia.

Other Mortality

White-beaked dolphins were hunted for food by residents in Newfoundland and Labrador (Alling and Whitehead 1987). These authors, based on interview data, estimated that 366 white-beaked dolphins were taken each year. The same authors reported that 25-50% of the killed dolphins were lost.

STATUS OF STOCK

The status of white-beaked dolphins, relative to OSP, in U.S. Atlantic coast waters is unknown. They are not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine population trends for this species. Because there are insufficient data to calculate PBR it is not possible to determine if stock is strategic and if the total fishery-related mortality and serious injury for this stock is significant and approaching zero mortality and serious injury rate. However, because this stock has a marginal occurrence in U.S. waters and there are no documented takes in U.S. waters, this stock has been designated as not strategic.

REFERENCES

Alling, A. K. and H. P. Whitehead. 1987. A preliminary study of the status of white-beaked dolphins, *Lagenorhynchus albirostris*, and other small cetaceans off the coast of Labrador. *Can. Fld. Nat. 101(2): 131-135.*

Barlow, J., S. L. Swartz, T. C. Eagle, and P. R. Wade. 1995. U.S. Marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. U.S.Dept. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Hai, D.J., J. Lein, D. Nelson, and K. Curren. 1996. A contribution to the biology of the white-sided dolphin, *Lagenorhnchus albirostris*, in waters off Newfoundland. *Can..Fld. Nat. 110(1).*

Katona, S. K., V. Rough, and D. T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. Washington, D. C. : *Smithsonian Institution Press*. 316 pp.

Kenney, R. D., P. M. Payne, D. W. Heineman and H. E. Winn. 1996. Shifts in Northeast shelf cetacean distributions relative to trends in Gulf of Maine/Georges Bank finfish abundance. Pp. 169-196. *In:* K. Sherman, N.A. Jaworski and T. Smada (eds.) *The northeast shelf ecosystem: assessment, sustainability, and management.* Blackwell Science, Cambridge, MA 02142, USA.

Leatherwood, S., D. K. Caldwell, and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Mikkelsen, A.M.H. and A. Lund. 1994. Intraspecific variation in the dolphins *Lagenorhnchus albirostris* and *L. acutus* (Mammalia: Cetacea) in metrical and non-metrical skull characters, with remarks on occurrence. *J. Zool., Lond. 234:289-299.*

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Reeves, R.R., R. L. Brownell Jr., C. C. Kinze, C. Smeenk and J. Lein. (in press). White-beaked dolphin (*Lagenorhnchus albirostris* (Gray 1846). *In*: S.H. Ridgway and R. Harrison (eds.) *Handbook of marine mammals, Vol 6.*

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

WHITE-SIDED DOLPHIN (*Lagenorhynchus acutus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

White-sided dolphins are found in temperate and sub-polar waters of the North Atlantic, primarily on continental shelf waters to the 100 m depth contour. The species inhabits waters from central west Greenland to North Carolina (about 35°N) and perhaps as far east as 43º W (Evans 1987). Distribution of sightings, strandings and incidental takes suggests the possibly existence of three stocks units: a Gulf of Maine, Gulf of St. Lawrence, and a Labrador Sea stock (Palka *et al.*, 1997). No genetic studies have been conducted to test this proposed population structure, although some samples are available to initiate such a study (about 25 specimens). Evidence for a separation between the well documented unit in the southern Gulf of Maine and a Gulf of St. Lawrence population comes from a hiatus of summer sightings along the Atlantic side of Nova Scotia. This has been reported in Gaskin (1992), is evident in Smithsonian stranding records, and was seen during an abundance survey conducted in summer 1995 that covered waters from Virginia to the entrance of the Gulf of St. Lawrence. White-sided dolphins were seen frequently in eastern Gulf of Maine waters and in waters at the mouth of the Gulf of St. Lawrence, but only one sighting was recorded in the waters between these two regions.

The Gulf of Maine stock of white-sided dolphins are most common in continental shelf waters from Hudson Canyon (approximately 39°N) north through Georges Bank, and in the Gulf of Maine to the lower Bay of Fundy. Sightings data indicate seasonal shifts in distribution. During January to April, low numbers of white-sided dolphins are found from Georges Bank to Jeffreys Ledge (off New Hampshire), and even lower numbers are south of Georges Bank, as documented by a few strandings collected on beaches of Virginia and North Carolina. From June through September, large numbers of white-sided dolphins are found from Georges Bank to lower Bay of Fundy. From October to December, white-sided dolphins occur at intermediate densities from southern Georges Bank to southern Gulf of Maine (Payne and Heinemann 1990). Sightings south of Georges Bank and around Hudson Canyon have been seen at all times of the year but at very low densities. The Virginia and North Carolina observations appear to represent the southern extent of the species range.

Prior to the 1970's, white-sided dolphins in U.S. waters were found primarily offshore on the continental slope, while white-beaked dolphins (*L. albirostris*) were found on the continental shelf. During the 1970's, there was an apparent switch in habitat use between these two species. This shift may of been a result of the increase in sand lance in the continental shelf waters (Katona *et al.* 1993; Kenney *et al.* 1996).

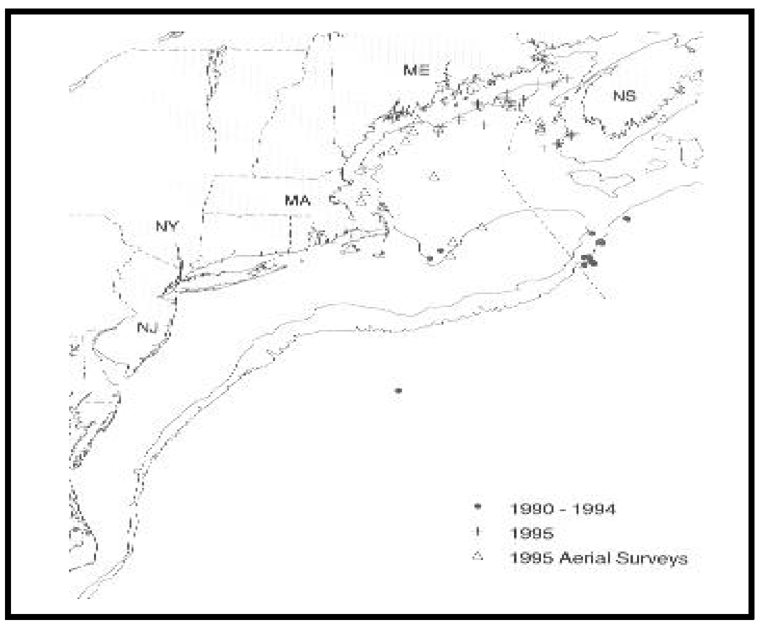

Figure 1. *Distribution of white-sided dolphin sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

POPULATION SIZE

The total number of white-sided dolphins along the eastern U.S. and Canadian Atlantic coast is unknown, although four estimates from select regions are available from spring, summer and autumn 1978-82, July-September 1991-92, June-July 1993, and July-September 1995 (Table 1; Figure 1).

A population size of 28,600 white-sided dolphins (CV=0.21) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate was based on an inverse variance weighted pooling of spring, summer and autumn data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 20,400 (CV=0.63) white-sided dolphins was estimated from two shipboard line transect surveys conducted during July to September 1991 and 1992 in the northern Gulf of Maine-lower Bay of Fundy region (Table 1; Palka *et al*. 1997). This population size is a weighted-average of the 1991 and 1992 estimates, where each annual estimate was weighted by the inverse of its variance. The data were collected during surveys designed to estimate abundance of harbor porpoises (Palka 1995). Two independent teams of observers on the same ship surveyed using naked eye in non-closing mode. Using the product integral analytical method (Palka 1995) and DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993) the abundance included an estimate of school size-bias, if applicable, an estimate of g(0), probability of detecting a group on the track line, but no correction for dive-time or ship avoidance. Variability was estimated using bootstrap re-sampling.

A population size of 729 (CV = 0.47) white-sided dolphins was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0), dive-time or ship avoidance. Variability was estimated using bootstrap re-sampling techniques.

A population size of 27,200 (CV=0.43) white-sided dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS/NEFSC unpublished data). This survey included the area covered by the above 1991 and 1992 surveys. For the 1995 survey, the total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey (Palka 1996). An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time or ship avoidance. Variability was estimated using bootstrap re-sampling techniques.

There are no published abundance estimates for this species in Canadian waters which lie farther north or east of the above surveys (Gaskin 1992).

The best available current abundance estimate for white-sided dolphins in U.S. waters is 27,200 (CV=0.43) as estimated from the July to September 1995 line transect survey because this survey is recent and provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for western North Atlantic white-sided dolphins. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring, summer & autumn 1978-82	Cape Hatteras, NC to Nova Scotia	28,600	0.21
Jul-Sep 1991-92	N. Gulf of Maine and Bay of Fundy	20,400	0.63
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	729	0.47

Jul-Sep 1995	Virginia to Gulf of St. Lawrence	27,200	0.43

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for white-sided dolphins is 27,200 (CV=0.43). The minimum population estimate for the western North Atlantic white-sided dolphins is 19,196 (CV=0.43).

Current Population Trend

There are insufficient data to determine population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: calving interval is 2-3 years; lactation period is 18 months; gestation period is 10-12 months and births occur from May to early August, mainly in June and July; length at birth is 110 cm; length at sexual maturity is 230-240 cm for males, and 201-222 cm for females; age at sexual maturity is 8-9 years for males and 6-8 years for females; mean adult length is 250 cm for males and 224 cm for females (Evans 1987); and maximum reported age for males is 22 years and for females, 27 years (Sergeant *et al.* 1980).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995) .

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 19,196 (CV=0.43). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic white-sided dolphin is 192.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

USA

Recently, within U.S. waters, white-sided dolphins have been caught in the New England multispecies sink gillnet fisheries, pelagic drift gillnet fishery, and the North Atlantic bottom trawl fishery (Table 2). Estimated average annual fishery-related mortality and serious injury to the western North Atlantic white-sided dolphin stock from these U.S. fisheries during 1992-1996 was 218 dolphins per year (CV = 0.23).

In the past, incidental takes of white-sided dolphins have been recorded in the New England and Bay of Fundy multispecies gillnet fisheries and the Atlantic foreign mackerel fishery. In the mid 1980's, during a University of Maine study, gillnet fishermen reported six takes of white-sided dolphins of which two carcasses were necropsied for biological studies (Gilbert and Wynne 1987; Gaskin 1992). NMFS foreign fishery observers reported 44 takes of Atlantic white-sided dolphins incidental to fishing activities in the continental shelf and continental slope waters between March 1977 and December 1991 (Waring *et al.* 1990; NMFS unpublished data). Of these animals, 96% were taken in the Atlantic mackerel fishery. This total includes nine documented takes by U.S. vessels involved in joint-venture fishing operations in which U.S. captains transfer their catches to foreign processing vessels. Prior to 1977, there was no documentation of marine mammal by-catch in distant-water fleet (DWF) activities off the northeast coast of the U.S. With implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) in that year, an observer program was established which has recorded fishery data and information of incidental by-catch of marine mammals. DWF effort in the U.S. Atlantic Exclusive Economic Zone (EEZ) under MFCMA has been directed primarily towards Atlantic mackerel and squid. From 1977 through 1982, an average of 120 different foreign vessels per year (range 102-161) operated within the Atlantic coast EEZ. In 1982, there were 112 different foreign vessels; 16%, or 18, were Japanese tuna longline vessels operating along the U.S. east coast. This was the first year that the

Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. Between 1983 and 1991, the numbers of foreign vessels operating within the Atlantic coast EEZ each year were 67, 52, 62, 33, 27, 26, 14, 13, and 9, respectively. Between 1983 and 1988, the numbers of DWF vessels included 3, 5, 7, 6, 8, and 8, respectively, Japanese longline vessels. Observer coverage on DWF vessels was 25-35% during 1977-82, and increased to 58%, 86%, 95%, and 98%, respectively, in 1983-86; 100% observer coverage was maintained during 1987-91. Foreign fishing operations for squid ceased at the end of the 1986 fishing season and for mackerel at the end of the 1991 season.

New England Multispecies Sink Gillnet

Between 1990 and 1996 there were 35 mortalities observed in the New England multispecies sink gillnet fishery. The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year this fishery has been covered by the program. In 1993 there were approximately 349 vessels (full and part time) in the New England multispecies sink gillnet fishery (Walden 1996). Observer coverage, expressed as a percentage of the number of trips has been 1%, 6%, 7%, 5%, 7%, 5%, and 4% for years 1990 to 1996, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. In January to March, the by-catch occurred in Massachusetts Bay, south of Cape Ann and west of Stellwagen Bank. From April to June, by-catch locations became more dispersed, from Casco Bay to Cape Ann, along the 30 fathom contour out to Jeffreys Ledge, with one take location near Cultivator Shoal and one in southern New England near Block Island. In July through September, incidental takes occurred from Frenchman's Bay to Massachusetts Bay. In inshore waters, the takes were aggregated while offshore takes were more dispersed. In October through December, takes were confined from Cape Elizabeth out to Jeffreys Ledge and south to Nantucket Sound. Estimated annual fishery-related mortalities (CV in parentheses) were 49 in 1991 (0.46), 154 in 1992 (0.35), 205 in 1993 (0.31), 240 in 1994 (0.51), 80 in 1995 (1.16), and 114 in 1996 (0.61) (Table 2; Bisack 1997). Average annual estimated fishery-related mortality during 1992-1996 was 159 white-sided dolphins (0.24) (Table 2).

Pelagic Drift Gillnet

During 1991 to 1996, two white-sided dolphins were observed taken in the Atlantic pelagic drift gillnet fishery. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995 and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. In 1994, 1995, and 1996 there were 11, 12, and 10 vessels, respectively, in the fishery (Table 2). Observer coverage, expressed as percent of sets observed was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Observer coverage dropped during 1996 because some vessels were deemed too small or unsafe by the contractor that provided observer coverage. Fishing effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 through 1996 were estimated separately for each year by summing the observed caught and the product of the average by-catch per haul and the number of unobserved hauls as recorded in logbooks. Variances were estimated using bootstrap re-sampling techniques (Bisack 1997). Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 4.4 in 1989 (.71), 6.8 in 1990 (.71), 0.9 in 1991 (.71), 0.8 in 1992 (.71), 2.7 in 1993 (0.17), 0 in 1994, 1995, and 1996. Estimated average annual mortality and serious injury related to this fishery during 1992-1996 was 0.7 white-sided dolphins (0.21) (Table 2).

North Atlantic Bottom Trawl

Three mortalities were documented between 1991 and 1996 in the North Atlantic bottom trawl fishery (Table 2). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year this fishery has been covered by the program. Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under the MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 (CV = 0.04) vessels (full and part time) participated annually in the fishery during 1989-1993. The fishery is active in New England waters in all seasons. The one white-sided dolphin taken in 1992 was in a haul that was composed of 43% cod, 20% silver hake, and 17% pollock. One of the 1994 takes was in a haul that was composed of 42% white hake, 19% pollock, and 16% monkfish. The other 1994 take was in a haul that kept seven species of which none were dominant. The estimated fishery-related mortality from 1992 was 110 (CV = 0.97), from 1994 it was 182 (CV=0.71), and it was 0 in the other years (Bisack 1997). The average annual estimate fishery-related mortality during 1992-1996 was 58.4 white-sided dolphins (CV = 0.57) (Table 2).

CANADA

There is little information available which quantifies fishery interactions involving white-sided dolphins in Canadian waters. Two white-sided dolphins were reported caught in groundfish gillnet sets in the Bay of Fundy during 1985 to 1989, and nine were taken in West Greenland between 1964 and 1966 in the now non-operational salmon drift nets (Gaskin 1992). Several (number not specified) were also taken during the 1960's in the now non-operational Newfoundland and Labrador groundfish gillnets. A few were taken in an experimental drift gillnet fishery for salmon off West Greenland which took place from 1965 to 1982 (Read 1994).

Between January 1993 and December 1994, 36 Spanish deep water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211sets), were observed in NAFO Fishing Area 3 (off the Grand Bank) (Lens 1997). A total of 47 incidental catches were recorded, which included six white-sided dolphins. The incidental mortality rate for white-sided dolphins was (0.042/set). More recent information on Canadian white-sided dolphin takes were not available.

Table 2. Summary of the incidental mortality of white-sided dolphins (*Lagenorhynchus acutus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
New England Multispecies Sink Gillnet	92-96	1993=349	Obs. Data Weighout Trip Logbook	.07, .05, .07, .05, .04	9, 7, 10[3], 2[3], 2[3]	154, 205, 240[3], 80[3], 114[3]	.35, .31, .51, 1.16, .61	158.6 (.24)
Pelagic Drift Gillnet	92-96	1994=11[4] 1995=12 1996=10	Obs. Data Logbook	.40, .42, .87, .99,.64	0[5], 2[5], 0[5], 0[5], 0[5]	0.8[5], 2.7[5], 0[5], 0[5], 0[5]	.71, 0.17, 0, 0, 0	0.7 (.21)
North Atlantic Bottom Trawl	92-96	1993=970	Obs. Data Weighout	.006, .004, .004,.011[6], NA[6]	1, 0, 2, 0, 0	110, 0, 182, 0, 0	.97, 0, .71, 0, 0	58.4 (.57)
Total								217.7 (.23)

1 Observer data (Obs. Data) are used to estimate by-catch rates, and the data are collected by the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects Weighout (Weighout) landings data, which are used as a measure of total effort for the sink gillnet fishery. Mandatory trip logbook (Trip Logbook) data are used to determine the spatial distribution of some fishing effort in the sink gillnet fishery. Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet fishery, and these data are collected by the Southeast Fisheries Science Center (SEFSC).

2 The observer coverage for the sink gillnet fishery is expressed as a percentage of trips, the pelagic drift gillnet fishery is expressed as a percentage of sets, and the Atlantic bottom trawl fishery is expressed as a percentage of days fished.

3 White-sided dolphins taken on observed pinger trips were added directly to the estimated total by-catch for that year. There was one observed white-sided dolphin take on a pinger trip in 1994, which was not included in the observed mortality column above. No takes were observed on pinger trips during 1995 and 1996.

4 1994 to 1996 are shown, other years were not available on an annual basis.

[5] For 1991-1993, pooled by-catch rates were used to estimate by-catch in months that had fishing effort but did not have observer coverage (Northridge 1996). In 1994 to 1996, observer coverage increased substantially, so by-catch rates were not pooled (Bisack 1997).

[6] Observer coverage for the Atlantic bottom trawl fishery in 1995 is based on only January to May data (the only time takes were observed). Observer coverage is currently not available for 1996.

Other Mortality

Mass strandings involving up to a hundred or more animals at one time are common for this species. From 1968 to 1995, 349 Atlantic white-sided dolphins were known to have stranded on the New England coast (Hain and Waring 1994; Smithsonian stranding records 1996). The causes of these strandings are not known. Because such strandings have been known since antiquity, it could be presumed that recent strandings are a normal condition (Gaskin 1992). It is unknown whether human causes, such as fishery interactions and pollution, have increased the number of strandings. Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

STATUS OF STOCK

The status of white-sided dolphins, relative to OSP, in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine population trends for this species. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because estimated average annual fishery-related mortality and serious injury exceeds PBR.

REFERENCES

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine Mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA, 5 pp.

Barlow, J., S. L. Swartz, T. C. Eagle, and P. R. Wade. 1995. U.S. Marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. U.S.Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bisack, K.D. 1997. Marine mammal bycatch estimates and their sampling distributions in the U.S. New England sink gillnet, pair trawl, Atlantic pelagic drift gillnet and North Atlantic bottom trawl fisheries - 1994 to 1996. NOAA, NMFS, NEFSC. Woods Hole, MA. Working paper SC/49/SM35 submitted to the IWC Scientific Committee meeting in Bournemouth, UK, Aug/Sept 1997.

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance Sampling: Estimating abundance of biological populations. *Chapman & Hall*, New York, 446 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Evans, P. G. H. 1987. The natural history of whales and dolphins. Facts on File Publications, New York, 343 pp.

Gaskin, D. E. 1992. Status of Atlantic white-sided dolphin, *Lagenorhynchus acutus*, in Canada. *Can. Fld. Nat. 106: 64-72.*

Gilbert, J. R. and K. M. Wynne. 1987. Marine mammal interactions with New England gillnet fisheries. Final Report, Contract No. NA-84-EAC-00070, N.M.F.S., Northeast Fisheries Science Center, Woods Hole, Massachusetts, 12 pp.

Hain, J. H. W. and G. T. Waring. 1994. Statuses of and human effects upon marine mammals. *In:* R. W. Langton , J. B. Pearce, and J.A. Gibson (eds), *Selected living resources, habitat conditions, and human perturbations of the Gulf of Maine: Environmental and ecological considerations for fishery managements*. NOAA Tech. Mem. NMFS-NE-106, Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Katona, S. K., V. Rough, and D. T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. *Smithsonian Institution Press*, Washington, DC, 316 pp.

Kenney, R.D., Payne, P.M., Heinemann, D.W. and Winn, H.E. 1996. Shifts in Northeast shelf cetacean distributions relative to trends in Gulf of Maine/Georges Bank finfish abundance. Pp. 169-196. *In:* K. Sherman, N.A. Jaworski and T. Smada (eds.). *The northeast shelf ecosystem: assessment, sustainability, and management*. Blackwell Science, Cambridge, MA 02142, USA.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES C.M. 8/Q. 10 pp.*

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna driftnet and pair trawl fisheries. Draft final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Palka, D., Read, A. and Potter, C. 1997. Summary of knowledge of white-sided dolphins (*Lagenorhynchus acutus*) from the U.S. and Canadian North Atlantic waters. *Rep. int. Whal. Commn. 47: 729-34.*

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. Northeast Fish. Sci. Cent. Ref. Doc. 96-04; 37p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.). Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16.*

Payne, M. and D. W. Heinemann. 1990. A distributional assessment of cetaceans in the shelf and shelf edge waters of the northeastern United States based on aerial and shipboard surveys, 1978-1988. Report to National Marine Fisheries Science Center, Woods Hole, Massachusetts.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Sergeant, D. E., D. J. St. Aubin, and J. R. Geraci. 1980. Life history and northwest Atlantic status of the Atlantic white-sided dolphin, *Lagenorhynchus acutus*. *Cetology No. 37: 1-12.*

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Walden, J. 1996. The New England gillnet effort study. NOAA, NMFS, NEFSC Ref. Doc. No. 96-10, 38pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry, and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull., U.S. 88(2): 347-360.*

COMMON DOLPHIN (*Delphinus delphis*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The common dolphin may be one of the most widely distributed species of cetaceans, as it is found world-wide in temperate, tropical, and subtropical seas. In the North Atlantic, common dolphins appears to be present along the coast over the continental shelf along the 200-300 m isobaths or over prominent underwater topography from 50° N to 40°S latitude (Evans 1994). The species is less common south of Cape Hatteras, although schools have been reported as far south as eastern Florida (Gaskin 1992). At least some of the reported sightings of common dolphins in the Gulf of Mexico may have been *Stenella clymene*, which has a color pattern similar to that of common dolphins (Evans 1994). Information regarding common dolphin stock structure in the western North Atlantic does not exist. However, a high variance in skull morphometric measurements suggests the existence of more than a single stock (J. G. Mead, pers. comm.).

Common dolphins are distributed in broad bands along the continental slope (100 to 2,000 meters), and are associated with other Gulf Stream features in waters off the northeastern U.S. coast (CETAP 1982; Selzer and Payne 1988; Waring *et al.* 1992). They are widespread from Cape Hatteras northeast to Georges Bank (35º to 42º North latitude) in outer continental shelf waters from mid-January to May (Hain *et al*. 1981; CETAP 1982; Payne *et al*. 1984). Common dolphins move northward onto Georges Bank and the Scotian Shelf from mid-summer to autumn. Selzer and Payne (1988) reported very large aggregations (greater than 3,000 animals) on Georges Bank in autumn. Common dolphins are rarely found in the Gulf of Maine, where temperature and salinity regimes are lower than on the continental slope of the Georges Bank/mid-Atlantic region (Selzer and Payne 1988). Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs during summer and autumn when water temperatures exceed 11°C (Sergeant *et al*. 1970; Gowans and Whitehead 1995).

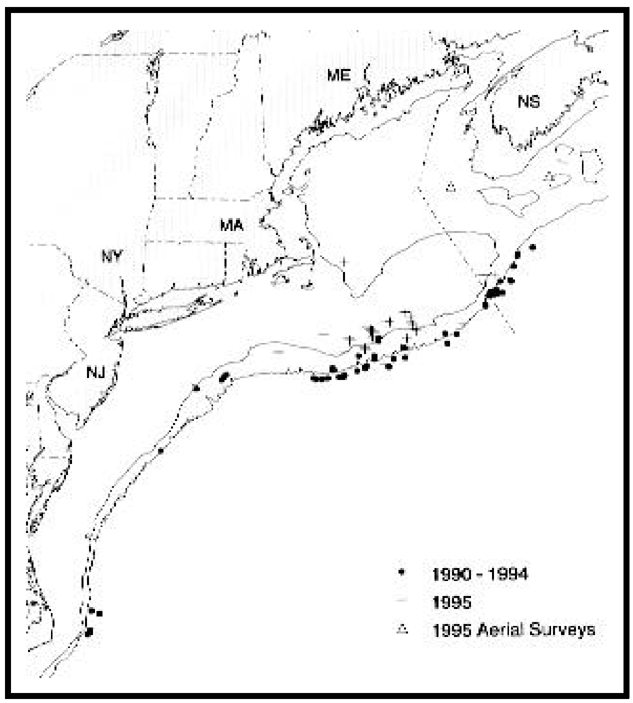

Figure 1. *Distribution of common dolphin sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

POPULATION SIZE

The total number of common dolphins off the eastern U.S. and Canadian Atlantic coast is unknown, although four estimates are available from selected regions during June-July 1991, June-July 1993, and July-September 1995 (Table 1; Figure 1).

A population size of 29,610 (CV = 0.39) common dolphins was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). R. Kenney (pers. comm.) provided abundance estimates that accounted for survey effort in two continental slope survey blocks and uncertainties resulting from sightings of unidentified small dolphins. The estimate is based on an inverse variance weighted pooling of spring and summer data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty, its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 22,215 (CV=0.40) common dolphins was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000 m isobaths from Cape Hatteras to Georges Bank (Table 1; Waring *et al.* 1992; Waring 1998). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but no corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 1,645 (CV=0.47) common dolphins was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000 m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 6,741(CV=0.69) common dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS, unpublished data). Total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. However, the August 1995 ship survey on Georges Bank was greatly hindered by hurricane events. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques.

Although the 1991, 1993, and 1995 surveys did not sample the same areas or encompass the entire common dolphin habitat (e. g., little effort in Scotian shelf edge waters), they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The 1991, 1993, and 1995 data suggest that, seasonally, at least several thousand common dolphins are occupying continental shelf edge waters, with perhaps highest abundance in the Georges Bank region. This is consistent with the earlier CETAP data from a decade previous. Survey coverage to date is not adequate to provide a definitive estimate of common dolphin abundance for the western North Atlantic.

The best available current abundance estimate for common dolphins is 22,215 (CV=0.40) as estimated from the June to July 1991 line transect survey because this survey provided the most complete coverage of the known habitat, particularly Georges Bank which was inadequately surveyed in 1995 (see above).

Table 1. Summary of abundance estimates for western North Atlantic common dolphin. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring & summer 1978-82	Cape Hatteras, NC to Nova Scotia	29,610	0.39
Jun-Jul 1991	Cape Hatteras, NC to Georges Bank, shelf edge only	22,215	0.40
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	1,645	0.47
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	6,741	0.69

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for common dolphins is 22,215 (CV=0.40). The minimum population estimate for the western North Atlantic common dolphin is 16,060 (CV=0.40).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 16,060 (CV=0.40). The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic common dolphin is 161.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality to this stock during 1992-1996 was 247 common dolphins (CV = 0.14; Table 2).

Fishery Information

USA

Prior to 1977, there was no documentation of marine mammal by-catch in distant-water fleet (DWF) activities off the northeast coast of the U.S. With implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA), an observer program was established which has recorded fishery data and information of incidental by-catch of marine mammals. DWF effort in the Atlantic coast Exclusive Economic Zone (EEZ) under MFCMA has been directed primarily towards Atlantic mackerel and squid. From 1977 through 1982, an average of 120 different foreign vessels per year (range 102-161) operated within the Atlantic coast EEZ. In 1982, there were 112 different foreign vessels; 16%, or 18, were Japanese tuna longline vessels operating along the U.S. east coast. This was the first year that the Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels. Between 1983 and 1991, the numbers of foreign vessels operating within the Atlantic coast EEZ each year were 67, 52, 62, 33, 27, 26, 14, 13, and 9, respectively. Between 1983 and 1988, the numbers of DWF vessels included 3, 5, 7, 6, 8, and 8, respectively, Japanese longline vessels. Observer coverage on DWF vessels was 25-35% during 1977-82, and increased to 58%, 86%, 95%, and 98%, respectively, in 1983-86. From 1987-91, 100% observer coverage was maintained. Foreign fishing operations for squid and mackerel ceased at the end of the 1986 and 1991 fishing seasons, respectively.

During the period 1977-1986, observers recorded 123 mortalities in foreign *Loligo* squid-fishing activities (Waring *et al*. 1990). In 1985 and 1986, Italian vessels took 56 and 54 animals, respectively, which accounts for 89% (n = 110) of the total takes in foreign *Loligo* squid-fishing operations. No mortalities were reported in foreign *Illex* squid fishing operations. Because of spatial/temporal fishing restrictions, most of the by-catch occurred along the continental shelf edge (100 m) isobath during winter (December to February).

From 1977-1991, observers recorded 110 mortalities in foreign mackerel-fishing operations (Waring *et al*. 1990; NMFS unpublished data). This total includes one documented take by a U.S. vessel involved in joint-venture fishing operations in which U.S. captains transfer their catches to foreign processing vessels. The by-catch occurred during winter/spring (December to May).

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet, pelagic pair trawl, mid-Atlantic coastal sink gillnet, North Atlantic bottom trawl, New England multispecies sink gillnet, and Atlantic squid, mackerel, butterfish trawl fisheries, but no mortalities or serious injuries have documented in pelagic longline fishery.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fishery information. Variances were estimated using bootstrap re-sampling techniques. Six hundred and six common dolphin mortalities were observed between 1989 and 1996 in this fishery. Mortalities were observed in all seasons and areas. Seven animals were released alive, but six were injured. Estimated annual mortality and serious injury attributable to this fishery (CV in parentheses) was 540 in 1989 (0.19), 893 in 1990 (0.18), 223 in 1991 (0.12), 227 in 1992 (0.09), 238 in 1993 (0.08), 163 in 1994 (0.02), 83 in 1995 (0), and 106 in 1996 (0.07); average annual estimated fishery-related mortality during 1992-1996 attributable to this fishery was 164 common dolphins (CV = 0.04) (Table 2). Injured and released alive animals are not included in the Table 2 mortality estimates. The 1992-1996 period provides a better characterization of this fishery (i.e., fewer vessels and increased observer coverage). Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Pelagic Pair Trawl

During the period 1989 to 1993, effort in the pelagic pair trawl fishery increased from zero hauls in 1989 and 1990, to an estimated 171 hauls in 1991 and then to an estimated 536 hauls in 1992 and 586 in 1993, 407 in 1994 and 440 in 1995. This fishery ceased operations in 1996, when NMFS rejected a petition to consider pair trawl gear as an authorized gear type in Atlantic tunas fishery. The fishery operated from August to November in 1991, from June to November in 1992, from June to October in 1993 (Northridge 1996), and from mid-summer to December in 1994 & 1995. Sea sampling began in October of 1992 (Gerrior *et al*. 1994) where 48 sets (9% of the total) were sampled. In 1993, 102 hauls (17% of the total) were sampled. In 1994 and 1995, 52% (212) and 55% (238), respectively, of the sets were observed. Nineteen vessels have operated in this fishery. The fishery operates in the area between 35°N to 41°N and 69°W to 72°W. Approximately 50% of the total effort was within a one degree square at 39°N, 72°W, around Hudson Canyon from 1991 to 1993. Examination of the (1991-1993) locations and species composition of the by-catch, showed little seasonal change for the six months of operation and did not warrant any seasonal or areal stratification of this fishery. Twelve mortalities were observed between 1991 and 1995. The estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was 5.6 in 1991 (0.53), 32 in 1992 (0.48), 35 in 1993 (0.43), 0 in 1994 (0), and 5.6 in 1995 (0.35). Average annual estimate fishery-related mortality attributable to this fishery during 1992-1993 was 18.2 common dolphins (CV = 0.30) (Table 2).

During the 1994 and 1995 experimental pelagic pair trawl fishing seasons, fishing gear experiments were conducted to collect data on environmental parameters, gear behavior, and gear handling practices to evaluate factors affecting catch and bycatch (Goudey 1995, 1996). Results of these studies have been presented at Offshore Cetacean Take Reduction Team Meetings.

New England Multispecies Sink Gillnet

In 1993, there were approximately 349 full and part-time vessels in the New England multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, and 4% for 1990 to 1996, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. In 1996, the first observed mortality of common dolphins in this fishery was recorded. The estimated mortality was 63 common dolphins (CV = 1.39); estimated annual mortality (1992-1996) was 12.6 common dolphins (CV = 1.39) (Table 2). Annual estimates of common dolphin by-catch in the New England multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort.

Atlantic Coastal Gillnet

Observer coverage of the U.S. Atlantic coastal gillnet fishery was initiated by the NEFSC Sea Sampling program in July, 1993; and from July to December 1993, 20 trips were observed. During 1994 and 1995 221 and 382 trips were observed, respectively. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. The number of vessels in this fishery is unknown, because records which are held by both state and federal agencies have not been centralized and standardized. Observer coverage, expressed as percent of tons of fish landed, was 5% and 4% for 1995 and 1996 (Table 2).

No common dolphins were taken in observed trips during 1993 and 1994. Two common dolphin were observed taken in 1995 and 1996 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All by-catches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 7.4 in 1995 (CV = 0.69) and 43 in 1996 (0.79). Average annual estimated fishery-related mortality attributable to this fishery during 1995-1996 was 25 common dolphins (CV = 0.68)

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 vessels (full and part time) participated annually in the fishery during 1991-1995. The fishery is active in all seasons in New England waters. Three mortalities were observed between 1991-1995. The estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was 0 in 1991, 0 in 1992, 0 in 1993, 0 in 1994 (0), and 142 in 1995 (0.77). Average annual estimated fishery-related mortality attributable to this fishery during 1992-1996 was 28.4 common dolphins (CV = 0.77) (Table 2).

Atlantic Squid, Mackerel, Butterfish Trawl

The mid-Atlantic mackerel and squid trawl fisheries were combined into the Atlantic mid-water trawl fishery in the revised proposed list of fisheries in 1995. The fishery occurs along the U.S. mid-Atlantic continental shelf region between New Brunswick, Canada, and Cape Hatteras year around. The mackerel trawl fishery was classified as a Category II fishery since 1990 and the squid fishery was originally classified as a Category II fishery in 1990, but was reclassified as a Category III fishery in 1992. The combined fishery was reclassified as a Category II fishery in 1995. In 1996, mackerel, squid, and butterfish trawl fisheries were combined into the Atlantic squid, mackerel, and butterfish trawl fishery, and maintained a Category II classification. Three common dolphin mortalities were observed in 1996 (Table 2). The estimate of the annual mortality is underway.

Estimated average annual mortality and serious injury during 1992-1996 for all of the NMFS-observed fisheries is 247 common dolphins per year (CV = 0.14) (Table 2).

CANADA

Between January 1993 and December 1994, 36 Spanish deep water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211sets), were observed in NAFO Fishing Area 3 (off the Grand Bank) (Lens 1997). A total of

47 incidental catches were recorded, which included one common dolphin. The incidental mortality rate for common dolphins was (0.007/set).

Table 2. Summary of the incidental mortality of common dolphins (*Delphinus delphis*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality [6]	Estimated CVs	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=11 1995=12 1996=10[3]	Obs. Data Logbook	.40, .42, .87, .99, .64	97, 113, 142, 82, 74	223, 227, 238, 163, 83[4],106	.12, .09, .08, .02, 0, .07	163.6 (.04)
Pelagic Pair Trawl	92-95	12	Obs. Data Logbook	.10, .18, .52, .54	3, 6, 0, 3	32, 35, 0, 5.6	.48, .43, 0, .35	18.2 (.30)
New England Multispecies Sink Gillnet	92-96	349	Obs. Data Weighout, Logbooks	.07, .05, .07, .05, .04	0, 0, 0, 0, 1	0, 0, 0, 0, 63	0, 0, 0, 0, 1.39	12.6 (1.39)
Mid-Atlantic Coastal Sink Gillnet	95-96	NA[7]	Obs. Data Weighout	.05, .04	2, 2	7.4, 43	.69, .79	25.0 (.68)
Atlantic squid, mackerel, butterfish trawl	96	NA[7]	Obs. Data Logbook	0.007	3	NA[7]	NA[7]	NA[7]
North Atlantic Bottom Trawl	92-96	970	Obs. Data Weighout	.006, .004, .004, .011[5], NA[7]	0, 0, 0, 3, 0	0, 0, 0, 142, 0	0, 0, 0, .77, 0	28.4 (.77)
TOTAL								247 (.14)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects weighout (Weighout) landings data, and total landings are used as a measure of total effort for the coastal gillnet fishery and days fished are used as total effort for the North Atlantic bottom trawl fishery. Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).

2 The observer coverage for the pelagic drift gillnet and pair trawl fishery is measured in terms of sets, and the North Atlantic bottom trawl fishery is in days fished. Assessments for the coastal gillnet fishery have not been completed. The number of trips sampled by the NEFSC Sea Sampling Program are reported here.

3 1994 - 1996 shown, other years not available on an annual basis.

4 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 7.0 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.50 animals.

5 Observer coverage for the North Atlantic bottom trawl fishery in 1995 is based on January to May data.

6 Injured and released alive animals are not included in the Table 2 mortality estimates.

7 Data not available.

Table 3. Summary of common dolphins (*Delphinus delphis*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured)

Fishery	Years	Ratio	Injured[5]	Uninjured
Pelagic Drift Gillnet	92-96	97/227, 113/238, 142/163, 82/83, 74/106	1[1], 3[2], 1[3], 0, 3[4]	1, 0, 0, 0, 0

1 Released alive and severely injured.
2 Released alive, 2 were moderately injured and 1 common dolphin was severely injured.
3 Released alive and gear was "in/around several body parts".
4 Released alive, one animal "seemed tired," but had few wounds, little bleeding from fluke. Both animals were smaller as compared to other common dolphins taken in the same set.
5 Injured and released alive animals are not included in the Table 2 mortality estimates.

Other Mortality

From 1992-1996, 42 common dolphins were stranded between North Carolina and Massachusetts, predominantly along beaches in the latter state (NMFS unpublished data).

STATUS OF STOCK

The status of common dolphins, relative to OSP, in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because average annual fishery-related mortality and serious injury exceeds PBR.

REFERENCES

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA. 5 pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S. T., D. R. Andersen, K. P. Burnham, and J. L. Laake. 1993. Distance Sampling: Estimating abundance of biological populations. *Chapman and Hall*, New York, 446 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Evans, W. E. 1994. Common dolphin, white-bellied porpoise. Pages 191-224. *In:* S. H. Ridgway and R. Harrison (eds.). Handbook of marine mammals, Volume 5: The first book of dolphins. *Academic Press*, San Diego

Gaskin, D. E. 1992. Status of common dolphin, *Delphinus delphis*, in Canada. *Can. Fld. Nat. 106: 55-63.*

Gerrior, P., A.S. Williams, and D.J. Christensen. 1994. Observations of the 1992 U.S. pelagic pair trawl fishery in the Northwest Atlantic. *Mar. Fish. Rev. 56(3): 24-27.*

Goudy, C.A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic, MITSG 95-6, Cambridge, MA. 10 pp.

Goudy, C.A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic, MITSG 96-17, Cambridge, MA. 13 pp.

Gowans S. and H. Whitehead. 1995. Distribution and habitat partitioning by small odontocetes in the Gully, a submarine canyon on the Scotian Shelf. *Can. J. Zool. 73: 1599-1608.*

Hain, J. H.W., R. K. Edel, H. E. Hays, S. K. Katona, and J. D. Roanowicz. 1981. General distribution of cetaceans in the continental shelf waters of the northeastern U.S. Pages II1-II277 *in* CETAP (Cetacean and Turtle Assessment program), A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf, Annual Report for 1979. Contract No. AA551-CT8-48, U.S. Dept. of Interior, Bureau of Land Management, Washington, DC.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993 . DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Leatherwood, S., D. K. Caldwell, and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES CM 1997/Q:8. 10 pp.*

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.). Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16.*

Payne, P. M., L. A. Selzer, and A. R. Knowlton. 1984. Distribution and density of cetaceans, marine turtles, and seabirds in the shelf waters of the northeastern United States, June 1980-December 1983, based on shipboard observations. NOAA/NMFS Contract No. NA-81-FA-C-00023.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Reilly, S. B. and J. Barlow. 1986. Rates of increase in dolphin population size. *Fish. Bull., U.S. 84(3): 527-533.*

Selzer, L. A. and P. M. Payne. 1988. The distribution of white-sided (*Lagenorhynchus acutus*) and common dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. *Mar. Mamm. Sci. 4(2): 141-153.*

Sergeant, D. E., A. W. Mansfield and B. Beck. 1970. Inshore records of cetacea for eastern Canada, 1949-68. *J. Fish. Res. Bd. Can. 27: 1903-1915.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G.T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA NMFS NEFSC, Lab. Ref. Doc. No. 98-09, 21pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull., U.S. 88(2): 347-360.*

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES Marine Mammals Comm. CM 1992/N: 12, 29 pp.*

ATLANTIC SPOTTED DOLPHIN (*Stenella frontalis*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two species of spotted dolphin in the Western Atlantic — the Atlantic spotted dolphin, *Stenella frontalis*, formerly *S. plagiodon* (Perrin *et al*. 1987), and the pantropical spotted dolphin, *S. attenuata*. These species are difficult to differentiate at sea.

Atlantic spotted dolphins are distributed in tropical and warm temperate waters of the western North Atlantic (Leatherwood *et al*. 1976). Their distribution is from southern New England, south through the Gulf of Mexico and the Caribbean to Venezuela (Leatherwood *et al*. 1976; Perrin *et al*. 1987). The large, heavily spotted form of the Atlantic spotted dolphin along the southeastern and Gulf coasts of the United States inhabits the continental shelf, usually being found inside or near the 200 m isobath (within 250-350 km of the coast) but sometimes coming into very shallow water adjacent to the beach. Off the northeast U.S. coast, spotted dolphins are widely distributed on the continental shelf, along the continental shelf edge, and offshore over the deep ocean south of 40° N (CETAP 1982). Atlantic spotted dolphins regularly occur in the inshore waters south of Chesapeake Bay and near the continental shelf edge and continental slope waters north of this region (Payne *et al*. 1984). Sightings have also been made along the north wall of the Gulf Stream and warm-core ring features (Waring *et al*. 1992). Stock structure in the western North Atlantic is unknown.

POPULATION SIZE

The total number of Atlantic spotted dolphins off the eastern U.S. coast is unknown. However, two population sizes are available for select regions from spring and summer 1978-82 and July-September 1995 (Table 1; Figure 1). Because *S. frontalis* and *S. attenuata* are difficult to differentiate at sea, the reported abundance estimates are for both species of spotted dolphins.

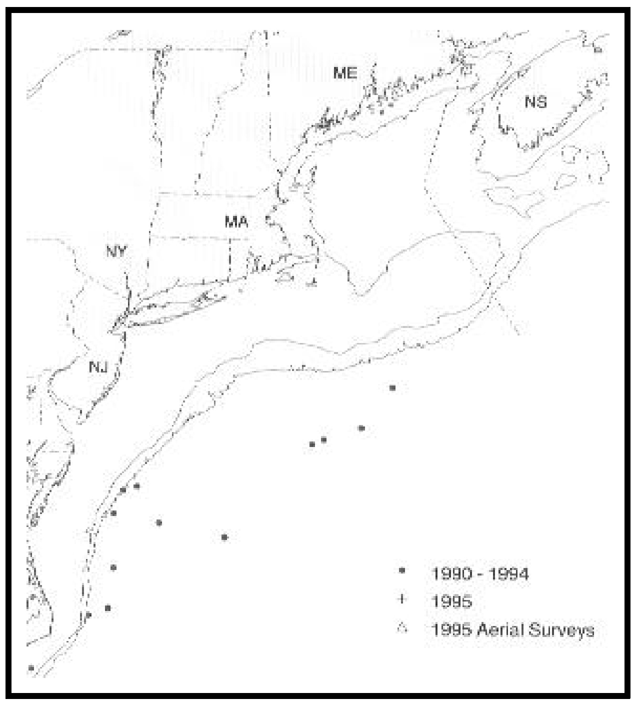

Figure 1. *Distribution of spotted dolphin sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

A population size of 6,107 (CV=0.27) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). R. Kenney (pers. comm.) provided abundance estimates for both species of spotted dolphins combined that accounted for survey effort in two continental slope survey blocks and uncertainties resulting from sightings of unidentified small dolphins. The estimate is based on an inverse variance weighted pooling of spring and summer data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. Furthermore, this survey did not cover important spotted dolphin habitat in the continental shelf between Cape Hatteras and Florida, and Atlantic deep oceanic waters. This estimate may not reflect the current true population size because of its high degree of uncertainty , its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of undifferentiated 4,772 (CV=1.27) spotted dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS, unpublished data). Total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques.

The best available current abundance estimate for the undifferentiated group of spotted dolphins is 4,772 (CV=1.27) as estimated from the July to September 1995 line transect survey (NMFS, unpublished data) because this survey is recent and provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for a combination of the Atlantic and pantropical spotted dolphin. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring & summer 1978-82	Cape Hatteras, NC to Nova Scotia	6,107	0.27
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	4,772	1.27

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for the undifferentiated group of spotted dolphins is 4,772 (CV=1.27). The minimum population estimate for the undifferentiated group of spotted dolphins is 1,617 (CV=1.27).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for the undifferentiated group of spotted dolphins is 1,617 (CV=1.27). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is set to 0.5 because this stock is of unknown status. PBR for the undifferentiated group of spotted dolphins combined is 16. However, it is not reasonable to calculate a PBR for the Atlantic spotted dolphin alone, because it was impossible to separately identify the two species.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality to this stock during 1992-1996 was 16 spotted dolphins (*Stenella* sp.) (CV = 0.08; Table 2).

Fishery Information

No spotted dolphin mortalities were observed in 1977-1991 foreign fishing activities.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989 and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras. Total fishery-related mortality and serious injury cannot be estimated separately for the two species of spotted dolphins in the U.S. Atlantic Exclusive Economic Zone (EEZ) because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that either species might have been subject to the observed fishery-related mortality and serious injury.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet and pelagic longline fisheries, but no mortalities or serious injuries have been documented in the pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal gillnet, and North Atlantic bottom trawl fisheries; and no takes have been documented in a review of Canadian gillnet and trap fisheries (Read 1994).

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fishery information. Variances were estimated using bootstrap re-sampling techniques. Forty-nine spotted dolphin mortalities were observed in the drift gillnet fishery between 1989 and 1996 and occurred northeast of Cape Hatteras within the 183 m isobath in February-April, and near Lydonia Canyon in October. Six whole animal carcasses that were sent to the Smithsonian were identified as Pantropical spotted dolphins (*S. attenuata*). The remaining animals were not identified to species. Estimated annual mortality and serious injury attributable to this fishery (CV in parentheses) was 25 in 1989 (.65), 51 in 1990 (.49), 11 in 1991 (.41), 20 in 1992 (0.18), 8.4 in 1993 (0.40), 29 in 1994 (0.01), 0 in 1995, and 2 in 1996 (0.06); average annual mortality and serious injury during 1992-1996 was 11.9 (0.08) (Table 2). The 1992-1996 period provides a better characterization of the pelagic drift gillnet fishery (i.e., fewer vessels and increased observer coverage).

Pelagic Longline

Interactions between the pelagic longline fishery and spotted dolphins have been reported; however, a vessel may fish in more than one statistical reporting area and it is not possible to separate estimates of fishing effort other than to subtract Gulf of Mexico effort from Atlantic fishing effort, which includes the Caribbean Sea. This fishery has been monitored with about 5% observer coverage, in terms of trips observed, since 1992. Total effort for the pelagic longline fishery (Atlantic, including the Caribbean), based on mandatory self-reported fishery information, was 11,279 sets in 1991, 10,605 sets in 1992, 11,538 in 1993, 11,231 sets in 1994, and 12,713 in 1995 (Cramer 1994; Scott and Brown 1997). The fishery has been observed nearly year round within every statistical reporting area within the EEZ and beyond. Most of the estimated marine mammal by-catch was from EEZ waters between South Carolina and Cape Cod. The 1992-1993, estimated take was based on a generalized linear model (Poisson error assumption) fit to the available observed incidental take and self-reported incidental take and effort data for the fishery (SEFSC unpublished data). The 1994-1995 estimates were based on the Delta-lognormal method (details in Scott and Brown 1997). Annual estimates of mortality and serious injury were based on observed takes across the entire pelagic longline fishery (including the Gulf of Mexico). All observed takes were used because the species occurs throughout the area of the fishery, but observed takes were infrequent in any given region of the fishery. Estimated annual mortality and serious injury attributable to this fishery (CV in parentheses) was 0 in 1992, 16 in 1993 (CV = 0.19), 0 in 1994 and 1995; average annual mortality and serious injury attributable to this fishery in 1992-1995 was 4.0 spotted dolphins (CV =0.19) (Table 2). Annual mortality estimates do not include any animals injured and released alive.

The 1992-1996 total average estimated annual fishery-related mortality of spotted dolphins in the U.S. EEZ was 15.9 (CV = 0.08) (Table 2). Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Table 2. Summary of the incidental mortality of spotted dolphins (*Stenella sp.*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated[6] Mortality	Estimated CVs	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=11[3] 1995=12 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	12, 0, 29, 0, 2	20[4], 8.4, 29, 0, 2	.18, .40, .01, 0, 0[5]	11.9 (.08)
Pelagic Longline	92-95		Obs. Data Logbook	.05	0, 1, 0, 0,	0, 16, 0, 0	0, .19, 0, 0	4 (.19)
TOTAL								15.9 (.08)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).

2 The observer coverage for the pelagic drift gillnet and pair trawl fishery is measured in terms of sets, and the longline fishery is in trips.

3 1994 and 1995 shown, other years not available on an annual basis.

4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). In 1994 and 1995, observer coverage increased substantially, and bycatch rates were not pooled for this period .

5 Estimates were based on 2 seasons. The two observed takes were during the winter season when observer coverage was 100%.

6 Annual mortality estimates do not include any animals injured and released alive.

Table 3. Summary of spotted dolphins (*Stenella sp.*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured)

Fishery	Years	Ratio	Injured[2]	Uninjured
Pelagic Longline	92-95	0, 1/16, 0, 0	0, 0,1[1], 0	0, 0, 1[1], 0

[1] 1994: Trip F15- Pantropical spotted dolphin released alive, tail wrapped in dropline and all was removed; Trip F16- Atlantic spotted dolphin, released alive, hook in corner of mouth, gangion line wrapped around mouth, line was removed but hook remained.

[2] Annual mortality estimates do not include any animals injured and released alive.

Other Mortality

From 1995-1996, six Atlantic spotted dolphins were stranded between North Carolina and Florida (NMFS unpublished data).

STATUS OF STOCK

The status of Atlantic spotted dolphins, relative to OSP in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. Total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because the average annual fishery-related mortality and serious injury of spotted dolphins would exceed PBR for this stock (if it could be calculated) even if the minimum population estimate for spotted dolphins were exclusively *S. frontalis*.

REFERENCES

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S. T., D. R. Andersen, K. P. Burnham, and J. L. Laake. 1993. Distance Sampling: Estimating abundance of biological populations. *Chapman and Hall*, New York, 446 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Cramer, J. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.). *Biology of the Phocoenids*. *Rep. int. Whal. Commn. Special Issue 16.*

Payne, P. M., L. A. Selzer and A. R. Knowlton. 1984. Distribution and density of cetaceans, marine turtles, and seabirds in the shelf waters of the northeastern United States, June 1980-December 1983, based on shipboard observations. NOAA/NMFS Contract No. NA-81-FA-C-00023.

Perrin, W. F.,E. D. Mitchell, J. G. Mead, D. K. Caldwell, M. C. Caldwell, P. J. H. van Bree, and W. H. Dawbin. 1987. Revision of the spotted dolphins, *Stenella* sp. *Mar. Mamm. Sci. 3(2): 99-170.*

Perrin, W. F., D. K. Caldwell, and M. C. Caldwell. 1994. Atlantic spotted dolphin. Pages 173-190. *In*: S. H. Ridgway and R. Harrison (eds.). Handbook of marine mammals, Volume 5: The first book of dolphins. *Academic Press*, San Diego, 418 pp.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Scott, G.P. and C.A. Brown. 1997. Estimates of marine mammal and marine turtle catch by the US Atlantic pelagic longline fleet in 1994-1995. Miami Laboratory Contribution MIA-96/97-28

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES Marine Mammals Comm. CM 1992/N:12, 29 pp.*

PANTROPICAL SPOTTED DOLPHIN (*Stenella attenuata*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two species of spotted dolphin in the Western Atlantic — the Atlantic spotted dolphin, *Stenella frontalis*, formerly *S. plagiodon* (Perrin *et al*. 1987), and the pantropical spotted dolphin, *S. attenuata*. These species are difficult to differentiate at sea.

The pantropical spotted dolphin is distributed worldwide in tropical and some sub-tropical oceans (Perrin *et al.* 1987; Perrin and Hohn 1994). Sightings of this species in the northern Gulf of Mexico occur over the deeper waters, and rarely over the continental shelf or continental shelf edge (Mullin *et al*. 1991; SEFSC, unpublished data). Pantropical spotted dolphins were seen in all seasons during recent seasonal aerial surveys of the northern Gulf of Mexico, and during recent winter aerial surveys offshore of the southeastern U.S. Atlantic coast (SEFSC unpublished data). Some of the Pacific populations have been divided into different geographic stocks based on morphological characteristics (Perrin *et al*. 1987; Perrin and Hohn 1994); however, there is no information on stock differentiation in the Atlantic population.

POPULATION SIZE

The total number of pantropical spotted dolphins off the eastern U.S. coast is unknown; however, two abundance estimates are available for the combination of both spotted dolphin species within portions of the northeastern U.S. Atlantic during spring and summer of 1978-82, and July-September 1995 (Table 1; Figure 1). Neither survey distinguishes between the two species or covers important spotted dolphin habitat in the continental shelf between Cape Hatteras and Florida, or in oceanic waters.

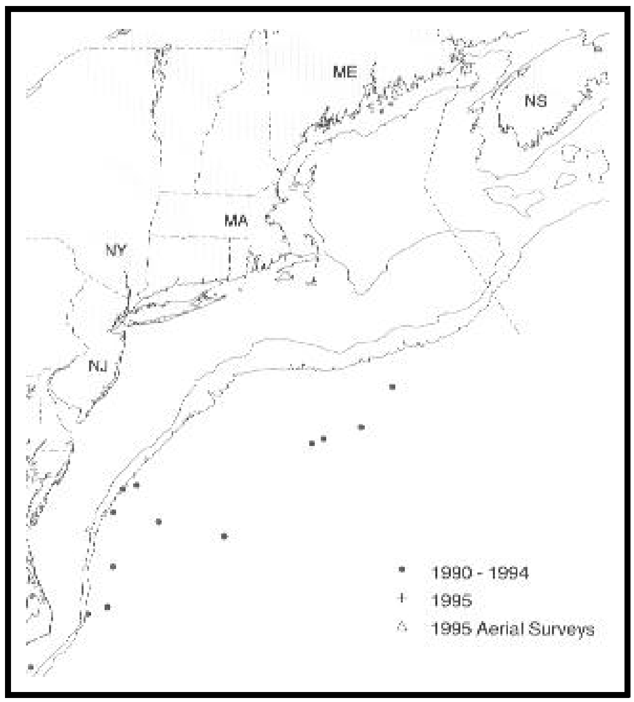

Figure 1. *Distribution of spotted dolphin sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

A population size of 6,107 spotted dolphins (CV=0.27) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). R. Kenney (pers. comm.) provided abundance estimates for both species of spotted dolphins combined that accounted for survey effort in two continental slope survey blocks and uncertainties resulting from sightings of unidentified small dolphins. The estimate is based on inverse variance-weighted pooling of the revised CETAP (1982) spring and summer data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty, its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

Due to insufficient numbers of spotted dolphin sightings collected during the August 1990, June-July 1991, August-September 1991 and June-July 1993 sighting surveys spotted dolphin abundance was not estimated.

A population size of undifferentiated 4,772 (CV = 1.27) spotted dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS, unpublished data). Total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al*. 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques.

The best available current abundance estimate for the undifferentiated group of spotted dolphins is 4,772 (CV=1.27) as estimated from the July to September 1995 line transect survey (NMFS, unpublished data) because this survey is recent and provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for both species of spotted dolphins. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring & summer 1978-82	Cape Hatteras, NC to Nova Scotia	6,107	0.27
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	4,772	1.27

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for spotted dolphins is 4,772 (CV=1.27). The minimum population estimate for spotted dolphins is 1,617 (CV=1.27).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for the undifferentiated group of spotted dolphins is 1,617 (CV=1.27). The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the undifferentiated group of spotted dolphins combined is 16. However, it is not reasonable to calculate a PBR for the pantropical spotted dolphin alone, because it was impossible to separately identify the two species.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or to this stock during 1992-1996 was 16 spotted dolphins (*Stenella* sp.) (CV = 0.08; Table 2).

Fishery Information

No spotted dolphin mortalities were observed in 1977-1991 foreign fishing activities.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989 and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras. Total fishery-related mortality and serious injury cannot be estimated separately for the two species of spotted dolphins in the U.S. Atlantic Exclusive Economic Zone (EEZ) because of the uncertainty in species identification by fishery observers. The Atlantic Scientific Review Group advised adopting the risk-averse strategy of assuming that either species might have been subject to the observed fishery-related mortality and serious injury.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet and pelagic longline fisheries, but no mortalities or serious injuries have been documented in the pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal gillnet, and North Atlantic bottom trawl fisheries; and no takes have been documented in a review of Canadian gillnet and trap fisheries (Read 1994).

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fishery information. Variances were estimated using bootstrap re-sampling techniques. Forty-nine spotted dolphin mortalities were observed in the drift gillnet fishery between 1989 and 1996 and occurred northeast of Cape Hatteras within the 183 m isobath in February-April, and near Lydonia Canyon in October. Six whole animal carcasses that were sent to the Smithsonian were identified as Pantropical spotted dolphins (*S. attenuata*). The remaining animals were not identified to species. Estimated annual mortality and serious injury attributable to this fishery (CV in parentheses) was 25 in 1989 (.65), 51 in 1990 (.49), 11 in 1991 (.41), 20 in 1992 (0.18), 8.4 in 1993 (0.40), 29 in 1994 (0.01), 0 in 1995, and 2 in 1996 (0.06); average annual mortality and serious injury during 1992-1996 was 11.9 (0.08) (Table 2). The 1992-1996 period provides a better characterization of the pelagic drift gillnet fishery (i.e., fewer vessels and increased observer coverage).

Pelagic Longline

Interactions between the pelagic longline fishery and spotted dolphins have been reported; however, a vessel may fish in more than one statistical reporting area and it is not possible to separate estimates of fishing effort other than to subtract Gulf of Mexico effort from Atlantic fishing effort, which includes the Caribbean Sea. This fishery has been monitored with about 5% observer coverage, in terms of trips observed, since 1992. Total effort for the pelagic longline fishery (Atlantic, including the Caribbean), based on mandatory self-reported fishery information, was 11,279 sets in 1991, 10,605 sets in 1992, 11,538 in 1993, 11,231 sets in 1994, and 12,713 in 1995 (Cramer 1994; Scott and Brown 1997). The fishery has been observed nearly year round within every statistical reporting area within the EEZ and beyond. Most of the estimated marine mammal by-catch was from EEZ waters between South Carolina and Cape Cod. The 1992-1993, estimated take was based on a generalized linear model (Poisson error assumption) fit to the available observed incidental take and self-reported incidental take and effort data for the fishery (SEFSC unpublished data). The 1994-1995 estimates were based on the Delta-lognormal method (details in Scott and Brown 1997). Annual estimates of mortality and serious injury were based on observed takes across the entire pelagic longline fishery (including the Gulf of Mexico). All observed takes were used because the species occurs throughout the area of the fishery, but observed takes were infrequent in any given region of the fishery. Estimated annual mortality and serious injury attributable to this fishery (CV in parentheses) was 0 in 1992, 16 in 1993 (CV = 0.19), 0 in 1994 and 1995; average annual mortality and serious injury attributable to this fishery in 1992-1995 was 4.0 spotted dolphins (CV =0.19) (Table 2). Annual mortality estimates do not include any animals injured and released alive.

The 1992-1996 total average estimated annual fishery-related mortality of spotted dolphins in the U.S. EEZ was 15.9 (CV = 0.08) (Table 2). Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Table 2. Summary of the incidental mortality of spotted dolphins (*Stenella sp.*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated[6] Mortality	Estimated CVs	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=11[3] 1995=12 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	12, 0, 29, 0, 2	20[4], 8.4, 29, 0, 2	.18, .40, .01, 0, 0[5]	11.9 (.08)
Pelagic Longline	92-95		Obs. Data Logbook	.05	0, 1, 0, 0,	0, 16, 0, 0	0, .19, 0, 0	4 (.19)
TOTAL								15.9 (.08)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).

2 The observer coverage for the pelagic drift gillnet and pair trawl fishery is measured in terms of sets, and the longline fishery is in trips.

3 1994 and 1995 shown, other years not available on an annual basis.

4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). In 1994 and 1995, observer coverage increased substantially, and bycatch rates were not pooled for this period.

5 Estimates were based on 2 seasons. The two observed takes were during the winter season when observer coverage was 100%.

6 Annual mortality estimates do not include any animals injured and released alive.

Table 3. Summary of spotted dolphins (*Stenella sp.*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured)

Fishery	Years	Ratio	Injured[2]	Uninjured
Pelagic Longline	92-95	0, 1/16, 0, 0	0, 0,1[1], 0	0, 0, 1[1], 0

[1] 1994: Trip F15- Pantropical spotted dolphin released alive, tail wrapped in dropline and all was removed; Trip F16- Atlantic spotted dolphin, released alive, hook in corner of mouth, gangion line wrapped around mouth, line was removed but hook remained.

[2] Annual mortality estimates do not include any animals injured and released alive.

Other Mortality

From 1995-1996, 15 Pantropical spotted dolphins were stranded between North Carolina and Florida (NMFS unpublished data). The 15 mortalities includes the 1996 mass stranding of 11 animals in Florida, five animals were successfully lured with food back to sea (NMFS unpubl. data).

STATUS OF STOCK

The status of pantropical spotted dolphins, relative to OSP in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. Total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because the average annual fishery-related mortality and serious injury of spotted dolphins would exceed PBR for this stock (if it could be calculated) even if the minimum population estimate for spotted dolphins were exclusively *S. attenuata*.

REFERENCES

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S.T., D.R. Anderson, K.P. Burnham and J.L. Laake. 1993. Distance sampling: estimating abundance of biological populations. *Chapman and Hall*, New York, NY, 442 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Cramer, J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.

Mullin, K., W. Hoggard, C. Roden, R. Lohoefener, C. Rogers and B. Taggart. 1991. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. OCS Study/MMS 91-0027. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, Louisiana, 108 pp.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.). Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16.*

Perrin, W. F.,E. D. Mitchell, J. G. Mead, D. K. Caldwell, M. C. Caldwell, P. J. H. van Bree, and W. H. Dawbin. 1987. Revision of the spotted dolphins, *Stenella* sp. *Mar. Mamm. Sci. 3(2): 99-170.*

Perrin, W. F., D. K. Caldwell, and M. C. Caldwell. 1994. Atlantic spotted dolphin. Pages 173-190. *In:* S. H. Ridgway and R. Harrison (eds.). Handbook of marine mammals, Volume 5: The first book of dolphins. *Academic Press*, San Diego, 418 pp.

Perrin, W. F. and A. A. Hohn. 1994. Pantropical spotted dolphin *Stenella attenuata*. Pages 71-98. *In*: S. H. Ridgway and R. Harrison (eds.). Handbook of marine mammals, Vol. 5: The first book of dolphins. *Academic Press*, San Diego, 418 pp.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Scott, G.P. and C.A. Brown. 1997. Estimates of marine mammal and marine turtle catch by the US Atlantic pelagic longline fleet in 1994-1995. Miami Laboratory Contribution MIA-96/97-28

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-012, 93 pp.

December 1998

STRIPED DOLPHIN (*Stenella coeruleoalba*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The striped dolphin, *Stenella coeruleoalba*, is distributed worldwide in temperate and tropical seas of the world. Striped dolphins are found in the western North Atlantic from Nova Scotia south to at least Jamaica and in the Gulf of Mexico. In general, striped dolphins appear to prefer continental slope waters offshore to the Gulf Stream (Leatherwood *et al*. 1976; Perrin *et al*. 1994; Schmidly 1981). There is no information concerning striped dolphin stock structure in the western North Atlantic.

In waters off the northeastern U.S. coast, striped dolphins are distributed along the continental shelf edge from Cape Hatteras to the southern margin of Georges Bank, and also occur offshore over the continental slope and rise in the mid-Atlantic region (CETAP 1982). Continental shelf edge sightings in this program were generally centered along the 1,000 m depth contour in all seasons (CETAP 1982). During 1990 and 1991 cetacean habitat-use surveys, striped dolphins were associated with the Gulf Stream north wall and warm-core ring features (Waring *et al*. 1992). Striped dolphins seen in a survey of the New England Sea Mounts (Palka 1997) were in waters that were between 20^0 to 27^0C and deeper than 900 m. Sightings of striped dolphins between Cape Hatteras, NC and the Atlantic side of Florida have not been documented in dedicated sighting surveys (Palka 1997), though there are records of strandings on beaches from North Carolina to Florida (Smithsonian database).

Although striped dolphins are considered to be uncommon in Canadian Atlantic waters (Baird *et al*. 1993), recent summer sightings (2-125 individuals) in the deeper and warmer waters of the Gully (submarine canyon off eastern Nova Scotia shelf) suggest that this region may be an important part of their range (Gowans and Whitehead 1995; Baird *et al*. 1997).

POPULATION SIZE

The total number of striped dolphins in the U.S. Exclusive Economic Zone (EEZ) is unknown; however, three abundance estimates are available for portions of the northeastern U.S. Atlantic during spring and summer 1978-82, August to September 1991, and July to September 1995 (Table 1; Figure 1).

A population size of 36,780 striped dolphins (CV=0.27) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). R. Kenney (pers. comm.) provided abundance estimates that accounted for survey effort in two continental slope survey blocks and uncertainties resulting from sighting of unidentified small dolphins. The estimate is based on an inverse variance weighted pooling of spring and summer data. An average of these seasons were chosen because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during these seasons. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty (e.g., large CV), its old age, and it

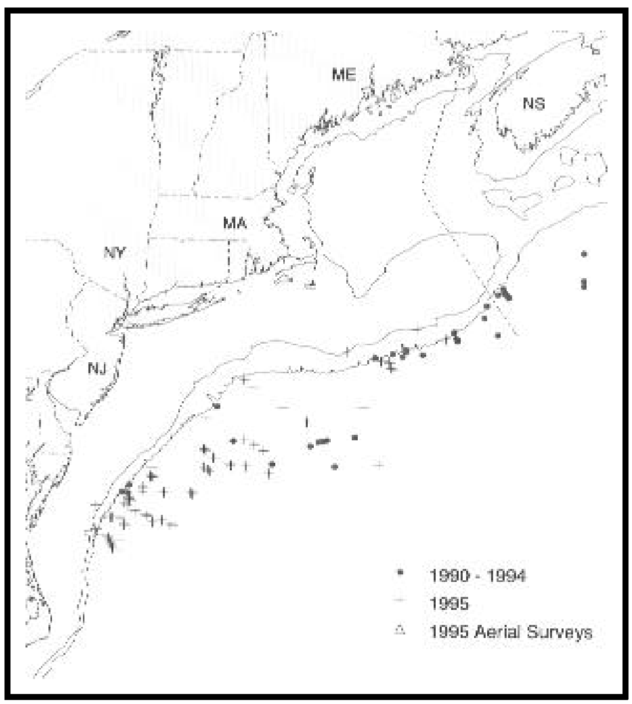

Figure 1. *Distribution of striped dolphin sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 25,939 (CV=0.36) and 13,157 (CV=0.45) striped dolphins was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Table 1; Anon. 1991). The study area included that covered in the CETAP study plus several additional continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. The data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993), where the CV was estimated using the bootstrap option. The abundance estimates do not include g(0) and were not pooled over platforms because the inter-platform calibration analysis has not been conducted.

Due to insufficient numbers of striped dolphin sightings collected during the August 1990, June-July 1991 (Waring, 1998), and June-July 1993 shipboard sighting surveys, striped dolphin abundances for these surveys were not estimated.

A population size of 31,669 (CV=0.73) striped dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS, unpublished data). Total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques.

The best available current abundance estimate for striped dolphins is 31,669 (CV=0.73) as estimated from the July to September 1995 line transect survey (NMFS, unpublished data) because this survey is recent and provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for western North Atlantic striped dolphins. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
spring & summer 1978-82	Cape Hatteras, NC to Nova Scotia	37,780	0.27
Aug-Sep 1991	Cape Hatteras, NC to Nova Scotia	25,939 and 13,157*	0.36 and 0.45*
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	31,669	0.73

* From data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for striped dolphins is 31,669 (CV=0.73). The minimum population estimate for the western North Atlantic striped dolphin is 18,220 (CV=0.73).

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 18,220 (CV=0.73). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is 0.5 because this stock is of unknown status. PBR for the western North Atlantic striped dolphin is 182.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality to this stock during 1992-1996 was 10.7 striped dolphins (CV = 0.08; Table 2).

Fishery Information

USA

No mortalities were observed in 1977-1991 foreign fishing activities off the northeast U.S. coast. Nineteen mortalities were documented between 1989 and 1993 (see below) in the pelagic drift gillnet fishery, and two mortalities were documented in 1991 in the North Atlantic bottom trawl fishery.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989 and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet and North Atlantic bottom trawl fisheries but no mortalities or serious injuries have been documented in the pelagic longline fisheries, pelagic pair trawl, New England multispecies sink gillnet, and mid-Atlantic coastal sink gillnet fisheries.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported Fishery information. Variances were estimated using bootstrap re-sampling techniques. Forty striped dolphin mortalities were observed in this fishery between 1989 and 1996 and occurred east of Cape Hatteras in January and February, and along the southern margin of Georges Bank in summer and autumn. Estimated annual mortality and serious injury (CV in parentheses) attributable to this fishery was 39 striped dolphins in 1989 (0.31), 57 in 1990 (0.33), 11 in 1991 (0.28), 7.7 in 1992 (0.31), 21 in 1993 (0.11), 13 in 1994 (0.06), 2 in 1995 (0), and 7 in 1996 (CV = 0.22). The 1992-1996 average annual mortality and serious injury to striped dolphins in the pelagic drift gillnet fishery was 10.7 (0.08) (Table 2). The 1992-1996 period provides a better characterization of this fishery (i.e., fewer vessels and increased observer coverage).

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under the MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 vessels (full and part time) participated annually in the fishery during 1989-1995. The fishery is active in New England waters in all seasons. The only reported fishery-related mortalities (two) occurred in 1991. Total estimated mortality and serious injury attributable to this fishery in 1991 was 181 (CV = 0.97); average annual mortality and serious injury during 1992-1996 was zero (Table 2).

Total estimated average annual fishery-related mortality and serious injury to this stock in the Atlantic during 1992-1996 was 10.7 (CV = 0.08) (Table 2).

CANADA

No mortalities were documented in review of Canadian gillnet and trap fisheries (Read 1994). However, in a recent review of striped dolphins in Atlantic Canada two records of incidental mortality have been reported (Baird *et al.* 1997) In the late 1960's and early 1970's two mortalities each, were reported in trawl and salmon net fisheries.

Between January 1993 and December 1994, 36 Spanish deep water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211sets), were observed in NAFO Fishing Area 3 (off the Grand Bank) (Lens 1997). A total of 47 incidental catches were recorded, which included two striped dolphins. The incidental mortality rate for common dolphins was (0.014/set)

Table 2. Summary of incidental mortality of striped dolphins (*Stenella coeruleoalba*) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate (CV in parentheses).

Fishery	Years	Number Vessel	Data Type[1]	Range of Observer Coverage[2]	Observed Mortality	Estimated Mortality	CVs	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12[3] 1995=11 1996=10	Obs Data Logbook	.40, .42, .87, .99, .64	0, 13, 12, 2, 7	7.7[4], 21, 13, 2.0[5], 10	.31, .11, .06, 0, .22	10.7 (.08)
TOTAL								10.7 (.08)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet and longline fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).

2 Observer coverage for the pelagic drift gillnet and bottom trawl fishery are in terms of sets.

3 1994 - 1996 shown, other years not available on an annual basis.

4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). In 1994 and 1995, observer coverage increased substantially, and bycatch rates were not pooled for this period.

5 One vessel was not observed and recorded 1 set in a 10 day trip (in the logbook). If you assume 1 set, the point estimate would increase by 0.01 animals.

Other Mortality

From 1995-1996, five striped dolphins were stranded between Massachusetts and Florida (NMFS unpublished data).

STATUS OF STOCK

The status of striped dolphins, relative to OSP, in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. The total fishery-related mortality and serious injury for this stock is less than 10% of the calculated PBR, therefore can be considered to be insignificant and approaching zero mortality and serious injury rate. Average annual fishery-related mortality and serious injury does not exceed the PBR; therefore, this is not a strategic stock.

REFERENCES

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA, NMFS, NEFSC & SEFSC, 4 pp. Available from NEFSC, Woods Hole Laboratory, Woods Hole, MA.

Baird, R.W., S. K. Hooker, H. Whitehead, and R. Etcheberry. 1997. A Review of records of striped dolphins (*Stenella coeruleoalba*) from Canadian waters. IWC Doc. SC/49/SM4, 10 pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S. T., D. R. Andersen, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. *Chapman and Hall,* New York, 446 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Cramer, J. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.

Gowans, S. and H. Whitehead. 1995. Distribution and habitat partitioning by small odontocetes in the Gully, a submarine canyon on the Scotian Shelf. *Can. J. Zool. 73:1599-1608.*

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES CM 1997/Q:8. 10 pp.*

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Pp. 27-50. *In*: A. Bjørge and G.P. Donovan (eds.). Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16*.

Palka, D.L. 1997. A review of striped dolphins (*Stenella coeruleoalba*) in US Atlantic waters. IWC Doc. SC/49/SM26, 13 pp.

Perrin, W. F., C. E. Wilson, and F. I. Archer II. 1994. Pages 129-159 *in*: S. H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Volume 5: The first book of dolphins, *Academic Press*, San Diego.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Schmidly, D. J. 1981. Marine mammals of the southeastern United States coast and the Gulf of Mexico. Pub. No. FWS/OBS-80/41, U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC, 163 pp.

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G.T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA NMFS NEFSC, Lab. Ref. Doc. No. 98-09, 21pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES Marine Mammals Comm. CM 1992/N:12, 29 pp.*

SPINNER DOLPHIN (*Stenella longirostris*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Spinner dolphins are distributed in oceanic and coastal tropical waters (Leatherwood *et al*. 1976). This is presumably an offshore, deep-water species (Schmidly 1981; Perrin and Gilpatrick 1994), and its distribution in the Atlantic is very poorly known. In the western North Atlantic, these dolphins occur in deep water along most of the U.S. coast south to the West Indies and Venezuela, including the Gulf of Mexico. Spinner dolphin sightings have occurred exclusively in deeper (>2,000 m) oceanic waters (CETAP 1982; Waring *et al*. 1992) off the northeast U.S. coast. Stranding records exist from North Carolina, South Carolina, and Florida in the Atlantic and in Texas and Florida in the Gulf of Mexico. The North Carolina strandings represent the northernmost documented distribution of this species in the Atlantic. Stock structure in the western North Atlantic is unknown.

POPULATION SIZE

The number of spinner dolphins inhabiting the U.S. Atlantic Exclusive Economic Zone (EEZ) is unknown and seasonal abundance estimates are not available for this species since it was rarely seen in any of the surveys.

Minimum Population Estimate

Present data are insufficient to calculate a minimum population estimate.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic spinner dolphin is unknown because the minimum population size is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total average annual estimated average fishery-related mortality and serious injury to this stock in the Atlantic during 1992-1996 was 0.38 spinner dolphin (CV = 0.35).

Fishery Information

There was no documentation of spinner dolphin mortality or serious injury in distant-water fleet (DWF) activities off the northeast U.S. coast (Waring *et al.*. 1990). No takes were documented in a review of Canadian gillnet and trap fisheries (Read 1994).

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported Fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989 and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic pair trawl, Northeast multispecies sink gillnet, mid-Atlantic coastal gillnet, and North Atlantic bottom trawl fisheries.

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported Fishery information. Variances were estimated using bootstrap re-sampling techniques. One spinner dolphin mortality was observed between 1989 and 1993 and occurred east of Cape Hatteras in March 1993. Estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was 0.7 in 1989 (1. 00), 1.7 in 1990 (1.00), 0.7 in 1991 (1.00), 1.4 in 1992 (0.31), 0.5 in 1993 (1.00), and zero from 1994-1996. Total average annual estimated average fishery-related mortality and serious injury to this stock in the Atlantic during 1992-1996 was 0.38 spinner dolphin (CV = 0.35) (Table 1). The 1992-1996 period provides a better characterization of this fishery (i.e., fewer vessels and increased observer coverage).

Table 1. Summary of the incidental mortality of spinner dolphins (*Stenella longirostris*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels [1]	Data Type [2]	Observer Coverage [3]	Observed Mortality	Estimated Mortality [4]	Estimated CVs [4]	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	1, 0, 0, 0, 0	1.4, 0.5, 0, 0[5], 0	.31, 1.0, 0, 0, 0	0.31 (.35)
TOTAL								0.31 (.35)

1 1994 and 1995 - 1996 shown, other years not available on an annual basis.

2 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort, and the data are collected at the Southeast Fisheries Science Center (SEFSC).

3 The observer coverage and unit of effort for the Pelagic Drift Gillnet is a set.

4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). In 1994 and 1995, observer coverage increased substantially, and bycatch rates were not pooled for this period.

5 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.8 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.1 animals.

STATUS OF STOCK

The status of spinner dolphins relative to OSP in the U.S. Atlantic EEZ is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. PBR cannot be calculated for this stock, but no fishery-related mortality and serious injury has been observed since 1992; therefore, total fishery-related mortality and serious injury can be considered insignificant and approaching zero mortality and serious injury rate. Population size and PBR cannot be estimated, but fishery-related mortality is very low; therefore, this stock is not a strategic stock.

REFERENCES

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report, Contract AA51-C78-48, Bureau of Land Management, Washington, DC, 538 pp.

Leatherwood, S., D.K. Caldwell, and H.E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. U.S. Dept. of Commerce, NOAA Tech. Rep. NMFS Circ. 396, 176 pp.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Perrin, W. F. and J. W. Gilpatrick, Jr. 1994. Spinner dolphin. Pages 99-128 *in:* S. H. Ridgway and R. Harrison (eds), Handbook of marine mammals, Volume 5: The first book of dolphins. *Academic Press*, San Diego, 418 pp.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Reilly, S. B. and J. Barlow. 1986. Rates of increase in dolphin population size. *Fish. Bull., U.S. 84(3): 527-533.*

Schmidly, D. J. 1981. Marine mammals of the southeastern United States coast and the Gulf of Mexico. Pub. No. FWS/OBS-80/41, U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC, 163 pp.

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES Marine Mammals Comm. CM 1992/N:12, 29 pp.*

BOTTLENOSE DOLPHIN (*Tursiops truncatus*): Western North Atlantic Offshore Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two hematologically and morphologically distinct bottlenose dolphin ecotypes (Duffield *et al*. 1983; Duffield 1986) which correspond to a shallow, warm water ecotype and a deep, cold water ecotype; both ecotypes have been shown to inhabit waters in the western North Atlantic Ocean (Hersh and Duffield 1990; Mead and Potter 1995; Curry and Smith 1997).

Bottlenose dolphins which had stranded alive in the western North Atlantic in areas with direct access to deep oceanic waters had hemoglobin profiles which matched that of the deep, cold water ecotype (Hersh and Duffield 1990). Hersh and Duffield (1990) also described morphological differences between the deep, cold water ecotype dolphins and dolphins with hematological profiles matching the shallow, warm water ecotype which had stranded in the Indian/Banana River in Florida. Based on the distribution of sightings during ship-based surveys (Figure 1) and survey personnel observations (NMFS unpublished data), the western North Atlantic offshore stock is believed to consist of bottlenose dolphins corresponding to the hematologically and morphologically distinct deep, cold water ecotype.

Extensive aerial surveys in 1979-1981 indicated that the stock extended along the entire continental shelf break from Georges Bank to Cape Hatteras during spring and summer (CETAP 1982; Kenney 1990). The distribution of sightings contracted towards the south in the fall and the central portion of the survey area was almost devoid of sightings in the winter, although there were still sightings as far north as the southern edge of Georges Bank. The offshore stock is concentrated along the continental shelf break in waters of depths > 25 m and extends beyond the continental shelf into continental slope waters in lower concentration (Figure 1) consistent with Kenney 1990. In Canadian waters, bottlenose dolphins have occasionally been sighted on the Scotian Shelf, particularly in the Gully (Gowans and Whitehead 1995; NMFS unpubl data). Dolphins with characteristics of the offshore type have been stranded as far south as the Florida Keys, but there are no abundance or distribution estimates available for this stock in U.S. Exclusive Economic Zone (EEZ) waters south of Cape Hatteras.

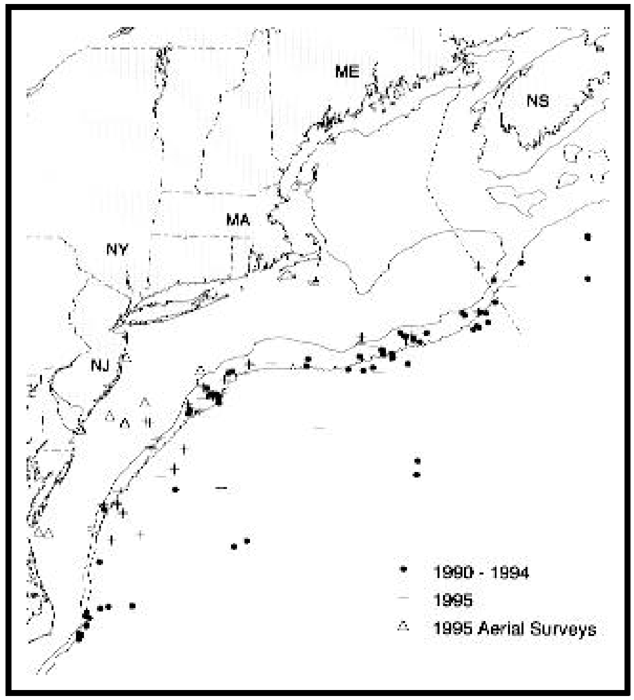

Figure 1. *Distribution of bottlenose dolphin sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

POPULATION SIZE

The total number of bottlenose dolphins off the Atlantic U.S. coast is unknown; however, six abundance estimates are available for portions of the northeastern U.S. Atlantic during fall of 1978-82, August 1990, June - July 1991, August-September 1991, June-July 1993, and July - September 1995 (Table 1 and Figure 1).

A population size of 7,696 offshore bottlenose dolphins (CV=0.58) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on fall data only, because the greatest proportion of the population off the northeast U.S. coast appeared in the study area the fall. This estimate does not include a correction for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty (e.g., large CV), its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 2,903 offshore bottlenose dolphins (CV=0.66) was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (Table 1; Waring *et al.* 1992). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 9,106 offshore bottlenose dolphins (CV=0.36) was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and 2,000 m isobaths from Cape Hatteras to Georges Bank (Table 1; Waring *et al.* 1992; Waring 1998). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but no corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 12,090 (CV=0.38) and 12,760 (CV=0.84) offshore bottlenose dolphins was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Table 1; Anon. 1991). The study area included that covered in the CETAP study plus several additional continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. The data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993), where the CV was estimated using the bootstrap option. The abundance estimates do not include g(0) and were not pooled over platforms because the inter-platform calibration analysis has not been conducted.

A population size of 716 offshore bottlenose dolphins (CV=0.44) was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000 m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 13,453 offshore bottlenose dolphins (CV=0.54) was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; NMFS unpubl data). Total track line length was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques.

Although the 1990-1995 surveys did not sample the same areas or encompass the entire offshore bottlenose dolphin habitat, they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The collective 1990-95 data suggest that, seasonally, at least several thousand bottlenose dolphins are occupying these waters; however, survey coverage to date is not judged adequate to provide a definitive estimate of bottlenose dolphin abundance in the western North Atlantic because of the limited scope of the shipboard surveys. The best available current abundance estimate for offshore bottlenose dolphins is 13,453 (CV=0.54) as estimated from the July to September 1995 line transect survey (NMFS unpubl. data) because this survey is recent and provided the most complete coverage of the known habitat.

Table 1. Summary of abundance estimates for the western North Atlantic offshore bottlenose dolphin. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
fall 1978-82	Cape Hatteras, NC to Nova Scotia	7,676	0.58
Aug 1990	Gulf Stream	2,903	0.66
Jun-Jul 1991	Cape Hatteras, NC to Georges Bank, shelf edge only	9,106	0.36
Aug-Sep 1991	Cape Hatteras, NC to Nova Scotia	12,090 and 12,760*	0.38 and 0.84*
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	716	0.44
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	13,453	0.54

* from data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for offshore bottlenose dolphins is 13,453 (CV=0.54). The minimum population estimate for the western North Atlantic offshore bottlenose is 8,794 (CV=0.54).

Current Population Trend

The data are insufficient to determine population trends.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for offshore bottlenose dolphins is 8,794 (CV=0.54). The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic offshore bottlenose dolphin is 88.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1992-1996 was 58 bottlenose dolphins (CV = 0.22).

Fishery Information

There was no documentation of marine mammal mortality or serious injury in distant-water fleet (DWF) activities off the northeast coast of the U.S. prior to 1977. A fisheries observer program which recorded fishery data and information on incidental by-catch of marine mammals was established with implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) in 1977. DWF effort in the U.S. Atlantic EEZ under MFCMA was directed primarily towards Atlantic mackerel and squid. An average of 120 different foreign vessels per year (range 102-161) operated within the Atlantic coast EEZ from 1977 through 1982. In 1982, the first year that the NMFS Northeast Regional Observer Program assumed responsibility for observer coverage of the longline vessels, there were 112 different foreign vessels, eighteen (16%) of which were Japanese tuna longline vessels operating along the U.S. east coast. Between 1983 and 1991, the number of foreign fishing vessels operating within the U.S. Atlantic EEZ each year declined from 67 to nine. Between 1983 and 1988, the numbers of DWF vessels included 3, 5, 7, 6, 8, and 8, respectively, Japanese longline vessels. Observer coverage on DWF vessels was 25-35% during 1977-82, and increased to 58%, 86%, 95%, and 98%, respectively, in 1983-86. From 1987-91, 100% observer coverage was maintained. Foreign fishing operations for squid ceased at the end of the 1986 fishing season and for mackerel at the end of the 1991 season. Observers in this program recorded nine bottlenose dolphin mortalities in foreign-fishing activities during 1977-1988 (Waring *et al*. 1990). Seven takes occurred in the mackerel fishery, and one bottlenose dolphin each was caught in both the squid and hake trawl fisheries.

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet, pelagic pair trawl, and North Atlantic bottom trawl fisheries, but no mortalities have documented in the Northeast multispecies sink gillnet and pelagic longline fisheries.

Pelagic Longline

Although there have been no reported mortalities of this stock by the pelagic longline fishery, one bottlenose dolphin was taken and released alive during 1993 in offshore waters outside of the U.S. EEZ (NMFS unpublished data). Vessels in this fishery may fish in more than one statistical reporting area and it is not possible to separate estimates of fishing effort other than to subtract Gulf of Mexico effort from Atlantic fishing effort, which includes the Caribbean Sea. This fishery has been monitored with about 5% observer coverage, in terms of trips observed, since 1992. Total effort for the pelagic longline fishery (Atlantic, including the Caribbean), based on mandatory self-reported fishery information, was 11,279 sets in 1991, 10,605 sets in 1992, and 11,538 in 1993 (Cramer 1994). The fishery has been observed nearly year round within every statistical reporting area within the EEZ and beyond.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197,164, and 149 respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fishery information. Variances were estimated using bootstrap re-sampling techniques. Fifty-seven bottlenose dolphin mortalities have been observed between 1989 and 1996. Estimated bottlenose dolphin kills (CV in parentheses) extrapolated for each year were 72 in 1989 (0.18), 115 in 1990 (0.18), 26 in 1991 (0.15), 28 in 1992 (0.10), 22 in 1993 (0.13), 14 in 1994 (0.04), 5 in 1995 (0), and zero in 1996. Mean annual estimated fishery-related mortality for this fishery in 1991-1996 was 13.6 bottlenose dolphins (CV=0.06) (Table 2).

Pelagic Pair Trawl

Effort in the pelagic pair trawl fishery ~~has~~ increased during the period 1989 to 1993, from zero hauls in 1989 and 1990, to an estimated 171 hauls in 1991, and then to an estimated 536 hauls in 1992, 586 in 1993, 407 in 1994, and 440 in 1995, respectively. This fishery ceased operations in 1996, when NMFS rejected a petition to consider pair trawl gear as an authorized gear type in Atlantic tunas fishery. The fishery operated from August-November in 1991, from June-November in 1992, from June-October in 1993 (Northridge 1996), and from mid-summer to November in 1994 and 1995. Sea sampling began in October 1992 (Gerrior *et al*. 1994), and 48 sets (9% of the total) were sampled in that season, 102 hauls (17% of the total) were sampled in 1993. In 1994 and 1995, 52% (212) and 55% (238), respectively, of the sets were observed. Nineteen vessels have operated in this fishery. The fishery extends from 35ºN to 41ºN, and from 69°W to 72°W. Approximately 50% of the total effort was within a one degree square at 39ºN, 72ºW, around Hudson Canyon. Examination of the locations and species composition of the by-catch, showed little seasonal change for the six months of operation and did not warrant any seasonal or areal stratification of this fishery (Northridge 1996). Thirty-two bottlenose dolphin mortalities were observed between 1991 and 1995. Estimated annual fishery-related mortality (CV in parentheses) was 13 dolphins in 1991 (0.52), 73 in 1992 (0.49), 85 in 1993 (0.41), 4 in 1994 (0.40) and 17 in 1995 (0.26). The 1992-1995 estimated mean annual bottlenose dolphin mortality attributable to this fishery is 45 (CV=0.28) (Table 2). Annual mortality estimates do not include any animals injured and released alive. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery. During the 1994 and 1995 experimental fishing seasons, fishing gear experiments were conducted to collect data on environmental parameters, gear behavior, and gear handling practices to evaluate factors affecting catch and bycatch (Goudey 1995, 1996). Results of these studies have been presented at Offshore Cetacean Take Reduction Team Meetings.

North Atlantic Bottom Trawl

Vessels in the North Atlantic bottom trawl fishery, a Category III fishery under the MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 (CV = 0.04) vessels (full and part time) participated annually in the fishery during 1989-1993. The fishery is active in New England waters in all seasons. One bottlenose dolphin mortality was documented in 1991 and the total estimated mortality in this fishery in 1991 was 91 (CV=0.97). Since 1992 there were no bottlenose mortalities observed in this fishery.

Atlantic Squid, Mackerel and Butterfish Trawl

The mid-Atlantic mackerel and squid trawl fisheries were combined into the Atlantic squid, mackerel and butterfish trawl fishery in 1996. These fisheries operate seasonally, principally in the U.S. mid-Atlantic and southern New England continental shelf region. The mackerel trawl fishery was classified as a Category II fishery since 1990 and the squid fishery was originally classified as a Category II fishery in 1990, but was reclassified as a Category III fishery in 1992. The combined fishery has been proposed for classification as a Category II fishery. In 1996, mackerel, squid, and butterfish trawl fisheries were combined into the Atlantic squid, mackerel, and butterfish trawl fishery, and maintained a Category II classification. Although there were reports of bottlenose dolphin mortalities in the foreign fishery during 1977-1988, there were no fishery-related mortalities of bottlenose dolphins reported in the self-reported fishery information from the mackerel trawl fishery between 1990-1992.

Total annual estimated average fishery-related mortality or serious injury to this stock during 1992-1996 was 58 bottlenose dolphins (CV = 0.22; Table 2).

Table 2. Summary of the incidental mortality of bottlenose dolphins (*Tursiops truncatus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12[3] 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	12, 6, 12, 5, 0	28, 22, 13, 5.0[4], 0	.10, .13, .05, 0, 0	13.6 (.06)
Pelagic Pair Trawl	92-95[5]	12	Obs. Data Logbook	.10, .18, .52, .54	4, 17, 2, 9	73, 85, 4.0, 17	.49, .41, .40, .26	44.8 (.28)
TOTAL								58.4 (0.22)

1 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects weighout (Weighout) landings data, and total landings are used as a measure of total effort for the coastal gillnet fishery and days fished are used as total effort for the North Atlantic bottom trawl fishery. Mandatory logbook (Logbook) data are used to measure total effort for the pelagic drift gillnet fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).

2 The observer coverage for the pelagic drift gillnet and pair trawl fishery is measured in terms of sets, and the North Atlantic bottom trawl fishery is in days fished. Assessments for the coastal gillnet fishery have not been completed. The number of trips sampled by the NEFSC Sea Sampling Program are reported here.

3 1994-1996 shown, other years not available on an annual basis.

4 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.42 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.03 animals.

5 Annual mortality estimates do not include any animals injured and released alive.

Table 3. Summary of bottlenose dolphins (*Tursiops truncatus*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured)

Fishery	Years	Ratio	Injured[1]	Uninjured
Pelagic Pair Trawl	92-95	4/73, 17/85, 2/4, 9/17	0, 0, 0 , 0	0, 0, 0, 0

1 Injured and released alive animals are not included in the Table 2 mortality estimates.

Other Mortality

Bottlenose dolphins are one of the most frequently stranded small cetacean along the Atlantic coast. Many of the animals show signs of human interaction (i.e., net marks, mutilation, etc.). The estimated number of animals that represent the offshore stock are presently under evaluation.

STATUS OF STOCK

The status of this stock relative to OSP in the Atlantic EEZ is unknown. The western north Atlantic offshore bottlenose dolphin is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine the population trends for this species. Total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. The status of this stock has been changed from strategic to non-strategic because the estimated annual fishery-related mortality and serious injury is below PBR.

REFERENCES

Anon. 1991. Northeast cetacean aerial survey and interplatform study. NOAA, NMFS, SEFSC & NEFSC, 4 pp. Available from NEFSC, Woods Hole Laboratory, Woods Hole, MA.

Anon. 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine mammal Survey. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA. 5 pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Buckland, S. T., D. R. Andersen, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. *Chapman and Hall*, New York, 446 pp.

CETAP (Cetacean and Turtle Assessment Program). 1982. A Characterization of Marine Mammals and Turtles in the Mid- and North Atlantic Areas of the U.S. Outer Continental Shelf, Final Report, Contract AA551-CT8-48, U.S. NTIS PB83-215855, Bureau of Land Management, Washington, DC, 576 pp.

Cramer J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.

Curry, B.E. and J. Smith. 1997. Phylogeographic structure of the bottlenose dolphin (*Tursiops truncatus*): stock identification and implications for management. Pages. 327-247 *in:* A.E. Dizon, S.J. Chivers and W.F. Perrin (eds.), *Molecular genetics of marine mammals*. Spec. Publ. 3 Society for Marine Mammalogy.

Duffield, D. A. 1986. Investigation of genetic variability in stocks of the bottlenose dolphin (*Tursiops truncatus*). Final report to the NMFS/SEFSC, Contract No. NA83-GA-00036, 53 pp.

Duffield, D. A., Ridgway, S. H., and Cornell, L. H. 1983. Hematology distinguishes coastal and offshore forms of dolphins (*Tursiops*). *Can. J. Zool*. *61: 930-933.*

Gerrior, P., A.S. Williams, and D.J. Christensen. 1994. Observations of the 1992 U.S. pelagic pair trawl fishery in the Northwest Atlantic. *U.S. Mar. Fish. Rev*. *56(3): 24-27.*

Goudy, C.A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic, MITSG 95-6, Cambridge, MA. 10 pp.

Goudy, C.A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic, MITSG 95-6, Cambridge, MA. 13 pp.

Hersh, S. L. and D. A. Duffield. 1990. Distinction between northwest Atlantic offshore and coastal bottlenose dolphins based on hemoglobin profile and morphometry. Pages 129-139 *in:* S. Leatherwood and R. R. Reeves (eds), The bottlenose dolphin. *Academic Press*, San Diego, 653 pp.

Kenney, R. D. 1990. Bottlenose dolphins off the northeastern United States. Pages 369-386 *in:* S. Leatherwood and R. R. Reeves (eds), The bottlenose dolphin. *Academic Press*, San Diego, 653 pp.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Mead, J.G. and C.W. Potter. 1995. Recognizing two populations for the bottlenose dolphin (*Tursiops truncatus*) off the Atlantic coast of North America: morphologic and ecologic considerations. *International Biological Research Institute Reports 5:31-43.*

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045. 18 pp.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. pp. 27-50 *in*: A. Bjørge and G.P. Donovan (eds.) Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16*.

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Waring, G.T. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. NOAA NMFS NEFSC, Lab. Ref. Doc. No. 98-09, 21pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Waring, G. T., P. Gerrior, P. M. Payne, B. L. Parry and J. R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. *Fish. Bull., U.S. 88(2): 347-360.*

Waring, G. T., C. P. Fairfield, C. M. Ruhsam and M. Sano. 1992. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. *ICES Marine Mammals Comm. CM 1992/N: 12, 29 pp.*

BOTTLENOSE DOLPHIN (*Tursiops truncatus*): Western North Atlantic Coastal Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two distinct bottlenose dolphin ecotypes (Duffield *et al.*. 1983; Duffield 1986; Mead and Potter 1995; Walker *et al*. in press) which correspond to a shallow, warm water ecotype and a deep, cold water ecotype; both ecotypes have been shown to inhabit waters in the western North Atlantic Ocean (Hersh and Duffield 1990; Mead and Potter 1995; Walker *et al*.. in press). Bottlenose dolphins which had stranded alive in the western North Atlantic in areas with direct access to deep oceanic waters had hemoglobin profiles matching that of the deep, cold water ecotype (Hersh and Duffield 1990). Hersh and Duffield (1990) also described morphological differences between the deep, cold water ecotype dolphins and dolphins with hematological profiles matching the shallow, warm water ecotype which had stranded in the Indian/Banana River in Florida. Because of their occurrence in shallow, relatively warm waters along the U.S. Atlantic coast and because their morphological characteristics are similar to the shallow, warm water ecotype described by Hersh and Duffield (1990), the Atlantic coastal bottlenose dolphin stock is believed to consist of this ecotype. There are currently insufficient data to allow separation of locally resident bottlenose dolphins (such as those from the Indian/Banana River) from the coastal stock in the western North Atlantic.

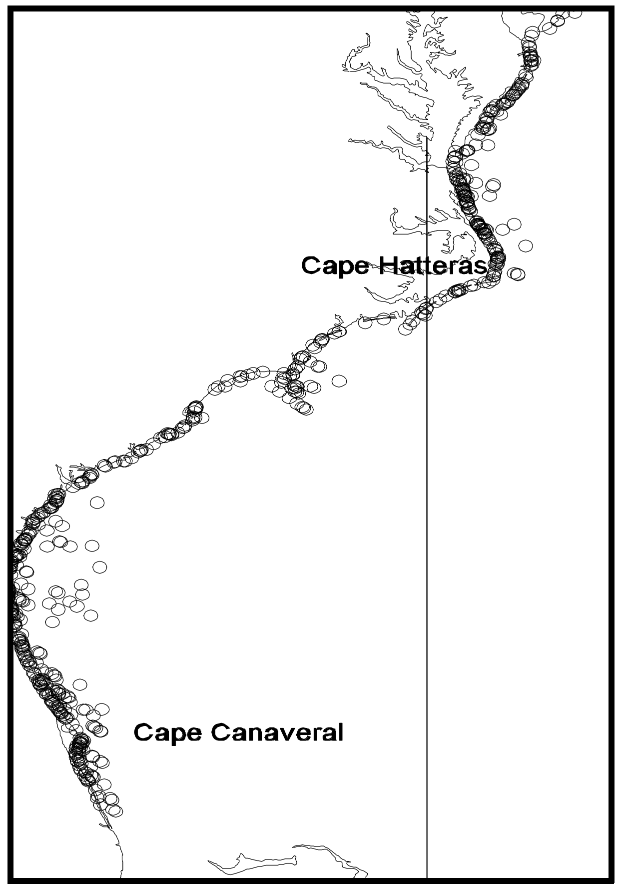

Figure 1. *Sightings of bottlenose dolphins during aerial surveys to the 25 m isobath north of Cape Hatteras during summer 1994, 9 km past the eastern Gulf Stream wall south of Cape Hatteras during winter 1991, and three coastal surveys within one km of shore from New Jersey to mid-Florida during the summer in 1994.*

The structure of the coastal bottlenose dolphin stock in the western North Atlantic is uncertain, but what is known about it suggests that the structure is complex. A portion of the coastal stock migrates north of Cape Hatteras, North Carolina, to New Jersey during the summer (Scott *et al*.. 1988). It has been suggested that this stock is restricted to waters < 25 m in depth within the northern portion of its range (Kenney 1990) because of an apparent disjunct distribution of bottlenose dolphins centered on the 25 m isobath which was observed during surveys of the region (CETAP 1980). The lowest density of bottlenose dolphins was observed over the continental shelf, with higher densities along the coast and near the continental shelf edge. The coastal stock is believed to reside south of Cape Hatteras in the late winter (Mead 1975; Kenney 1990); however, the depth distribution of the stock south of Cape Hatteras is uncertain and the coastal and offshore stocks may overlap there. There was no apparent longitudinal discontinuity in bottlenose dolphin herd sightings during aerial surveys south of Cape Hatteras in the winter (Blaylock and Hoggard 1994).

Scott *et al*.. (1988) hypothesized a single coastal migratory stock ranging seasonally from as far north as Long Island, NY, to as far south as central Florida, citing stranding patterns during a high mortality event in 1987-88 and observed density patterns along the U.S. Atlantic coast. Figure 1 illustrates the distribution of 584 bottlenose dolphin herd sightings during aerial surveys from shore to approximately 9 km past the Gulf Stream edge south of Cape Hatteras in the winter in 1992 (Blaylock and Hoggard 1994), from shore seaward to the 25 m isobath during the summer north of Cape Hatteras in 1994 (Blaylock 1995), and within one km of the shore from New Jersey to mid-Florida during three coastal surveys conducted during the summer in 1994 (Blaylock 1995). The proportion of the sightings illustrated which might be of bottlenose dolphins from other than the coastal stock is unknown; however, it is reasonable to assume that the coastal surveys within one km of shore minimized inclusion of the offshore stock.

A working hypothesis for the coastal bottlenose dolphin stock structure postulates that there are local, resident stocks in certain embayments and that transient stocks migrate seasonally into and out of these embayments (Scott *et al.*. 1988). In the Indian-Banana River, 28 of 36 marked bottlenose dolphins either resided in or returned to the river system for a period of at least ten years (Odell and Asper 1990). Eight of the marked dolphins were never positively resighted. None of the marked dolphins were reported from outside the river system; however, search outside of the river system was limited. If the working hypothesis is correct, exchange between resident and transient components of the coastal stock could be sufficient to mask any genetic indicators of stock distinction, even though the stock components might be sufficiently distinct to respond differently to population pressures. Additional, recent information, suggests that more than one stock does exist along the mid-Atlantic coast (summarized in Hohn 1997).

POPULATION SIZE

Mitchell (1975) estimated that the coastal bottlenose dolphin population which was exploited by a shore-based net fishery until 1925 (Mead 1975) was at least 13,748 bottlenose dolphins in the 1800s. Recent estimates of bottlenose dolphin abundance in the U.S. Atlantic coastal area were made from two types of aerial surveys. The first type was aerial survey using standard line transect sampling with perpendicular distance data analysis (Buckland *et al.*. 1993) and the computer program DISTANCE (Laake *et al.*. 1993). The alternate survey method consisted of a simple count of all bottlenose dolphins seen from aerial surveys within one km of shore.

An aerial line-transect survey was conducted during February-March 1991 in the coastal area south of Cape Hatteras. Sampling transects extended orthogonally from shore out to approximately 9 km past the western wall of the Gulf Stream into waters as deep as 140 m, and the area surveyed extended from Cape Hatteras to mid-Florida (Blaylock and Hoggard 1994). Systematic transects were placed randomly with respect to bottlenose dolphin distribution and approximately 3.3% of the total survey area of approximately 89,900 km^2 was visually searched. Survey transects, area, and dates were chosen utilizing the known winter distribution of the stocks in order to sample the entire coastal population; however, the offshore stock may represent some unknown proportion of the resulting population size estimates. Preliminary estimates of abundance were derived through the application of distance sampling analysis (Buckland *et al.*. 1993) and the computer program DISTANCE (Laake *et al.*. 1993) to the perpendicular distance sighting data. Bottlenose dolphin abundance was estimated to be 12,435 dolphins with coefficient of variation (CV) = 0.18 and the log-normal 95% confidence interval was 9,684-15,967 (Blaylock and Hoggard 1994). An aerial survey was conducted during late January-early March 1995, following nearly the same design as the 1991 survey. Preliminary analysis (following the same procedures described above) resulted in an abundance estimate of 21,128 dolphins (CV = 0.22) with a long-normal 95% confidence interval of 13,815-32,312.

Perpendicular sighting distance analysis (Buckland *et al.*. 1983) of line transect data from an aerial survey throughout the northern portion of the range in July 1994, from Cape Hatteras to Sandy Hook, New Jersey, and from shore to the 25 m isobath, resulted in an abundance estimate of 25,841 bottlenose dolphins (CV = 0.40) (Blaylock 1995) within the approximately 25,600 km^2 area. These data were collected during a pilot study for designing future surveys and are considered to be preliminary in nature. An aerial survey of this area was conducted during mid July-mid August 1995. Data from the pilot study was used to design this survey; survey sampling was designed to produce an abundance estimate with a CV of 0.20 or less. Preliminary analysis (following the same procedures described above for the surveys south of Cape Hatteras) resulted in an abundance estimate of 12,570 dolphins (CV = 0.19) with a log-normal 95% confidence interval of 8,695-18,173.

Either of the aerial line transect surveys and the resulting abundance estimates may have included dolphins from the offshore stock. It is not currently possible to distinguish the two bottlenose dolphin ecotypes during visual aerial surveys and the distribution of the two ecotypes in U.S. Atlantic EEZ waters is uncertain. Additional research is needed to interpret the significance of the line transect survey results.

An aerial survey of the coastal waters within a one km strip along the shore from Sandy Hook to approximately Vero Beach, Florida, was also conducted during July 1994 (Blaylock 1995). Dolphins from the offshore stock are believed unlikely to occur in this area. Observers counted all bottlenose dolphins seen within the one km strip alongshore from Cape Hatteras to Sandy Hook (northern area) and within the one km strip alongshore south of Cape Hatteras to approximately Vero Beach (southern area). The average of three counts of bottlenose dolphins in the northern area was 927 dolphins (range = 303-1,667) and the average of three counts of bottlenose dolphins in the southern area was 630 dolphins (range = 497-815). The sum of the highest counts in both areas was 2,482 dolphins.

Minimum Population Estimate

Reasonable assurance of a minimum population estimate was not provided by line transect surveys because the proportion of dolphins from the offshore stock which might have been observed is unknown. The minimum population size was therefore taken as the highest count of bottlenose dolphins within the one km strip from shore between Sandy Hook and Vero Beach obtained during the July 1994 survey. The maximum count within one km of shore between Sandy Hook and Cape Hatteras was 1,667 bottlenose dolphins and it was 815 bottlenose dolphins within one km of shore between Cape Hatteras and Vero Beach. The resulting minimum population size estimate for the western North Atlantic coastal bottlenose dolphin stock is 2,482 dolphins.

Current Population Trend

Kenney (1990) reported an estimated 400-700 bottlenose dolphins from the inshore strata of aerial surveys conducted along the U.S. Atlantic coast north of Cape Hatteras in the summer during 1979-1981. These estimates resulted from line transect analyses; thus, they cannot be used in comparison with the direct count data collected in 1994 to assess population trends.

There was no significant difference in bottlenose dolphin abundance estimated from aerial line transect surveys conducted south of Cape Hatteras in the winter of 1983 and the winter of 1991 using comparable survey designs (NMFS unpublished data; Blaylock and Hoggard 1994) in spite of the 1987-88 mortality incident during which it was estimated that the coastal migratory population may have been reduced by up to 53% (Scott *et al.*. 1988).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock. The maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of the minimum population size, one-half the maximum productivity rate, and a “recovery” factor (Wade and Angliss 1997). The “recovery “ factor, which accounts for endangered, depleted, and threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.50 because this stock is listed as depleted under the Marine Mammal Protection Act. PBR for the U.S. Atlantic coastal bottlenose dolphin stock is 25 dolphins.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

From 1992-1995, one hundred and eighty-nine bottlenose dolphins stranded in waters north of Cape Hatteras (Virginia to Massachusetts) (NMFS, unpublished data). The majority of the strandings within this northern area occurred in Virginia (n = 116, 61%). An unknown number (analysis underway) of these animals have shown signs of entanglement with fishing gear or interactions with fishing activities. In 1993, eight bottlenose dolphins in Virginia and one in Maryland were reported as entangled in fishing gear, but the gear type was not reported (NMFS unpublished data). Signs of interaction with fisheries (entanglement, net marks, missing appendages) were present in 22% of the bottlenose dolphin strandings investigated in North Carolina in 1993 (NMFS unpublished data). In 1994, 1995, and 1 January-August 31, 1996, one hundred and ninety-two, 196, and 154, respectively, strandings were reported in the NMFS southeast region (Florida to North Carolina) (NMFS, unpublished data). In 1994, 24 (12%) showed signs of human interaction, 14 (7% of total strandings) had evidence of entanglement with fishing gear. In 1995, 23 (12%) showed signs of human interaction, 12 (6%) cases had evidence of entanglement with fishing gear. Southeast U.S. Marine mammal stranding records indicated that from 1988-1995 an average of 22 bottlenose dolphins showed signs of human interaction (net marks, entanglement, mutilations, boat strikes, gunshot wounds) annually.

North Carolina stranding records show the highest incidence of fishery interactions from the SE Atlantic Region. North Carolina data from 1993 through 1996 have been examined to better determine the annual percentages of human interaction. Due to the extent of decomposition and/or the level of experience of the examiner, a determination cannot always be made as to whether or not a stranding occurred due to human interaction. Of the 230 bottlenose dolphin strandings reported in North Carolina from 1993 to 1996, evidence of fisheries interactions was documented in 67 cases (42% of those cases for which a human interaction determination could be made). In addition, other types of human interaction (*i.e*.: prop cuts, gun shots, etc.) were documented in 17 instances (11% of the total number of cases in which a determination was made) (NMFS, unpublished data).

Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the dolphins which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. In addition, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

Fishery Information

Menhaden purse seiners have reported an annual incidental take of one to five bottlenose dolphins (NMFS 1991, pp. 5-73). Observer data are not available. The Atlantic menhaden purse seine fishery targets the Atlantic menhaden, *Brevortia tyrannus*, in Atlantic coastal waters approximately 3-18 m in depth. Twenty-two vessels operate off northern Florida to New England from April-January (NMFS 1991, pp. 5-73).

Coastal gillnets operate in different seasons targeting different species in different states throughout the range of this stock. Most nets are staked close to shore, but some are allowed to drift, and nets range in length from 91 m to 914 m. A gillnet fishery for American shad, *Alosa sapidissima*, operates seasonally from Connecticut to Georgia, with nets being moved from coastal ocean waters into fresh water with the shad spawning migration (Read 1994). It is considered likely that a few bottlenose dolphins are taken in this fishery each year (Read 1994). The portion of the fishery which operates along the South Carolina coast was sampled by observers during 1994 and 1995, and no fishery interactions were observed (McFee *et al.* 1996). The North Carolina sink gillnet fishery operates in October-May targeting weakfish, croaker, spot, bluefish, and dogfish. Another gillnet fishery along the North Carolina Outer Banks targets bluefish in January-March. Similar mixed-species gillnet fisheries, under state jurisdiction, operate seasonally along the coast from Florida to New Jersey, with the exclusion of Georgia. There are no estimates of bottlenose dolphin mortality or serious injury available for these fisheries. A rough estimate of the average total annual coastal gillnet fishing effort is given in Table I.

Observer coverage of the U.S. Atlantic coastal gillnet fisheries for monkfish and dogfish, primarily, was initiated by the NEFSC Sea Sampling program in July, 1993. From July to December 1993, 20 trips were observed. By 1996, 350 trips were observer, representing about less than 5% coverage. This coastal gillnet fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. The number of vessels in this fishery is unknown, because records are held by both state and federal agencies, and have not, as of yet, been centralized and standardized. Still, only one bottlenose dolphins has been taken in the observed trips, despite large numbers of stranded dolphins with signs of fishery interactions. Hence, this observer program is not covering those components of the coastal gillnet complex responsible for most of the interactions with coastal bottlenose dolphins.

The shrimp trawl fishery operates from North Carolina through northern Florida virtually year around, moving seasonally up and down the coast. Estimated total fishing effort is given in Table I. One bottlenose dolphin was recovered dead from a shrimp trawl in Georgia in 1995 (Southeast U.S. Marine Mammal Stranding Network unpublished data), but no bottlenose dolphin mortality or serious injury has been previously reported to NMFS.

Table I. *Roughly estimated average annual fishing effort (number deployed) by gear type for U.S. Atlantic coastal fisheries from New Jersey to Key West, Florida, in 1992-1993, having the potential for causing serious injury or mortality to bottlenose dolphins (NMFS unpublished data).*

Gear Type	Effort
Haul seines	222
Purse seines	11,962
Otter trawls, bottom	22,550
Otter trawls, midwater	70

A haul seine fishery operates along northern North Carolina beaches during the spring and fall targeting mullet, spot, sea trout, and bluefish. There has been no by-catch of marine mammals reported to NMFS.

Other Mortality

The nearshore habitat occupied by this stock is adjacent to areas of high human population and in the northern portion of its range is highly industrialized. The blubber of stranded dolphins examined during the 1987-88 mortality event contained anthropogenic contaminants in levels among the highest recorded for a cetacean (Geraci 1989). There are no estimates of indirect human-caused mortality resulting from pollution or habitat degradation, but a recent assessment of the health of live-captured bottlenose dolphins from Matagorda Bay, Texas, associated high levels of certain chlorinated hydrocarbons with low health assessment scores (Reif *et al.*., in review).

STATUS OF STOCK

This stock is considered to be depleted relative to OSP and it is listed as depleted under the Marine Mammal Protection Act (MMPA). There are data suggesting that the population was at an historically high level immediately prior to the 1987-88 mortality event (Keinath and Musick 1988); however, the 1987-88 anomalous mortality event was estimated to have decreased the population by as much as 53% (Scott *et al*.. 1988). A comparison of historical and recent winter aerial survey data in the area south of Cape Hatteras found no statistically significant difference between population size estimates (Student's t-test, $P > 0.10$), but these estimates may have included an unknown proportion of the offshore stock Population trends cannot be determined due to insufficient data.

There are limited observer data directly linking serious injury and mortality to fisheries (e.g., in the stop net fishery in North Carolina), but the total number of bottlenose dolphins assumed from this stock which stranded showing signs of fishery or human-related mortality exceeded PBR in 1993 and again by mid-1997. In North Carolina alone, human-related mortality approached PBR in each of the intervening years. The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR, and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate.

The species is not listed as threatened or endangered under the Endangered Species Act, but because this stock is listed as depleted under the MMPA it is a strategic stock.

REFERENCES

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Blaylock, R. A. 1995. A pilot study to estimate abundance of the U.S. Atlantic coastal migratory bottlenose dolphin stock. NOAA Tech. Mem. NMFS-SEFSC-362, 9 pp.

Blaylock, R. A. and W. Hoggard. 1994. Preliminary estimates of bottlenose dolphin abundance in southern U.S. Atlantic and Gulf of Mexico continental shelf waters. NOAA Tech. Mem. NMFS-SEFSC-356, 10 pp.

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. *Chapman & Hall*, London, 446 pp.

CETAP (Cetacean and Turtle Assessment Program). 1982. "A Characterization of Marine Mammals and Turtles in the Mid- and North Atlantic Areas of the U.S. Outer Continental Shelf, Final Report", Contract AA551-CT8-48, U.S. NTIS PB83-215855, Bureau of Land Management, Washington, DC, 576 pp.

Duffield, D. A. 1986. Investigation of genetic variability in stocks of the bottlenose dolphin (*Tursiops truncatus*). Final report to the NMFS/SEFC, Contract No. NA83-GA-00036, 53 pp.

Duffield, D. A., Ridgway, S. H., and Cornell, L. H. 1983. Hematology distinguishes coastal and offshore forms of dolphins (*Tursiops*). *Can. J. Zool*. *61: 930-933.*

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

Hersh, S. L. and D. A. Duffield. 1990. Distinction between northwest Atlantic offshore and coastal bottlenose dolphins based on hemoglobin profile and morphometry. Pg. 129-139 *in*: S. Leatherwood and R. R. Reeves (eds), The bottlenose dolphin. *Academic Press*, San Diego, 653 pp.

Hohn, A.A. 1997. Design for a multiple-method approach to determine stock structure of bottlenose dolphins in the mid-Atlantic. NOAA Technical Memorandum NMFS-SEFSC-401, 22 pp.

Keinath, J. A. and J. A. Musick. 1988. Population trends of the bottlenose dolphin (*Tursiops truncatus*) in Virginia. Final Contract Report, Contract No. 40-GENF-800564, Southeast Fisheries Science Center, Miami, FL, 36 pp.

Kenney, R. D. 1990. Bottlenose dolphins off the northeastern United States. Pg. 369-386 *in:* S. Leatherwood and R. R. Reeves (eds), The bottlenose dolphin. *Academic Press*, San Diego, 653 pp.

Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 1993. DISTANCE user's guide, V2.0. Colorado Cooperative Fish & Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

McFee, W.E., D.L. Wolf, D.E. Parshley, and P.A. Fair. 1996. Investigation of marine mammal entanglement associated with a seasonal coastal net fishery. NOAA Technical Memo. NMFS-SEFSC-38, 22pp. + 8 Tables, 5 Figures, 6 Appendices.

Mead, J. G. 1975. Preliminary report on the former net fisheries for *Tursiops truncatus* in the western North Atlantic. *J. Fish. Res. Bd. Can. 32(7): 1155-1162.*

Mead, J.G. and C.W. Potter. 1995. Recognizing two populations of the bottlenose dolphin (*Tursiops truncatus*) off the Atlantic coast of North America: morphologic and ecologic considerations. *International Biological Research Institute Reports 5:31-43.*

Mitchell, E. 1975. Porpoise, dolphin and small whale fisheries of the world. Status and problems. Int. Union Conserv. *Natur. Resour. Monogr. 3: 1-129.*

NMFS. 1991. Proposed regime to govern the interactions between marine mammals and commercial fishing operations after October 1, 1993. Draft Environmental Impact Statement, June 1991.

Odell, D. K. and E. D. Asper. 1990. Distribution and movements of freeze-branded bottlenose dolphins in the Indian and Banana Rivers, Florida. Pg. 515-540 *in:* S. Leatherwood and R. R. Reeves (eds), The bottlenose dolphin. *Academic Press*, San Diego, 653 pp.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Reif, J. S., L. J. Hansen, S. Galloway, G. Mitchum, T. L. Schmitt. In review. The relationship between chlorinated hydrocarbon contaminants and selected health parameters in bottlenose dolphins (*Tursiops truncatus*) from Matagorda Bay, Texas, 1992. Colorado State University, Fort Collins, and NMFS, Southeast Fisheries Science Center, Miami, Florida.

Scott, G. P., D. M. Burn, and L. J. Hansen. 1988. The dolphin dieoff: long term effects and recovery of the population. Proceedings: Oceans '88, IEEE Cat. No. 88-CH2585-8,Vol. 3: 819-823.

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Walker, J.L., C.W. Potter, and S.A. Macko. In press. The diets of modern and historic bottlenose dolphin populations reflected through stable isotopes. *Mar. Mamm. Sci.*

HARBOR PORPOISE (*Phocoena phocoena*): Gulf of Maine/Bay of Fundy Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

This stock is found in U.S. and Canadian Atlantic waters. The distribution of harbor porpoises has been documented by sighting surveys, strandings, and takes reported by NMFS observers in the Sea Sampling Program. During summer (July to September), harbor porpoises are concentrated in the northern Gulf of Maine and southern Bay of Fundy region, generally in waters less than 150 m deep (Gaskin 1977; Kraus *et al.* 1983; Palka 1995a, b). During fall (October-December) and spring (April-June), harbor porpoises are widely dispersed from New Jersey to Maine, with lower densities farther north and south. They are seen from the coastline into the middle of the Gulf of Maine (>200 m deep). During winter (January to March), intermediate densities of harbor porpoises can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada. There does not appear to be a temporally coordinated migration or a specific migratory route to and from the Bay of Fundy region. Though, during the fall, several satellite tagged harbor porpoises did favor the 92m isobath, which is consistent with observations of high rates of incidental catches in this depth range (Read and Westgate 1997). There were two stranding records from Florida (Smithsonian strandings data base).

Gaskin (1984, 1992) proposed that there were four separate populations in the western North Atlantic: the Gulf of Maine/Bay of Fundy, Gulf of St. Lawrence, Newfoundland and Greenland populations. Recent analyzes involving mtDNA (Wang *et al.* 1996), organochlorine contaminants (Westgate *et al.* 1997), heavy metals (Johnston 1995), and life history parameters (Read and Hohn 1995) support Gaskin's proposal. In particular, there is a suggestion that the Gulf of Maine/Bay of Fundy females are different than Gulf of St. Lawrence females, but males were statistically indistinguishable (Palka *et al.* 1996). Research on microsatellites, a potentially powerful genetic tool, is currently being conducted to re-analyze existing genetic data and analyze new samples in order to resolve the larger scale stock structure question. This report follows Gaskin's hypothesis on harbor porpoise stock structure in the western North Atlantic; Gulf of Maine and Bay of Fundy harbor porpoises are recognized as a single management stock separate from harbor porpoise populations in the Gulf of St. Lawrence, Newfoundland, and Greenland.

POPULATION SIZE

To estimate the absolute population size of harbor porpoises aggregated in the Gulf of Maine/Bay of Fundy region, three line-transect sighting surveys were conducted during the summers of 1991, 1992 and 1995 (Table 1; Figure 1).

The population sizes were 37,500 harbor porpoises in 1991 (CV = 0.29, 95% confidence interval (CI) = 26,700-86,400) (Palka 1995a), 67,500 harbor porpoises in 1992 (CV = 0.23, 95% CI = 32,900-104,600), and 74,000 harbor porpoises in 1995 (CV=0.20, 95% CI = 40,900-109,100) (Palka 1996). The inverse variance weighted-average abundance estimate (Smith *et al.* 1993) was 54,300 harbor porpoises (CV = 0.14, 95% CI = 41,300-71,400). Possible reasons for inter-annual differences in abundance and distribution include experimental error and inter-annual changes in water temperature and availability of primary prey species (Palka 1995b).

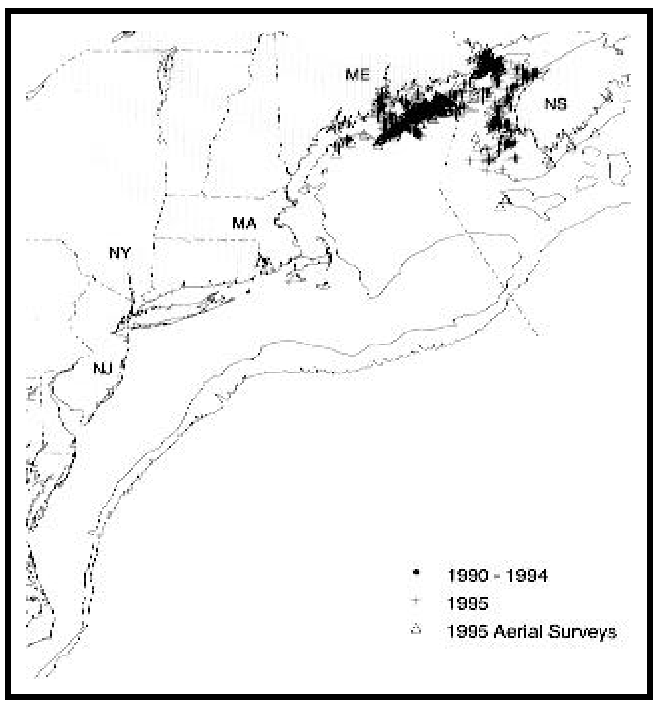

Figure 1. *Distribution of harbor porpoise sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

The shipboard sighting survey procedure used in all three surveys involved two independent teams on one ship that searched using the naked eye in non-closing mode. Abundance, corrected for g(0), the probability of detecting an animal group on the track line, was estimated using the direct-duplicate method (Palka 1995a) and variability was estimated using bootstrap re-sampling methods. Potential biases not explicitly accounted for are ship avoidance and time of submergence. During 1995 a small section of the region was surveyed by airplane while the rest of the region was surveyed by ship, as in previous years. An abundance estimate including g(0) was estimated for both the plane and ship (Palka 1996). During 1995, in addition to the Gulf of Maine/Bay of Fundy area, waters from Virginia to the mouth of the Gulf of St. Lawrence were surveyed and no harbor porpoises were seen except in the vicinity of the Gulf of Maine/Bay of Fundy.

Table 1. Summary of abundance estimates for the Gulf of Maine/Bay of Fundy harbor porpoise. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Jul-Aug 1991	N. Gulf of Maine & lower Bay of Fundy	37,500	0.29
Jul-Sep 1992	N. Gulf of Maine & lower Bay of Fundy	67,500	0.23
Jul-Sep 1995	N. Gulf of Maine & lower Bay of Fundy	74,000	0.20
Inverse variance-weighted average of above 1991, 1992 and 1995 estimates		54,300	0.14

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for harbor porpoises is 54,300 (CV=0.14). The minimum population estimate for the Gulf of Maine/Bay of Fundy harbor porpoise is 48,289 (CV=0.14).

Current Population Trend

There are insufficient data to determine the population trends for this species. Previous abundance estimates for harbor porpoises in the Gulf of Maine/Bay of Fundy are available from earlier studies, (e. g. 4,000 animals, Gaskin 1977, and 15,800 animals, Kraus *et al.* 1983). These estimates cannot be used in a trends analysis because they were for selected small regions within the entire known summer range and, in some cases, did not incorporate any estimate of g(0) (NEFSC 1992).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Although current population growth rates of Gulf of Maine/Bay of Fundy harbor porpoises have not been estimated due to lack of data, several attempts have been made to estimate potential population growth rates. Barlow and Boveng (1991), who used a re-scaled human life table, estimated the upper bound of the annual potential growth rate to be 9.4%. Woodley and Read (1991) used a re-scaled Himalayan tahr life table to estimate a likely annual growth rate of 4%. In an attempt to estimate the potential population growth rate which incorporated many of the uncertainties in survivorship and reproduction, Caswell *et al.* (1998) used a Monte Carlo method to calculate a probability distribution of growth rates, which indicated that the median estimate for the potential annual rate of increase is approximately 10%. This analysis underscored the considerable uncertainty that exists regarding the potential rate of increase in this population. For the purposes of this assessment, the maximum net productivity rate, R_{max} was assumed to be 0.04, consistent with values used for other cetaceans for which direct observations of maximum rate of increase are not available. The 0.04 value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995). Given the three available estimates for the potential productivity rate, the value for R_{max} is currently being re-evaluated.

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 48,289 (CV=0.14). The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the Gulf of Maine/Bay of Fundy harbor porpoise is 483.

ANNUAL HUMAN-CAUSED MORTALITY

Fishery Information

Gulf of Maine/Bay of Fundy harbor porpoise takes have been documented in the U.S. New England multispecies sink gillnet, Mid-Atlantic coastal gillnet, and Atlantic pelagic drift gillnet fisheries, and in the Canadian Bay of Fundy sink gillnet fishery and herring weir fishery. The average annual mortality estimate of harbor porpoises for 1992 to 1996 from the above U.S. fisheries is 1,667 (CV=0.09).

USA

Recent data on incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered. From late 1992, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and south of Cape Hatteras.

New England Multispecies Sink Gillnet

Most of the harbor porpoise takes from U.S. fisheries are from the New England multispecies sink gillnet fishery. In 1984 the New England multispecies sink gillnet fishery was investigated by a sampling program that collected information concerning marine mammal by-catch. Approximately 10% of the vessels fishing in Maine, New Hampshire, and Massachusetts were sampled. Among the eleven gillnetters who received permits and logbooks, 30 harbor porpoises were reported caught. It was estimated, using rough estimates of fishing effort, that a maximum of 600 harbor porpoises were killed annually in this fishery (Gilbert and Wynne 1985, 1987).

In 1990, an observer program was started by the NMFS to investigate marine mammal takes in the New England multispecies sink gillnet fishery. There have been 362 harbor porpoise mortalities related to this fishery observed between 1990 and 1996 and one was released alive uninjured. In 1993, there were approximately 349 full and part-time vessels in the New England multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, and 4% for years 1990 to 1996, respectively. By-catch in the northern Gulf of Maine occurs primarily from June to September; while in the southern Gulf of Maine by-catch occurs from January to May and September to December. Annual estimates of harbor porpoise by-catch in the New England multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. By-catch estimates include a correction factor for the under-recorded number of by-caught animals that occurred during unobserved hauls on trips with observers on the boat, when applicable. Need for such a correction became evident following re-analysis of data from the sea sampling program indicating that for some years by-catch rates from unobserved hauls were lower than that for observed hauls. Further analytical details are given in Palka (1994), CUD (1994), and Bravington and Bisack (1996). These revised by-catch estimates replace those published earlier (Smith *et al.* 1993). These estimates are still negatively biased because they do not include harbor porpoises that fell out of the net while still underwater. This bias cannot be quantified at this time. Estimated annual by-catch (CV in parentheses) from this fishery during 1990-1996 was 2,900 in 1990 (0.32), 2,000 in 1991 (0.35), 1,200 in 1992 (0.21), 1,400 in 1993 (0.18) (Bravington and Bisack 1996; CUD 1994), 2100 in 1994 (0.18), 1400 in 1995 (0.27) (Bisack 1997a), and 1200

(0.25) in 1996. Average estimated harbor porpoise mortality and serious injury in the New England multispecies sink gillnet fishery during 1992-1996 was 1,460 (0.10).

There appeared to be no evidence of differential mortality in U.S. or Canadian gillnet fisheries by age or sex in animals collected before 1994, although there was substantial inter-annual variation in the age and sex composition of the by-catch (Read and Hohn 1995). However, with a larger sample, from harbor porpoises examined by necropsy or from tissues received from sea sampling observers (n=171 between 1989 and 1997), the sex ratio is now 58 females and 113 males (A. Read, pers com). Investigations are currently underway to determine spatial-temporal patterns in the sex ratio.

Two preliminary experiments, using acoustic alarms (pingers) attached to gillnets, that were conducted in the Gulf of Maine during 1992 and 1993 took 10 and 33 harbor porpoises, respectively. During fall 1994 a controlled scientific experiment was conducted in the southern Gulf of Maine, where all nets with and without active pingers were observed (Kraus *et al.* 1997). In this experiment 25 harbor porpoises were taken in 423 strings with non-active pingers (controls) and two harbor porpoises were taken in 421 strings with active pingers. In addition, 17 other harbor porpoises were taken in nets with pingers that were not in the experiment (Table 2). During 1995 to 1996, experimental fisheries were conducted where all nets in a designated area used pingers and only a sample of the nets were observed. During November-December 1995, the experimental fishery was conducted in the southern Gulf of Maine (Jeffreys Ledge) region, where no harbor porpoises were observed taken in 225 pingered nets. During April 1996, three other experimental fisheries occurred. In the Jeffreys Ledge area, in 88 observed hauls using pingered nets nine harbor porpoises were taken. In the Massachusetts Bay region, in 171 observed hauls using pingered nets two harbor porpoises were taken. And, in a region just south of Cape Cod, in 53 observed hauls using pingered nets no harbor porpoises were taken. All takes from pingered nets were added directly to the estimated total bycatch for the rest of that year in the rest of the fishery.

U.S. Atlantic Coastal Gillnet

Before an observer program was in place, Polacheck *et al.* (1995) reported one incidental take in shad nets in the York River, Virginia. Then in July 1993, an observer program was initiated in the U.S. Atlantic coastal gillnet fishery by the NEFSC Sea Sampling program. Twenty trips were observed during 1993. During 1994 and 1995 221 and 382 trips were observed, respectively. This fishery, which extends from North Carolina to New York, is actually a combination of small vessel fisheries that target a variety of fish species, some of which operate right off the beach. The number of vessels in this fishery is unknown, because records which are held by both state and federal agencies have not been centralized and standardized. Observer coverage, expressed as percent of tons of fish landed, was 5% and 4% for 1995 and 1996 (Table 2). No harbor porpoises were taken in observed trips during 1993 and 1994. During 1995 and 1996, respectively, 6 and 19 harbor porpoises were observed taken (Table 2). During 1995 and 1996, observed fishing effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All documented by-catches during 1995 and 1996 were from January to April. By-catch estimates were determined using methods similar to that used for by-catch estimates in the New England multispecies gillnet fishery (Bravington and Bisack 1996; Bisack 1997a). Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 103 (0.57) and 311 (0.31) for 1995 and 1996, respectively. However, because the spatial-temporal distribution of observer coverage did not cover all types of gillnet fisheries in the mid-Atlantic region during all times of the year, it is likely that the estimated numbers are under-estimates. Average estimated harbor porpoise mortality and serious injury from the Mid-Atlantic coastal gillnet fishery during 1995 and 1996 was 207 (CV=0.27) (Table 2).

Pelagic Drift Gillnet

One harbor porpoise was observed taken during the 1991-1996 Atlantic pelagic drift gillnet fishery. The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. In 1994, 1995, and 1996 there were 11, 12, and 10 vessels, respectively, in the fishery (Table 2). The estimated number of hauls in 1991, 1992, 1993, 1994, 1995 and 1996 were 233, 243, 232, 197, 164, and 149 respectively. Observer coverage, expressed as percent of sets was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. The decline in observer coverage in 1996 is attributable to trips made by vessels that were deemed unsafe (size/condition) for observers. Fishing effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994, 1995, and 1996 were estimated separately for each year by summing the observed caught and the product of the average by-catch per haul and the number of unobserved hauls as recorded in logbooks. Variances were estimated using bootstrap re-sampling techniques (Bisack 1997b). The one observed by-catch was notable because it occurred in continental shelf edge waters adjacent to Cape Hatteras (Read *et al.* 1996). Estimated annual fishery-related mortality (CV in parentheses) attributable to this fishery was 0.7 in 1989 (7. 00), 1.7 in 1990 (2.65), 0.7 in 1991 (1.00), 0.4 in 1992 (1.00), 1.5 in 1993 (0.34), and 0 for 1994 to1996. Average estimated harbor porpoise mortality and serious injury in the Atlantic pelagic drift gillnet fishery during 1992-1996 was 0.4 (CV=0.34) (Table 2).

North Atlantic Bottom Trawl

One harbor porpoise mortality was observed in the North Atlantic bottom trawl fishery between 1989 and 1996. Vessels in this fishery, a Category III fishery under the MMPA, were observed in order to meet fishery management needs, rather than marine mammal management needs. An average of 970 (CV = 0.04) vessels (full and part time) participated annually in the fishery during 1989-1993. This fishery is active in New England waters in all seasons. The one take occurred in February 1992 east of Barnegatt Inlet, New York at the continental shelf break. The animal was clearly dead prior to being taken by the trawl, because it was severely decomposed and the tow duration of 3.3 hours was insufficient to allow extensive decomposition; therefore, there is no estimated by-catch for this fishery.

CANADA

Bay of Fundy Sink Gillnet

During the 1980's, Canadian total harbor porpoise by-catch in the Bay of Fundy sink gillnet fishery was thought to be low, based on casual observations and discussions with fishermen. The estimated harbor porpoise by-catch in 1986 was 94-116 and in 1989 it was 130 (Trippel *et al.* 1996). The Canadian gillnet fishery occurs mostly in the western portion of the Bay of Fundy during the summer and early autumn months, when the density of harbor porpoises is highest. Polacheck (1989) reported there were 19 gillnetters active in 1986, 28 active in 1987, and 21 in 1988.

More recently, an observer program implemented in the summer of 1993 provided a total by-catch estimates of 424 harbor porpoises. No measure of variability was estimated. The observer program was expanded in 1994 and the by-catch was estimated to be between 80-120 harbor porpoises where the fishing fleet consisted of 28 vessels (Trippel *et al.* 1996). During 1995, due to groundfish quotas being exceeded, the gillnet fishery was closed during July 21 to August 31, 1995. During the open fishing period of 1995, 89% of the fishing trips were observed, all in the Swallowtail region. Approximately 30% of these observed trips used pingered nets. The estimated by-catch was 87 harbor porpoises (Trippel *et al.* 1996). No confidence interval was able to be computed due to lack of coverage in the Wolves fishing grounds. During 1996, the Canadian gillnet fishery was closed from August 20 to September 30, 1996. Preliminary estimates of by-catch from 1996 were in the range of 20-50 harbor porpoises.

Herring Fishing Weirs

Harbor porpoises takes have been observed in Canadian fishing weirs, though not in U.S. fishing weirs. However, no program has been set up to observer U.S. fishing weirs. In the Bay of Fundy, weirs are presently operating from May to September each year. Weirs are found along the southwestern shore of the Bay of Fundy, and scattered along the western Nova Scotia and northern Maine coasts. There were 180 active weirs in the western Bay of Fundy and 56 active weirs in Maine in 1990 (Read 1994). It is unknown how many herring weirs currently exist in U.S. and Canadian waters. Smith *et al.* (1983) estimated approximately 70 harbor porpoises become trapped annually and, on average, 27 died annually , and the rest were released alive. At least 43 harbor porpoises were trapped in Bay of Fundy weirs in 1990, but the number killed is unknown. In 1993, after a cooperative program between fishermen and Canadian biologists began, over 100 harbor porpoises were released alive and an unknown number died (Read 1994). Records from more current interactions are presently being audited and will be presented in the next report.

Table 2. Summary of the incidental mortality of harbor porpoise (*Phocoena phocoena*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
New England Multispecies Sink Gillnet	92-96	1993=349	Obs. Data Weighout, Trip Logbook	.07, .05, .07, .05, .04	51[3], 53[3], 99[3],43[3], 52[3]	1200[3],1400[3], 2100[3],1400[3], 1200[3]	.21, .18, .18, .27, .25	1460 (.10)
Pelagic Drift Gillnet	92-96	1994=11[4] 1995=12 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	0, 1, 0, 0, 0	0.4[5], 1.5[5], 0, 0, 0	1.00, .34, 0, 0, 0	0.4 (.34)
Mid-Atlantic Coastal Sink Gillnet	95-96[6]	NA[7]	Obs. Data Weighout	.05, .04	6, 19	103, 311	.57, .31	207 (0.27)
TOTAL								1667 (.09)

1 Observer data (Obs. Data) are used to estimate by-catch rates, and are collected by the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects Weighout (Weighout) landings data. Total landings are used as a measure of total effort for the sink gillnet fisheries. Mandatory trip logbook (Trip Logbook) data are used to determine the spatial distribution of some fishing effort in the New England multispecies sink gillnet fishery. Mandatory logbook (Logbook) data are used to estimate total effort for the pelagic drift gillnet fishery, and are collected at the Southeast Fisheries Science Center (SEFSC).

2 The observer coverage for the sink gillnet fishery is expressed as a percentage of trips; for the pelagic drift gillnet fishery it is expressed as a percentage of sets, the unit of effort for this fishery; and for the Mid-Atlantic coastal sink gillnet fishery it is expressed as a percentage of fish landed, the unit of effort for this fishery.

3 Harbor porpoise taken on observed pinger trips were added directly to the estimated total by-catch for that year. There were 10, 33, 44, 0, and 11 observed harbor porpoise takes on pinger trips from 1992 to 1996, respectively. In addition, there were nine observed harbor porpoise takes in 1995 on trips dedicated to fish sampling versus marine mammals (Bisack 1997a).

4 1994 to 1996 are shown, other years were not available on an annual basis.

5 For 1991-1993, pooled by-catch rates were used to estimate by-catch in months that had fishing effort but did not have observer coverage (Northridge 1996). In 1994 to 1996, observer coverage increased substantially, and so by-catch rates were not pooled (Bisack 1997b).

6 Only 1995 and 1996 data are reported because the observed coverages in 1993 and 1994 were negligible during the times of the year when harbor porpoise takes were possible.

7 The number of vessels in the Mid-Atlantic coastal sink gillnet fishery is not available.

Other Mortality

There is evidence that harbor porpoises were harvested by natives in Maine and Canada before the 1960's, and the meat was used for human consumption, oil, and fish bait (NEFSC 1992). The extent of these past harvests is unknown, though it is believed to be small. Up until the early 1980's, small kills by native hunters (Passamaquoddy Indians) were reported. Although, in recent years it was believed to have nearly stopped (Polacheck 1989) until recent public media reports depicted a Passamoquoddy tribe member dressing out a harbor porpoise. Further articles describing use of porpoise products for food and other purposes were timed to coincide with ongoing legal action in state court.

Sixty-four harbor porpoise strandings were reported from Maine to North Carolina between January and June, 1993. Fifty of those harbor porpoises were reported stranded in the U.S. Atlantic region from New York to North Carolina between February and May. Many of the carcasses recovered in this area during this time period had cuts and body damage suggestive of net marking (Haley and Read 1993). Five out of eight carcasses and fifteen heads from the strandings that were examined showed signs of human interactions (net markings on skin and missing flippers or flukes). Decomposition of the remaining animals prevented determination of the cause of death. Earlier reports of harbor porpoise entangled in gillnets in Chesapeake Bay and along the New Jersey coast and reports of apparent mutilation of harbor porpoise carcasses, raised concern that the 1993 strandings were related to a coastal net fishery, such as the American shad coastal gillnet fishery (Haley and Read 1993).

Between 1994 and 1996, 107 harbor porpoise carcasses were recovered from beaches in Maryland, Virginia, and North Carolina. Only juvenile harbor porpoises were present in this sample. Of the 40 harbor porpoises for which cause of death could be established, 25 displayed definitive evidence of entanglement in fishing gear. In four cases it was possible to determine that the animal was entangled in monofilament nets (Cox *et al.*, 1998).

Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

STATUS OF STOCK

The status of harbor porpoises, relative to OSP, in the U.S. Atlantic EEZ is unknown. The National Marine Fisheries Service has proposed listing the Gulf of Maine harbor porpoise as threatened under the Endangered Species Act (NMFS 1993). The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because average annual fishery-related mortality and serious injury exceeds PBR.

REFERENCES

Barlow, J. and P. Boveng. 1991. Modeling age-specific mortality for marine mammal populations. *Mar. Mamm. Sci. 7:50-65*.

Barlow, J., S. L. Swartz, T. C. Eagle, and P. R. Wade. 1995. U.S. Marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. U.S.Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bisack, K.D. 1997a. Harbor porpoise bycatch estimates in the New England multispecies sink gillnet fishery: 1994 and 1995. *Rep. int. Whal. Comm 47: 705-14.*

Bisack, K.D. 1997b. Marine mammal bycatch estimates and their sampling distributions in the U.S. New England sink gillnet, pair trawl, Atlantic pelagic drift gillnet and North Atlantic bottom trawl fisheries: 1994 to 1996. Working paper SC/49/SM35 submitted to the IWC Scientific Committee meeting in Bournemouth, UK, Aug/Sept 1997.

Bravington, M. V. and K. D. Bisack. 1996. Estimates of harbor porpoise by-catch in the Gulf of Maine sink gillnet fishery, 1990-1993. *Rep. int. Whal. Comm 46: 567-74*.

Caswell, H., S. Brault, A. Read, and T. Smith. (1998). Harbor porpoise and fisheries: an uncertainty analysis of incidental mortality. *Ecological Applications, 8(4):1226-1238.*

Cox, T.M., A.J. Read, S. Barco, J. Evans, D. Gannon, H.N. Koopman, W.A. McLellan, K. Murray, J. Nicolas, D.A. Pabst, C. Potter, M. Swingle, V.G. Thayer, K.M. Touhey, and A.J. Westgate. 1998. Documenting the bycatch of harbor porpoises, *Phocoena phocoena*, in coastal gill net fisheries from stranded carcasses. *Fish. Bull. 96(4):727-734.*

CUD [Conservation and Utilization Division]. 1994. Estimating harbor porpoise by-catch in the Gulf of Maine sink gillnet fishery, NOAA, NMFS, NEFSC Ref. Doc. 94-24, Woods Hole, Massachusetts.

Gaskin, D. E. 1977. Harbour porpoise, *Phocoena phocoena* (L.), in the western approaches to the Bay of Fundy 1969-75. *Rep. int. Whal. Comm 27: 487-492.*

Gaskin, D. E. 1984. The harbor porpoise *Phocoena phocoena* (L.): Regional populations, status, and information on direct and indirect catches. *Rep. int. Whal. Comm 34: 569-586.*

Gaskin, D. E. 1992. The status of the harbour porpoise. *Can. Fld. Nat. 106: 36-54.*

Gilbert, J. R. and K. M. Wynne. 1985. Harbor seal populations and fisheries interactions with marine mammals in New England, 1984. Fourth Annual Report, Contract NA-80-FA-C-00029, Northeast Fisheries Center, Woods Hole, MA, 15 pp.

Gilbert, J. R. and K. M. Wynne. 1987. Harbor seal populations and fisheries interactions with marine mammals in New England. Final Report Contract NA-EA-C-0070, Northeast Fisheries Center, Woods Hole, Massachusetts. 15 pp.

Haley, N. J. and A. J. Read. 1993. Summary of the workshop on harbor porpoise mortalities and human interaction. NOAA Tech. Mem. NMFS-F/NER 5.

Johnston, D.W. 1995. Spatial and temporal differences in heavy metal concentrations in the tissues of harbour porpoises (*Phocoena phocoena* L.) from the western North Atlantic. M.S. Thesis, University of Guelph, Guelph, Ontario, Canada. 152pp.

Kraus, S.D., A. Read, E. Anderson, K. Baldwin, A. Solow, T. Sprawling and J. Williamson. 1997. Acoustic alarms reduce porpoise mortality. *Nature 388: 525.*

Kraus, S. D., J. H. Prescott, and G. S. Stone. 1983. Harbour porpoise, *Phocoena phocoena*, in the U.S. coastal waters of the Gulf of Maine: A survey to determine seasonal distribution and abundance. Report to the Director, National Marine Fisheries Service, Northeast Region, Woods Hole, Massachusetts, 15 pp.

NEFSC [Northeast Fisheries Science Center]. 1992. Harbor porpoise in eastern North America: Status and research needs. Results of a scientific workshop held May 5-8, 1992 at the Northeast Fisheries Science Center, Woods Hole, MA. NOAA, NMFS, NEFSC Ref. Doc. 92-06, Woods Hole, Massachusetts.

NMFS [National Marine Fisheries Service]. 1993. Proposed listing of Gulf of Maine population of harbor porpoises as threatened under the Endangered Species Act. *Federal Register 58: 3108-3120, January 07, 1993.*

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna driftnet and pair trawl fisheries. Draft final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500045, 18 pp.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. Northeast Fish. Sci. Cent. Ref. Doc. 96-04; 37p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Palka, D.L., Read, A.J., Westgate, A.J. and Johnston, D.W. 1996. Summary of current knowledge of harbour porpoises in U.S. and Canadian Atlantic waters. *Rep. int. Whal. Commn 46:559-565.*

Palka, D. 1995a. Abundance estimate of the Gulf of Maine harbor porpoise. pp. 27-50 In: A. Bjørge and G.P. Donovan (eds.) Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16.*

Palka, D. 1995b. Influences on spatial patterns of Gulf of Maine harbor porpoises. pp. 69-75 *In:* A.S. Blix, L. Walløe and Ø. Ulltang (eds.) Whales, seals, fish and man. *Elsevier Science B.V.* The Netherlands.

Palka, D. (editor). 1994. Results of a scientific workshop to evaluate the status of harbor porpoises (*Phocoena phocoena*) in the western North Atlantic. NOAA, NMFS, NEFSC [Northeast Fisheries Science Center] Ref. Doc. 94-09, Woods Hole, Massachusetts.

Polacheck, T. 1989. Harbor porpoises and the gillnet fishery. *Oceanus 32(1): 63-70.*

Polacheck, T., F. W. Wenzel, and G. Early. 1995. pp 169-180 *In*: A. Bjørge and G.P. Donovan (eds.) Biology of the Phocoenids. *Rep. int. Whal. Commn. Special Issue 16.*

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Read, A.J. and A.J. Westgate. 1997. Monitoring the movements of harbour porpoises (*Phocoena phocoena*) with satellite telemetry. *Marine Biology 130:315-22.*

Read, A.J., J.R. Nicolas and J.E. Craddock. 1996. Winter capture of a harbor porpoise in a pelagic drift net off North Carolina. *Fish. Bull. US 94: 381-83.*

Read, A. J. and A. A. Hohn. 1995. Life in the fast lane: The life history of harbour porpoises from the Gulf of Maine. *Mar. Mamm. Sci. 11(4)423-440.*

Smith, G. J. D., A. J. Read, and D. E. Gaskin. 1983. Incidental catch of harbor porpoises, *Phocoena phocoena* (L.), in herring weirs in Charlotte County, New Brunswick, Canada. *Fish. Bull., U.S. 81(3): 660-2.*

Smith, T., D. Palka, and K. Bisack. 1993. Biological significance of by-catch of harbor porpoise in the Gulf of Maine demersal gillnet fishery. NOAA, NMFS, NEFSC [Northeast Fisheries Science Center] Ref. Doc. 93-23, Woods Hole, Massachusetts.

Trippel, E.A., J. Y. Wang, M. B. Strong, L. S. Carter and J. D. Conway. 1996. Incidental mortality of harbour porpoise (*Phocoena phocoena*) by the gillnet fishery in the lower Bay of Fundy. *Can. J. Fish. Aquat. Sci*. *53:1294-1300*.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Wang, J.Y., D.E. Gaskin and B.N. White. 1996. Mitochondrial DNA analysis of harbour porpoise, *Phocoena phocoena*, subpopulations in North American waters. *Can. J. Fish. Aquat. Sci. 53: 1632-45.*

Walden, J. 1996. The New England gillnet effort study. NOAA, NMFS, NEFSC Ref. Doc. No. 96-10, 38pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Westgate, A.J., D.C.G. Muir, D.E. Gaskin, M.C.S. and Kingsley. 1997. Concentrations and accumulation patterns of organochlorine contaminants in the blubber of harbour porpoises, *Phocoena phocoena*, from the coast of Newfoundland, the Gulf of St. Lawrence and the Bay of Fundy/Gulf of Maine. *Envir. Pollut 95: 105-119.*

Woodley, T. H. and A. J. Read. 1991. Potential rates of increase of a harbor porpoise (*Phocoena phocoena*) population subjected to incidental mortality in commercial fisheries. *Can. J. Fish. Aquat. Sci*. *48:2429-35*.

HARBOR SEAL (*Phoca vitulina*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The harbor seal is found in the western North Atlantic, from the eastern Canadian Arctic and Greenland south to southern New England and New York, and occasionally to the Carolinas (Boulva and McLaren 1979; Katona *et al*. 1993; Gilbert and Guldager 1998). Although the stock structure of the western North Atlantic population is unknown, it is thought that harbor seals found along the eastern U.S. and Canadian coasts represent one population (Temte *et al*.. 1991). Breeding and pupping normally occurs in waters north of the New Hampshire/Maine border, although breeding occurred as far south as Cape Cod in the early part of the twentieth century (Temte *et al*.. 1991; Katona *et al*.. 1993).

Harbor seals are year-round inhabitants of the coastal waters of eastern Canada and Maine (Katona *et al*. 1993), and occur seasonally along the southern New England and New York coasts from September through late May (Schneider and Payne 1983). Scattered sightings and strandings have been recorded as far south as Florida (NMFS unpublished data). A general southward movement from the Bay of Fundy to southern New England waters occurs in autumn and early winter (Rosenfeld *et al*.. 1988; Whitman and Payne 1990). A northward movement from southern New England to Maine and eastern Canada occurs prior to the pupping season, which takes place from mid-May through June along the Maine Coast (Richardson 1976; Wilson 1978; Whitman and Payne 1990; Kenney 1994). No pupping areas have been identified in southern New England (Payne and Schneider 1984). The overall geographic range throughout coastal New England has not changed significantly during the last century (Payne and Selzer 1989).

The majority of animals moving into southern New England waters are juveniles. Whitman and Payne (1990) suggest that the age-related dispersal may reflect the higher energy requirements of younger animals.

POPULATION SIZE

Since passage of the MMPA in 1972, the number of seals along the New England coast has increased nearly five-fold. Coast-wide aerial surveys along the Maine coast have been conducted in May/June during pupping in 1981, 1982, 1986, 1993, and 1997 (Table 1; Gilbert and Stein 1981; Gilbert and Wynne 1983, 1984; Kenney 1994; and Gilbert and Guldager 1998). These numbers are considered to be a minimum abundance estimate because they are uncorrected for animals in the water or outside the survey area. Increased abundance of seals in the northeast region has also been documented during aerial and boat surveys of overwintering haul-out sites in southern New England and eastern Long Island (Payne and Selzer 1989; Rough 1995). Canadian scientists counted 3,600 harbor seals during an August 1992 aerial survey in the Bay of Fundy (Stobo and Fowler 1994), but noted that the survey was not designed to obtain a population estimate.

Table 1. Summary of abundance estimates for the western Atlantic harbor seal. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{min}) and coefficient of variation (CV).

Month/Year	Area	N_{min}	CV
May/June 1981	Maine coast	10,540 (676)[1]	None reported
May/June 1982	Maine coast	9,331 (1,198)	None reported
May/June 1986	Maine coast	12,940 (1,713)	None reported
May/June 1993	Maine coast	28,810 (4,250)	None reported
May/June 1997	Maine coast	30,990 (5,359)	None reported
August 1992	Bay of Fundy	3,600	None reported

[1]Pup counts are in brackets

Minimum Population Estimate

A minimum population estimate is 30,990 seals, based on uncorrected total counts along the Maine coast in 1997.

Current Population Trend

The annual increase since 1993 has been 1.8 % (Gilbert and Guldager 1998). Since 1981, the average increase has been 4.2 % (Gilbert and Gualdager 1998), about 50% of the 8.9 percent annual increase estimated Kenney (1994) from counts through 1993. Similarly, the number of pups along the Maine coast has increased at an annual rate of 12.9% over the 1981-1997 period (Gilbert and Guldager 1998). Possible factors contributing to this increase include MMPA protection and increased prey. There are no indications that population growth has slowed or that it is at or near its potential maximum level. The rapid increase observed during the past two decades may reflect past reduction of the population by historical bounty hunting, possibly to a very low level.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 30,990. The maximum productivity rate is 0.12, the default value for pinnipeds. The recover factor (F_R) for this stock is 1.0, the value for stocks with unknown population status, but know to be increasing. PBR for counts in U.S. waters is 1,859.

ANNUAL HUMAN-CAUSED MORTALITY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1992-1996 was 898 harbor seals (CV = 0.11; Table 2).

Harbor seals were bounty hunted in New England waters until the late 1960's. This hunt may have caused the demise of this stock in U.S. waters (Katona *et al*. 1993). Researchers and fishery observers have documented incidental mortality in several fisheries, particularly within the Gulf of Maine (see below). An unknown level of mortality also occurs in the aquaculture industry (i.e., salmon farming), and by deliberate shooting (NMFS unpublished data).

Fishery Information

USA

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Incidental takes of harbor seals have been recorded in groundfish gillnet, herring purse seine, halibut tub trawl, and lobster fisheries (Gilbert and Wynne, 1985 and 1987). A study conducted by the University of Maine reported a combined average of 22 seals entangled annually by 17 groundfish gillnetters off the coast of Maine (Gilbert and Wynne 1987). All seals were young of the year and were caught from late June through August, and in early October. Interviews with a limited number of mackerel gillnetters indicated only one harbor seal entanglement and a negligible loss of fish to seals. Net damage and fish robbing were not reported to be a major economic concern to gillnetters interviewed (Gilbert and Wynne 1987).

Herring purse seiners have reported accidentally entrapping seals off the mid-coast of Maine, but indicated that the seals were rarely drowned before the seine was emptied (Gilbert and Wynne 1985). Capture of seals by halibut tub trawls are rare. One vessel captain indicted that he took one or two seals a year. These seals were all hooked through the skin and released alive, indicating they were snagged as they followed baited hooks. Infrequent reports suggest seals may rob bait off longlines, although this loss is considered negligible (Gilbert and Wynne 1985).

Incidental takes in lobster traps in inshore waters off Maine are reportedly rare. Captures of approximately two seal pups per port per year were recorded by mid-coastal lobstermen off Maine (Gilbert and Wynne 1985). Seals have been reported to rob bait from inshore lobster traps, especially in the spring, when fresh bait is used. These incidents may involve only a few individual animals. Lobstermen claim that seals consume shedding lobsters.

New England Multispecies Sink Gillnet

In 1993, there were approximately 349 full and part-time vessels in the New England multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, and 4% for 1990 to 1996, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. There were 224 harbor seal mortalities, excluding three animals taken in the 1994 pinger experiment (NMFS unpublished data), observed in the New England multispecies sink gillnet fishery between 1990 and 1996. Annual estimates of harbor seal by-catch in the New England multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990-1996 was 602 in 1990 (0.68), 231 in 1991 (0.22), 373 in 1992 (0.23), 698 in 1993 (0.19), 1,330 in 1994 (0.25), 1,179 in 1995 (0.21), and 911 in 1996 (0.27). The 1994 and 1995 by-catches, respectively, include 14 and 179 animals from the estimated number of unknown seals (based on observed mortalities of seals that could not be identified to species). The unknown seals were prorated, based on spatial/temporal patterns of by-catch of harbor seals, gray seals, harp seals, and hooded seals. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1992-1996 was 898 harbor seals (CV = 0.11). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The by-catch occurred in Massachusetts Bay, south of Cape Ann and west of Stellwagen Bank during January-March. By-catch locations became more dispersed during April-June from Casco Bay to Cape Ann, along the 30 fathom contour out to Jeffreys Ledge, with one take location near Cultivator Shoal and one off southern New England near Block Island. Incidental takes occurred from Frenchman's Bay to Massachusetts Bay during July-September. In inshore waters, the takes were aggregated while offshore takes were more dispersed. Incidental takes were confined from Cape Elizabeth out to Jeffreys Ledge and south to Nantucket Sound during October-December.

CANADA

An unknown number of harbor seals have been taken in Newfoundland and Labrador, Gulf of St. Lawrence and Bay of Fundy groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, Atlantic Canada cod traps, and in Bay of Fundy herring weirs (Read 1994). Furthermore, some of these mortalities (e.g., seals trapped in herring weirs) are the result of direct shooting. The Canadian government has recently implemented a pilot program that permits mariculture operators to use acoustic deterrents or shoot problem seals.

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

Herring weirs are also distributed throughout the Bay of Fundy; it has been reported that 180 weirs were operating in the Bay of Fundy in 1990 (Read 1994).

In 1996, observers recorded seven harbor seals (one released alive) in Spanish deep water trawl fishing on the southern edge of the Grand Bank (NAFO Areas 3) (Lens, 1997). Seal by-catches occurred year-round, but interactions were highest during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

Table 2. Summary of the incidental mortality of harbor seal (Phoca vitulina) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality[3]	Estimated Mortality[3]	Estimated CVs	Mean Annual Mortality
New England Multispecies Sink Gillnet	92-96	349	Obs. Data Weighout, Logbooks	.07, .05, .07, .05, .04	24, 22, 86, 56, 36	373, 698, 1330, 1179, 911	.23, .19, .25, .21, .27	898 (.11)
TOTAL								898 (.11)

1 Observer data (Obs. Data) are used to measure by-catch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects Weighout (Weighout) landings data, and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of some fishing effort in the New England multispecies sink gillnet fishery.

2 The observer coverage for the New England multispecies sink gillnet fishery is measured in trips.

3 In 1994, 1995 and 1996, respectively, observed mortality on “marine mammal trips” was 59, 41 and 37 animals. Only these mortalities were used to estimate total harbor seal by-catch. In 1994, 3 mortalities were observed on “fish trips” and 24 on “pinger trips.” In 1995, 15 mortalities were recorded on “fish trips”. In 1996 two mortalities were recorded on “pinger trips” and three on “fish trips”. See Bisack (1997) for “trip” type definitions.

Other Mortality

Annually, small numbers of harbor seals regularly strand throughout their migratory range. Most stranding, however, occur during the winter period in southern New England and mid- Atlantic regions (NMFS unpublished data). However, the 1992-1997 harbor seal strandings data are currently under review and will be provided in the 1999 report. Sources of mortality include human interactions (boat strikes and fishing gear, power plant intake (12-20 per year; NMFS unpubl. Data), oil, shooting), storms, abandonment by the mother, and disease (Katona *et al*. 1993; NMFS unpublished data). Interactions with Maine salmon aquaculture operations appears to be increasing, although the magnitude of interactions and seal mortalities has not been quantified (Anon 1996). In 1980, more than 350 seals were found dead in the Cape Cod area from an influenza outbreak (Geraci *et al*. 1981).

Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured may wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery-interaction.

STATUS OF STOCK

The status of harbor seals, relative to OSP, in the U.S. Atlantic EEZ is unknown, but the population is increasing. The species is not listed as threatened or endangered under the Endangered Species Act. Gilbert and Guldager (1998) estimated a 4.4% annual rate of increase of this stock in Maine coastal waters based on 1981, 1982, 1986, 1993, 1997 surveys conducted along the Maine coast. The population is increasing despite the known fishery-related mortality. Total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR and, therefore, cannot be considered to be approaching zero mortality and serious injury rate. This is not a strategic stock because human-related mortality and serious injury does not exceed PBR.

REFERENCES

Anon. 1996. Report of the Gulf of Maine Aquaculture-Pinniped Interaction Task Force. Available from NMFS, Office of Protected Resources. Silver Springs, MD. 70 pp.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bisack, K.D. 1997. Harbor porpoise bycatch estimates in the New England multispecies sink gillnet fishery: 1994 and 1995. *Rep. int. Whal. Comm. 47:705-14.*

Boulva, J. and I. A. McLaren. 1979. Biology of the harbor seal, *Phoca vitulina*, in eastern Canada. *Bull. Fish. Res. Bd. Can. 200:1-24.*

Bravington, M. V. and K. D. Bisack. 1996. Estimates of harbor porpoise by-catch in the Gulf of Maine sink gillnet fishery, 1990-93. *Rep. int. Whal. Commn. 46:567-574.*

Geraci, R., D. J. St. Aubin and I. K. Barker. 1981. Mass mortality of harbor seals: pneumonia associated with influenza A virus. *Science 215: 1129-1131.*

Gilbert, J.R. and N. Guldager. 1998. Status of harbor and gray seal populations in northern New England. Final Report to: National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. Under NMFS/NER Cooperative Agreement 14-16-009-1557. 13 pp.

Gilbert, J.R. and J.L. Stein. 1981. Harbor seal populations and marine mammal fisheries interactions. 1981 annual report. Northeast Fisheries Science Center. Contract NA-80-FA-C-00029.

Gilbert, J.R. and K.M. Wynne. 1983. Harbor seal populations and marine mammal fisheries interactions, 1982. Second annual report. Northeast Fisheries Science Center. Contract NA-80-FA-C-00029.

Gilbert, J.R. and K.M. Wynne. 1984. Harbor seal populations and marine mammal fisheries interactions, 1983. Third annual report. Northeast Fisheries Science Center. Contract NA-80-FA-C-00029.

Gilbert, J. R. and K. M. Wynne. 1985. Harbor seal populations and fisheries interactions with marine mammals in New England, 1984. Interim Rep., NOAA NA-84-EAC-00070, NMFS, NEFSC., Woods Hole, MA, 15 pp.

Gilbert, J. R. and K. M. Wynne. 1987. Marine mammal interactions with New England gillnet fisheries. Final Report Contract No. NA-84-EAC-00070, NOAA, NMFS, NEFSC, Woods Hole, MA, 12 pp.

Katona, S. K., V. Rough, and D. T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. Smithsonian Institution Press: Washington, DC, 316 pp.

Kenney, M.K. 1994. Harbor seal population trends and habitat use in Maine. M.S. Thesis. University of Maine, Orono, ME. 55 pp.

Kenney, M. K. and J. R. Gilbert. 1994. Increase in harbor and gray seal populations in Maine. Dept. of Commerce, NOAA-NMFS Contract Rep. 50-EANF-2-00064, 19 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES C.M. 8/Q. 10 pp.*

Payne. P. M. and D. C. Schneider. 1984. Yearly changes in abundance of harbor seals, *Phoca vitulina*, at a winter haul-out site in Massachusetts. *Fish. Bull., U.S. 82: 440-442.*

Payne, P. M. and L. A. Selzer. 1989. The distribution, abundance and selected prey of the harbor seal, *Phoca vitulina concolor*, in southern New England. *Mar. Mamm. Sci. 5(2): 173-192.*

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Richardson, D.T. 1976. Assessment of harbor and gray seal populations in Maine 1974-1975. Final report to Marine Mammal Commission. Contract No. MM4AC009.

Rosenfeld M., M. George and J. M. Terhune. 1988. Evidence of autumnal harbour seal, *Phoca vitulina*, movement from Canada to the United States. *Can. Field-Nat. 102(3): 527-529.*

Rough, V. 1995. Gray seals in Nantucket Sound, Massachusetts, winter and spring, 1994. Final report to Marine Mammal Commission, Contract T10155615, 28 pp. NTIS Pub. PB95-191391.

Schneider, D. C. and P. M. Payne. 1983. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. *J. Mamm. 64(3): 518-520.*

Stobo, W.T. and G.M. Fowler. 1994. Aerial surveys of seals in the Bay of Fundy and off southwest Nova Scotia. *Can. Tech. Rep. Fish. Aquat. Sci. 1943:57 pp.*

Temte, J.L., M.A. Bigg and O. Wiig. 1991. Clines revisited: the timing of pupping in the harbour seal *(Phoca vitulina*). *J. Zool. Lond. 224: 617-632.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Walden, J. 1996. The New England gillnet effort survey. NOAA, NMFS, NEFSC, Woods Hole, Massachusetts. NEFSC [Northeast Fisheries Science Center] Ref. Doc. 99-10. 38p.

Whitman, A. A. and P. M. Payne. 1990. Age of harbour seals, *Phoca vitulina concolor*, wintering in southern New England. *Can. Field-Nat. 104(4): 579-582.*

Wilson, S. C. 1978. Social organization and behavior of harbor seals, *Phoca concolor*, in Maine. Final Report to Marine Mammal Commission, Contract MM6ACO13, GPO-PB-280-188.

GRAY SEAL (*Halichoerus grypus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The gray seal is found in the western North Atlantic from New England to Labrador and is centered in the Sabel Island region of Nova Scotia (Katona *et al*. 1993; Davies 1957). This stock is separated by both geography and differences in the breeding season from the eastern Atlantic stock (Bonner 1981). The western Atlantic stock is distributed and breeds principally in eastern Canadian waters; however, small numbers of animals and pupping have been observed on several isolated islands along the Maine coast and in Nantucket-Vineyard Sound, Massachusetts (Katona *et al*. 1993; Rough 1995; J. R. Gilbert, pers. comm., University of Maine, Orono, ME). In recent years, a year-round breeding population of approximately 400 animals has been documented on the outer Cape Cod and Nantucket Island (Dennis Murley, pers. comm., Mass. Audubon Society, Wellfleet, MA). Gilbert (pers. comm) has also documented a resident colony in Maine.

POPULATION SIZE

Estimates of the total western Atlantic gray seal population are not available; however, four estimates of portions of the stock are available for Sable Island, the Maine coast, and Muskeget Island (Nantucket) and Monomoy, (Cape Cod) Massachusetts (Table 1). The 1986 population estimate for individuals on Sable Island, Nova Scotia that are one year old and older was between 100,000 and 130,000 animals (Stobo and Zwanenburg 1990). The 1993 estimate of the Sable Island and Gulf of St. Lawrence stocks was 143,000 animals (Mohn and Bowen 1994). The population in waters off Maine has increased from about 30 in the early 1980's to between 500-1,000 animals in 1993; recently 29-49 pups/year have been recorded in Penobscot Bay (J. R. Gilbert, pers. comm.). Maximum counts of individuals at a winter breeding colony on Muskeget Island, west of Nantucket Island obtained during the spring molt did not exceed 13 in any year during the 1970s, but rose to 61 in 1984, 192 in 1988, 503 in 1992, and 1,549 in 1993. Aerial surveys in April and May of 1994 recorded a peak count of 2,010 gray seals for Muskeget Island and Monomoy combined (Rough 1995).

Table 1. Summary of abundance estimates for the western North Atlantic gray seal. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{min}) and coefficient of variation (CV). Unk=unknown.

Month/Year	Area	N_{min}	CV
1986	Sable Island	100,000 to 130,000	None reported
1993	Sable Island and Gulf of St. Lawrence	143,000	None reported
1993	Maine coast	500-1000	None reported
Apr-May 1994	Muskeget Island and Monomoy, MA (only US portion of stock)	2,010	None reported

Minimum Population Estimate

The minimum population estimate for U.S. waters, based on uncorrected total counts (see above), is 2,010 gray seals.

Current Population Trend

Gray seal abundance is likely increasing in the U.S. Atlantic Exclusive Economic Zone (EEZ), but the percent increase is unknown. The population has been increasing for several decades in Canadian waters.

Pup production on Sable Island, Nova Scotia, has been about 13% per year since 1962 (Mohn and Bowen 1994). Approximately 57% of the western North Atlantic population is from the Sable Island stock.

Winter breeding colonies in Maine and on Muskeget Island may provide some measure of gray seal population trends and expansion in distribution. Sightings in New England increased during the 1980s as the gray seal population and range expanded in eastern Canada. Five pups were born at Muskeget in 1988. The number of pups increased to 12 in 1992, 30 in 1993, and 59 in 1994 (Rough 1995).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. One study that estimated pup production on Sable Island estimated the annual production rate was 13% (Mohn and Bowen 1994).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 2,010 (CV=unk). The maximum productivity rate is 0.12, the default value for pinnipeds. The recover factor (F_R) for this stock is 1.0, the value for stocks with unknown population status, but know to be increasing. PBR for the western North Atlantic gray seal is 121.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Gray seals, like harbor seals, were hunted for bounty in New England waters until the late 1960's. This hunt may have severely depleted this stock in U.S. waters (Rough 1995).

Total annual estimated average fishery-related mortality or serious injury to this stock during 1992-1996 was 41 gray seals (CV = 0.30; Table 2).

Fishery Information

USA

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

New England Multispecies Sink Gillnet

In 1993, there were approximately 349 full and part-time vessels in the New England multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, and 4% for 1990 to 1996, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. There were 15 gray seal mortalities observed in the New England multispecies sink gillnet fishery between 1992 and 1996 (Table 2). Eight of the observed mortalities occurred in winter (January - May), 7 in the southern Gulf of Maine and one in the "mid-coast closed area." Only one mortality was observed in northern Maine waters, which occurred in autumn (September-December) 1995. One of the 1993 observed mortalities was in May, and was from SE of Block Island. In addition, V. Rough (pers. comm.) has documented several animals with netting around their necks in the Cape Cod/Nantucket area. An unknown level of mortality also occurs in the mariculture industry (i.e., salmon farming) and by deliberate shooting (NMFS unpublished data).

Annual estimates of gray seal by-catch in the New England multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990-1996 was zero in 1990-1992, 18 in 1993 (1.00), 19 in 1994 (0.95), 117 in 1995 (0.42), and 49 in 1996 (0.49). The

1995 by-catch includes 28 animals from the estimated number of unknown seals (based on observed mortalities of seals that could not be identified to species). The unknown seals were prorated, based on spatial/temporal patterns of by-catch of harbor seals, gray seals, harp seals, and hooded seals. Further, they will likely have little impact on the estimates presented. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1992-1996 was 41 gray seals (CV = 0.30). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996).

CANADA

An unknown number of gray seals have been taken in Newfoundland and Labrador, Gulf of St. Lawrence, and Bay of Fundy groundfish gillnets, Atlantic Canada and Greenland salmon gillnets, Atlantic Canada cod traps, and in Bay of Fundy herring weirs (Read 1994). In addition to incidental catches, some mortalities (e.g., seals trapped in herring weirs) were the result of direct shooting, and there were culls of about 1,700 animals annually during the 1970's and early 1980's on Sable Island (Anon. 1986).

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

Herring weirs are also distributed throughout the Bay of Fundy; it has been reported that 180 weirs were operating in the Bay of Fundy in 1990 (Read 1994).

In 1996, observers recorded three gray seals (one released alive) in Spanish deep water trawl fishing on the southern edge of the Grand Bank (NAFO Areas 3) (Lens, 1997). Seal by-catches occurred year-round, but interactions were highest during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

Table 2. Summary of the incidental mortality of gray seal (*Halichoerus grypus*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality[3]	Estimated Mortality[3]	Estimated CVs	Mean Annual Mortality
New England Multispecies Sink Gillnet	92-96	349	Obs. Data Weighout, Logbooks	.07, .05, .07, .05, .04	0, 2, 3, 7, 3	0, 18, 19, 117, 49	0, 1.00, .95, .42, .49	41 (.30)
TOTAL								41 (.30)

1 Observer data (Obs. Data) are used to measure by-catch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects Weighout (Weighout) landings data, and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of some fishing effort in the New England multispecies sink gillnet fishery.

2 The observer coverage for the New England multispecies sink gillnet fishery is measured in trips.

3 In 1994 and 1995, respectively, observed mortality on “marine mammal trips” was 2 and 6 animals. Only these mortalities were used to estimate total gray seal by-catch. In 1994 and 1995, one mortality in each year was recorded on a “fish trip.” See Bisack (1997) for “trip” type definitions.

Other Mortality

The 1992-1997 gray seal strandings data are currently under review and will be provided in the 1999 report. Stranding data probably underestimate the extent of fishery-related mortality and serious injury because not all of the marine mammals which die or are seriously injured wash ashore, nor will all of those that do wash ashore necessarily show signs of entanglement or other fishery interaction.

STATUS OF STOCK

The status of the gray seal population, relative to OSP, in U.S. Atlantic EEZ waters is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. Recent data indicate that this population is increasing. In New England waters, both the number of pupping sites and pup production is increasing. The total fishery-related mortality and serious injury for this stock is less than 10% of the calculated PBR and, therefore, can be considered to be approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury in the U.S. Atlantic EEZ does not exceed PBR and this is not a strategic stock.

REFERENCES

Anon. 1986. Seals and sealing in Canada. Rep. of the Royal Commission on Seals and Sealing, Vol. 1, 65 pp. Available from Canadian Government Publishing Centre, Ottawa, Canada.

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bisack, K.D. 1997. Harbor porpoise bycatch estimates in the New England multispecies sink gillnet fishery: 1994 and 1995. *Rep. int. Whal. Comm. 47:705-14.*

Bonner, W.N. 1981. Grey seal, *Halichoerus grypus*. *In:* S.H. Ridgway and R. J. Harrison, eds., Handbook of Marine Mammals, vol. 2, pp. 111-144. London: *Academic Press*.

Bravington, M. V. and K. D. Bisack. 1996. Estimates of harbor porpoise by-catch in the Gulf of Maine sink gillnet fishery, 1990-93. Rep. int. Whal. Commn. 46:567-574. Bonner, W. N. 1981. Grey seal *Halichoerus grypus Fabricus*, 1791. Pages 111-144 *in*: S. H. Ridgeway and R. J. Harrison (eds), Handbook of Marine Mammals, Vol. 2: Seals. *Academic Press*, London, 359 pp.

Davies, J. L. 1957. The geography of the gray seal. *J. Mamm. 38: 297-310.*

Katona, S. K., V. Rough, and D. T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. *Smithsonian Institution Press*, Washington, DC. 316 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES C.M. 8/Q. 10 pp.*

Mohn, R. and W. D. Bowen. 1994. A model of grey seal predation on 4VsW cod and its effects on the dynamics and potential yield of cod. *DFO Atlantic Fisheries Res. Doc. 94/64.*

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Rough, V. 1995. Gray seals in Nantucket Sound, Massachusetts, winter and spring, 1994. Final report to Marine Mammal Commission, Contract T10155615, 28 pp. *NTIS Pub. PB95-191391.*

Stobo, W. T. and K. C. T. Zwanenburg. 1990. Grey seal (*Halichoerus grypus*) pup production on Sable Island and estimates of recent production in the northwest Atlantic. Pages 171-184 *in* W. D. Bowen (editor), Population biology of sealworm (*Pseudoterranova decipiens*) in relation to its intermediate and seal hosts. *Can. Bull. Fish. and Aq. Sci.* 222.

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Walden, J. 1996. The New England gillnet effort survey. NOAA, NMFS, NEFSC, Woods Hole, Massachusetts. NEFSC [Northeast Fisheries Science Center] Ref. Doc. 99-10. 38p.

HARP SEAL (*Phoca groenlandica*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The harp seal occurs throughout much of the North Atlantic and Arctic Oceans (Ronald and Healey 1981; Lavigne and Kovacs 1988); however, in recent years, numbers of sightings and strandings have been increasing off the east coast of the United States from Maine to New Jersey (Katona *et al*. 1993; Stevick and Fernald 1998; B. Rubinstein pers. comm., New England Aquarium). These appearances usually occur in January-May, when the western North Atlantic stock of harp seals is at its southern most point of migration. The worlds' harp seal population is divided into three separate stocks, each identified with a specific breeding site (Bonner 1990; Lavigne and Kovacs 1988). The largest stock is located in the western North Atlantic off eastern Canada and is divided into two breeding herds which breed on the pack ice. The Front herd breeds off the coast of Newfoundland and Labrador, and the Gulf herd breeds near the Magdalen Islands in the middle of the Gulf of St. Lawrence (Sergeant 1965; Lavigne and Kovacs 1988). The second stock breeds in the White Sea off the coast of the Soviet Union, and the third stock breeds on the West Ice off of eastern Greenland (Lavigne and Kovacs 1988; Anon 1998).

Harp seals are highly migratory (Sergeant 1965; Stenson and Sjare 1997). Breeding occurs at different times between mid-February and April for each stock. Adults then assemble north of their whelping patches to undergo the annual molt. The migration then continues north to Arctic summer feeding grounds. In late September, after a summer of feeding, nearly all adults and some of the immature animals migrate southward along the Labrador coast, usually reaching the entrance to the Gulf of St. Lawrence by early winter. There they split into two groups, one moving into the Gulf and the other remaining off the coast of Newfoundland. Following mating, the seals disperse to feed, and in late April they again concentrate in large numbers on the ice to molt.

The extreme southern limit of the harp seal's habitat extends into the U.S. Atlantic Exclusive Economic Zone (EEZ) during winter and spring. The influx of harp seals and geographic distribution in New England to mid-Atlantic waters is based on stranding data.

POPULATION SIZE

The total population size of harp seals is unknown; however, three seasonal abundance estimates are available which used a variety of methods including aerial surveys and mark-recapture (Table 1). Generally, these methods include surveying the whelping concentrations and modeling pup production. Harp seal pup production in the 1950s was estimated at 645,000 (Sergeant 1975), decreasing to 225,000 by 1970 (Sergeant 1975). Estimates began to increase at this time and have continued to rise, reaching 478,000 in 1979 (Bowen and Sergeant 1983; Bowen and Sergeant 1985) and 577,900 in 1990 (Stenson *et al*. 1993).

Roff and Bowen (1983) developed an estimation model to provide a more precise estimate of total population. This technique incorporates recent pregnancy rates and estimates of age-specific hunting mortality (CAFSAC 1992). Total population can be determined by multiplying pup production by a factor between 5.35 and 5.38, giving a total of approximately three million harp seals in 1990 (Table 1).

Shelton *et al*. (1992) applied a harp seal estimation model to the 1990 pup production and obtained an estimate of 3.1 million (range 2.7-3.5 million; Stenson 1993) (Table 1). Using a revised population model, 1994 pup count data, and two assumptions regarding pup mortality rates; Shelton *et al.*. (1996) estimated pup production and total population size for the period 1955-1994. The 1994 total population estimates were 4.5-4.8 million harp seals (Table 1).

Table 1. Summary of abundance estimates (pups and total) for western North Atlantic harp seals. Year and area covered during each abundance survey, and resulting abundance estimate (N_{min}) and coefficient of variation (CV).

Month/Year	Area	N_{min}	CV
1990	Eastern Atlantic Canada-Labrador	577,900 pups	None reported
1994	Eastern Atlantic Canada-Labrador	702,900 pups	0.09
1990	Eastern Atlantic Canada-Labrador	3 million	None reported
1990	Eastern Atlantic Canada-Labrador	3.1 million	None reported
1994	Eastern Atlantic Canada-Labrador	4.5-4.8 million	None reported

Minimum population estimate

Present data are insufficient to calculate the minimum population estimate for U.S. waters. It is estimated there are at least 4.5-4.8 million harp seals in Canada (Shelton *et al.*. 1996).

Current population trend

The population appears to be increasing in U.S. waters, judging from the increased number of stranded harp seals, but the magnitude of the suspected increase is unknown. However, most of these strandings represent juveniles and pups, and there is no evidence of a resident stock in U.S. waters (Rubinstein 1994; Rubinstein pers. com.). In Canada, since 1990 the average annual growth rate has been estimated to be about 5% (Shelton *et al.*. 1996).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. The best data are based on Canadian studies. Recent studies indicate that pup production has increased, but the rate of population increase cannot be quantified at this time (Stenson *et al.*. 1996). The mean age of sexual maturity was 5.8 yrs in the mid-1950's, declining to 4.6 yrs in the early 1980's and then increasing to 5.4 yrs in the early 1990's (Sjare *et al.*. 1996).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.12, the default value for pinnipeds. The recover factor (F_R) for this stock is 1.0, the value for stocks with unknown population status, but know to be increasing. PBR for the western North Atlantic harp seal in U.S. waters is unknown. Applying the formula to the minimum population estimate for Canadian waters results in a "PBR" of 288,000 harp seals.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Harp seals have been commercially hunted since the mid-1800's in the Canadian Atlantic (Stenson 1993). A total allowable catch (TAC) of 200,000 harp seals was set for the large vessel hunt in 1971. The TAC varied until 1982 when it was set at 186,000 seals, and remained at this level through 1995 (Stenson 1993; Anon 1998). The TAC was increased to 250,000 and 275,000, respectively in 1996 and 1997 (Anon 1998). Catches ranged from 124,000 to 231,000 from 1971-1982, declining to a range of 19,000 to 94,000 between 1983-1995, and increased dramatically to 242,000 (1996) and 261,000 (1997) (Stenson 1993; Anon 1998). The commercial catches do not account for subsistence takes.

Total annual estimated average fishery-related mortality or serious injury to this stock during 1992-1996 was 329 harp seals (CV = 0.33; Table 2).

Fishery Information

USA

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Recent by-catch has been observed by NMFS Sea Samplers in the New England multispecies sink gillnet fisheries, but no mortalities have been documented in the Mid-Atlantic coastal gillnet, Atlantic drift gillnet, pelagic pair trawl or pelagic longline fisheries.

In 1993, there were approximately 349 full and part-time vessels in the New England multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, and 4% for 1990 to 1996, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. There were 69 harp seal mortalities observed in the New England multispecies sink gillnet fishery between 1990 and 1996. Annual estimates of harp seal by-catch in the New England multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990-1996 was zero (1990-1993), 861 in 1994 (0.58), 694 in 1995 (0.27), and 89 in 1996 (0.55). The 1994 and 1995 by-catches, respectively, include 16 and 153 animals from the estimated number of unknown seals (based on observed mortalities of seals that could not be identified to species). The unknown seals were prorated, based on spatial/temporal patterns of by-catch of harbor seals, gray seals, harp seals, and hooded seals. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1992-1996 was 329 harp seals (CV = 0.33). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The by-catch occurred only in winter (January-May) and was mainly in waters between Cape Ann and New Hampshire. One observed mortality was in waters south of Cape Cod.

CANADA

An unknown number of harp seals have been taken in Newfoundland and Labrador groundfish gillnets (Read 1994). Harp seals are being taken in Canadian lumpfish and groundfish gillnets, and trawls, but estimates of total removals have not been calculated to date (Anon. 1994).

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

In 1996, observers recorded four harp seals (one released alive) in Spanish deep water trawl fishing on the southern edge of the Grand Bank (NAFO Areas 3) (Lens, 1997). Seal by-catches occurred year-round, but interactions were highest during April-June. Many of the seals that died during fishing activities were unidentified. The proportion of sets with mortality (all seals) was 2.7 per 1,000 hauls (0.003).

Table 2. Summary of the incidental mortality of harp seal (*Phoca groenlandica*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
New England Multispecies Sink Gillnet	92-96	349	Obs. Data Weighout, Logbooks	.07, .05, .07, .05, .04	0, 0, 33, 27, 9	0, 0, 861, 694, 89	0, 0, .58, .27, .55	329 (.33)
TOTAL								329 (.33)

1 Observer data (Obs. Data) are used to measure by-catch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects Weighout (Weighout) landings data, and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of some fishing effort in the New England multispecies sink gillnet fishery.

2 The observer coverage for the New England multispecies sink gillnet fishery is measured in trips.

Other Mortality

From 1988-1993 strandings each year were under 50, approaching 100 animals in 1994, and exceeding 100 animals in 1995-1996 (Rubinstein 1994; B. Rubinstein, pers. comm.). In addition, in 1996 there was a stranding in North Carolina. The increased number of strandings may indicate a possible shift in distribution or expansion southward into U.S. waters; if so, fishery interactions may increase.

STATUS OF STOCK

The status of the harp seal stock, relative to OSP, in the U.S. Atlantic EEZ is unknown, but the population appears to be increasing in Canadian waters. The species is not listed as threatened or endangered under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is believed to be very low relative to the population size in Canadian waters and can be considered insignificant and approaching zero mortality and serious injury rate. The level of human-caused mortality and serious injury in the U.S. Atlantic EEZ is unknown, but believed to be very low relative to the total stock size; therefore, this is not a strategic stock.

REFERENCES

Anon. 1998. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals. 28 August-3 September 1997, Copenhagen, Denmark. *ICES CM 1998/Assess:3. 35 pp.*

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Bravington, M. V. and K. D. Bisack. 1996. Estimates of harbor porpoise by-catch in the Gulf of Maine sink gillnet fishery, 1990-93. *Rep. int. Whal. Commn. 46:567-574.*

Bonner, W. N. 1990. The natural history of seals. *Fact on File*, New York, 196 pp.

Bowen, W.D. and D.E. Sergeant. 1983. Mark-recapture estimates of harp seal pup (*Phoca groenlandica*) production in the northwest Atlantic. *Can. J. Fish. Aquat. Sci. 40: 728-742.*

Bowen, W. D. and D. E. Sergeant. 1985. A Mark-recapture estimate of 1983 Harp seal Pup Production in the Northwest Atlantic. NAFO SCR. Doc. 85/I/1.

CAFSAC. 1992. Update on population estimates of Harp seal in the Northwest Atlantic. Canadian Atlantic Fisheries Scientific Advisory Committee, CAFSAC Adv. Doc. 92/8.

Katona, S. K., V. Rough, and D. T. Richardson. 1993. A field guide to whales, porpoises, and seals from Cape Cod to Newfoundland. *Smithsonian Institution Press*, Washington, DC. 316 pp.

Lavigne, D. M. and K. M. Kovacs. 1988. Harps and Hoods Ice Breeding Seals of the Northwest Atlantic. University of Waterloo Press, Waterloo, Ontario, Canada, 174 pp.

Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. *ICES C.M. 8/Q. 10 pp.*

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Roff, D. A. and W. D. Bowen. 1983. Population dynamics and management of the Northwest Atlantic harp seal. *Can. J. Fish. Aquat. Sci.* 40: 919-932.

Ronald, K. and P. J. Healey. 1981. Harp Seal. Pages 55-87 *in*: S. H. Ridgway and R. J. Harrison (eds), Handbook of marine mammals, Vol. 2: Seals. *Academic Press*, New York, 359 pp.

Rubinstein, B. 1994. An apparent shift in distribution of ice seals, *Phoca groenlandica*, *Cystophora cristata*, and *Phoca hispida*, toward the east coast of the United States. M.A. Thesis, Boston University, Boston, MA, 45 pp.

Sergeant, D.E. 1965. Migrations of harp seal *Pagophilus groenlandicus* (Erxleben) in the Northwest Atlantic. *J. Fish. Res. Bd. Can. 22:433-464*.

Sergeant, D. E. 1975. Estimating numbers of Harp seals. *Rapp. P. -v. Reun. Cons. Int. Explor. Mer. 169: 274-280.*

Shelton, P. A., N. G. Caddigan and G. B. Stenson. 1992. Model estimates of harp seal population trajectories in the Northwest Atlantic. CAFSAC Res. Doc. 92/89, 23 pp.

Shelton, P.A., G.B. Stenson, B. Sjare and W.G. Warren. 1996. Model estimates of harp seal numbers-at-age for the Northwest Atlantic NAFO Sci. Coun. Studies 26:1-14.

Sjare, B., G.B. Stenson and W.G. Warren. 1996. Summary of female harp seal reproductive parameters in the Northwest Atlantic. NAFO Sci. Coun. Studies 26:41-46.

Stenson, G. B. 1993. The status of pinnipeds in the Newfoundland region. NAFO SCR Doc. 93/34.

Stenson, G. B., R. A. Myers, M. O. Hammill, I-H Ni, W. G. Warren, and M. S. Kingsley. 1993. Pup Production of Harp Seals, *Phoca groenlandica*, in the Northwest Atlantic. *Can. J. Fish. Aquat. Sci. 50: 2429-2439.*

Stenson, G.B., M.O. Hammill, M.C.S. Kingsley, B. Sjare, W.G. Warren, and R.A. Myers. 1996. 1994 pup production of Northwest Atlantic harp seals, *Phoca groenlandica*. NAFO Sci. Coun. Studies 26:47-62.

Stenson, G.B. and B. Sjare. 1997. Seasonal distribution of harp seals, *Phoca groenlandica*, in the Northwest Atlantic. *ICES C.M. 1997/CC:10 (Biology and Behavior II). 23 pp.*

Stevick, P.T. and T.W. Fernald. 1998. Increase in extralimital records of harp seals in Maine. *Northeastern Naturalist 5(1)75-82.*

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Walden, J. 1996. The New England gillnet effort survey. NOAA, NMFS, NEFSC, Woods Hole, Massachusetts. NEFSC [Northeast Fisheries Science Center] Ref. Doc. 99-10. 38p.

HOODED SEAL (*Cystophora cristata*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The hooded seal occurs throughout much of the North Atlantic and Arctic Oceans (King 1983) preferring deeper water and occurring farther offshore than harp seals (Lavigne and Kovacs 1988; Stenson *et al.*. 1996). Hooded seals tend to wander far out of their range and have been seen as far south as Puerto Rico, with increased occurrences from Maine to Florida. These appearances usually occur between January and May. Although it is not known which stock these seals come from, it is known that during this time frame, the Northwest Atlantic stock of hooded seals are at their southern most point of migration in the Gulf of St. Lawrence. The worlds' hooded seal population is divided into three separate stocks, each identified with a specific breeding site (Lavigne and Kovacs 1988). In the northwest Atlantic, whelping occurs in the Davis Strait, off Newfoundland and in Gulf of St. Lawrence (Stenson *et al.*. 1996). One stock, which whelps off the coast of eastern Canada, is divided into two breeding herds (Front and Gulf) which breed on the pack ice. The Front herd (largest) breeds off the coast of Newfoundland and Labrador and the Gulf herd breeds in the Gulf of St. Lawrence. The second stock breeds in the Davis Strait, and the third stock occurs on the West Ice off eastern Greenland.

Hooded seals are a highly migratory species. Hooded seals remain on the Newfoundland continental shelf during winter/spring (Stenson *et al.*. 1996). Breeding occurs at about the same time in March for each stock. Adults from all stocks then assemble in the Denmark Strait to molt between late June and August (King 1983; Anon 1995), and following this, the seals disperse widely. Some move south and west around the southern tip of Greenland, and then north along the west coast of Greenland. Others move to the east and north between Greenland and Svalbard during late summer and early fall (Lavigne and Kovacs 1988). Little else is known about the activities of hooded seals during the rest of the year until they assemble again in February for breeding.

Hooded seals are rarely found in the U.S. Atlantic Exclusive Economic Zone. Small numbers of hooded seals at the extreme southern limit of their range occur in the winter and spring seasons. The influx of harp seals and geographic distribution in New England to mid-Atlantic waters is based on stranding data.

POPULATION SIZE

The number of hooded seals in the western North Atlantic is unknown. Seasonal abundance estimates are available based on a variety of analytical methods based on commercial catch data, and including aerial surveys. These methods often include surveying the whelping concentrations and modeling the pup production. Several estimates of pup production at the Front are available. Hooded seal pup production between 1966 and 1977 was estimated between 25,000 - 32,000 annually (Benjaminsen and Oritsland 1975; Sergeant 1976; Lett 1977; Winters and Bergflodt 1978; Stenson *et al.*. 1996). Estimated pup production dropped to 26,000 hooded seal pups in 1978 (Winters and Bergflodt 1978). Pup production estimates began to increase after 1978, reaching 62,000 (95% CI. 43,700 - 89,400) by 1984 (Bowen *et al.*. 1987). Bowen *et al.*. (1987) also estimated pup production in the Davis Strait at 18,600 (95% C.I. 14,000 - 23,000). A 1985 survey at the Front (Hay *et al*. 1985) produced a estimate of 61,400 (95% C.I. 16,500 - 119,450). Hammill *et al*. (1992) estimated pup production to be 82,000 (SE=12,636) in 1990. No recent population estimate is available, but assuming a ratio of pups to total population of 1:5, pup production in the Gulf and Front herds would represent a total population of approximately 400,000-450,000 hooded seals (Stenson 1993). Based on the 1990 survey, Stenson *et al.*. (1996) suggests that pup production may have increased at about 5% per year since 1984. However, because of exchange between the Front and the Davis Strait stocks, the possibility of a stable or slightly declining level of pup production are also likely (Stenson 1993; Stenson *et al.*. 1996). It appears that the number of hooded seals is increasing.

Table 1. Summary of pup production estimates for western North Atlantic hooded seals. Year and area covered during each abundance survey, and resulting abundance estimate (N_{min}) and coefficient of variation (CV).

Month/Year	Area	N_{min}	CV
1978	Front herd: Newfoundland/ Labrador	26,000	None reported
1984	Front herd: Newfoundland/Labrador	62,000	None reported
1984	Davis Strait	18,600	None reported
1985	Front herd: Newfoundland/Labrador	61,400	None reported
1990	Front herd: Newfound/Labrador	82,100	None reported

Minimum population estimate

Present data are insufficient to calculate the minimum population estimate for U.S. waters. It is estimated that there are approximately 400,000 hooded seals (5:1 ratio of adults to pups) in Canadian waters (Stenson *et al.*. 1993).

Current population trend

The population appears to be increasing in U.S. Atlantic EEZ, judging from stranding records, although the actual magnitude of this increase is unknown. The Canadian population appears to be increasing but, because different methods have been used over time to estimate population size, the magnitude of this increase has not been quantified.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. The most appropriate data are based on Canadian studies. Pup production in Canada may be increasing slowly (5% per annum), but due to the wide confidence intervals and lack of understanding regarding stock dynamics, it is possible that pup production is stable or declining (Stenson 1993).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.12. This value is based on theoretical modeling showing that pinniped populations may not grow at rates much greater than 12% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a “recovery” factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is unknown. The maximum productivity rate is 0.12, the default value for pinnipeds. The recover factor (F_R) for this stock is 1.0, the value for stocks with unknown population status, but know to be increasing. PBR for the western North Atlantic hooded seal in U.S. waters is unknown. Applying the formula to abundance estimates (400,000) in Canadian waters results in a PBR= 24,000 hooded seals.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

In Atlantic Canada, hooded seals have been commercially hunted at the Front since the late 1800's. In 1974 total allowable catch (TAC) was set at 15,000, and reduced to 12,000 in 1983 and to 2,340 in 1984 (Stenson 1993; Anon 1998). From 1991- 1992 the TAC was increased to 15,000. A TAC of 8,000 was set for 1993, and held at that level through 1997. From 1974 through 1982, the average catch was 12,800 animals, mainly pups. Since 1983 catches ranged from 33 in 1986 to 6,425 in 1991, with a mean catch of 1,001 between 1983 and 1995. In 1996 catches (25,754) were more than three times the allowable quota (Anon 1998). The high catch was attributable to good ice conditions and strong market demand. Catches in 1997 were 7,058, slightly below the TAC.

Hunting in the Gulf of St. Lawrence (below 50^0N) has been prohibited since 1964. No commercial hunting of hooded seals is permitted in the Davis Strait.

Total annual estimated average fishery-related mortality or serious injury to this stock in U.S. waters during 1992-1996 was 5.6 hooded seals (CV = 0.96; Table 2).

Fishery Information

USA

Data on current incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras.

Recent by-catch has been observed by NMFS Sea Samplers in the New England multispecies sink gillnet fisheries, but no mortalities have been documented in the Mid-Atlantic coastal gillnet, Atlantic drift gillnet, pelagic pair trawl or pelagic longline fisheries.

In 1993, there were approximately 349 full and part-time vessels in the New England multispecies sink gillnet fishery, which covered the Gulf of Maine and southern New England (Table 2). An additional 187 vessels were reported to occasionally fish in the Gulf of Maine with gillnets for bait or personal use; however, these vessels were not covered by the observer program (Walden 1996) and their fishing effort was not used in estimating mortality. Observer coverage in terms of trips has been 1%, 6%, 7%, 5%, 7%, 5%, and 4% for 1990 to 1996, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. There was one hooded seal mortality observed in the New England multispecies sink gillnet fishery between 1990 and 1996. Annual estimates of hooded seal by-catch in the New England multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990-1996 was zero (1990-1994), and 28 in 1995 (0.96), and zero in 1996. The 1995 by-catch includes five animals from the estimated number of unknown seals (based on observed mortalities of seals that could not be identified to species). The unknown seals were prorated, based on spatial/temporal patterns of by-catch of harbor seals, gray seals, harp seals, and hooded seals. Average annual estimated fishery-related mortality and serious injury to this stock attributable to this fishery during 1992-1996 was 5.6 hooded seals (CV = 0.96). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The by-catch occurred only in winter (January-May) and was in waters between Cape Ann and New Hampshire.

CANADA

An unknown number of hooded seals have been taken in Newfoundland and Labrador groundfish gillnets (Read 1994).

There were 3,121 cod traps operating in Newfoundland and Labrador during 1979, and about 7,500 in 1980 (Read 1994). This fishery was closed at the end of 1993 due to collapse of Canadian groundfish resources.

Hooded seals are being taken in Canadian lumpfish and groundfish gillnets and trawls; however, estimates of total removals have not been calculated to date.

Table 2. Summary of the incidental mortality of hooded seal (*Cystophora cristata*) by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels	Data Type [1]	Observer Coverage [2]	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
New England Multispecies Sink Gillnet	92-96	349	Obs. Data Weighout, Logbooks	.07, .05, .07, .05, .04	0, 0, 0, 1, 0	0, 0, 0, 28, 0	0, 0, 0, .96, 0	5.6 (.96)
TOTAL								5.6 (.96)

1 Observer data (Obs. Data) are used to measure by-catch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects Weighout (Weighout) landings data, and total landings are used as a measure of total effort for the sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of some fishing effort in the New England multispecies sink gillnet fishery.

2 The observer coverage for the New England multispecies sink gillnet fishery is measured in trips.

Other Mortality

In 1988-93, strandings were less than 20 per year, and from 1994-1996 they increased to about 50 per annum (Rubinstein 1994; Rubinstein, pers. comm). Carcasses were recovered from Massachusetts, Connecticut, and New York (Rubinstein 1994), North Carolina and U.S. Virgin Islands (NMFS, unpubl. data). The increased number of strandings may indicate a possible shift in distribution or range expansion southward into U.S. waters; if so, fishery interactions may increase.

STATUS OF STOCK

The status of hooded seals relative to OSP in U.S. Atlantic EEZ is unknown, but the population appears to be increasing in Canada. They are not listed as threatened or endangered under the Endangered Species Act. The total fishery-related mortality and serious injury for this stock is believed to be very low relative to the population size in Canadian waters and can be considered insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because the level of human-caused mortality and serious injury is believed to be very low relative to overall stock size.

REFERENCES

Anon. 1995. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals. 5-9 June 1995, Dartmouth, Nova Scotia Canada. NAFO SCS Doc. 95/16. Serial No. N2569. 40 pp.

Anon. 1998. Report of the Joint ICES/NAFO Working Group on Harp and Hooded Seals. 28 August - 3 September 1997, Copenhagen, Denmark. *ICES CM 1998/Assess:3. 35 pp.*

Barlow, J., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 pp.

Benjaminsen, T., and T. Oritsland. 1975. The survival of year-classes and estimates of production and sustainable yield of northwest Atlantic harp seals. *Int. Comm. Northwest Atl. Fish. Res. Doc. 75/121.*

Bowen, W.D., R.A. Myers and K. Hay. 1987. Abundance estimation of a dispersed, dynamic population: Hooded seals (*Cystophora cristata*) in the Northwest Atlantic. *Can. J. Fish. Aquat. Sci. 44: 282-295.*

Bravington, M. V. and K. D. Bisack. 1996. Estimates of harbor porpoise by-catch in the Gulf of Maine sink gillnet fishery, 1990-93. *Rep. int. Whal. Commn. 46:567-574.*

Hammill, M. O., G. B. Stenson, and R. A. Myers. 1992. Hooded seal (*Cystophora cristata*) pup production in the Gulf of St. Lawrence. *Can. J. Fish. Aquat. Sci. 49: 2546-2550.*

Hay, K., G. B. Stenson, D. Wakeham, and R. A. Myers. 1985. Estimation of pup production of hooded seals (*Cystophora cristata*) at Newfoundland during March 1985. Con. Atl. Fish. Sci. Adv. Comm. 85/96.

King, J. E. 1983. Seals of the World. *Cornell University Press*, Ithaca, NY, 240 pp.

Lavigne, D. M. and K. M. Kovacs. 1988. Harps and Hoods Ice Breeding Seals of the Northwest Atlantic. *University of Waterloo Press*, Waterloo, Ontario, Canada, 174 pp.

Lett, P.F. 1977. A model to determine stock size and management options for the Newfoundland hooded seal stock. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 77/25.

Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. *Rep. int. Whal. Commn. Special Issue 15: 133-147.*

Rubinstein, B. 1994. An apparent shift in distribution of ice seals, *Phoca groenlandica*, *Cystophora cristata*, and *Phoca hispida*, toward the east coast of the United States. M.A. Thesis, Boston University, Boston, MA, 45 pp.

Sergeant, D.E. 1976. Research on hooded seals *Cystophora cristata* Erxleben in 1976. International Commission for the Northwest Atlantic Fisheries Research Document 76/X/126.

Stenson, G. B. 1993. The status of pinnipeds in the Newfoundland region. NAFO SCR Doc. 93/34.

Stenson, G.B., R.A. Myers, I-H Ni and W.G. Warren. 1996. Pup production of hooded seals (*Cystophora cristata*) in the northwest Atlantic. NAFO Sci. Coun. Studies 26:105-114.

Wade, P.R., and R.P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

Walden, J. 1996. The New England gillnet effort survey. NOAA, NMFS, NEFSC, Woods Hole, Massachusetts. NEFSC [Northeast Fisheries Science Center] Ref. Doc. 99-10. 38p.

Winters, G. H. And B. Bergflodt. 1978. Mortality and productivity of the Newfoundland hooded seal stock. International Commission for the Northwest Atlantic Fisheries Res. Doc. 78/XI/91.

INDEX