

## U.S. Atlantic and Gulf of Mexico

# Marine Mammal Stock Assessments -- 2000 

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## About This Report:

Report History: This report is the fifth in a series compiling marine mammal stock assessments for U.S. Atlantic and Gulf of Mexico waters. The first report was issued in July 1995 as NOAA Technical Memorandum NMFS-SEFSC-363. The second report was issued in October 1997 as NOAA Technical Memorandum NMFS-NE-114. The third report, which included stock assessments only for U.S. Atlantic waters, was issued in February 1999 as NOAA Technical Memorandum NMFS-NE-116. The fourth report was issued in October 1999 as NOAA Technical Memorandum NMFS-NE-153.

Editorial Treatment: To distribute this report quickly, it has not undergone the normal technical and copy editing by the Northeast Fisheries Science Center's (NEFSC) editor as have most other issues in the NOAA Technical Memorandum NMFS-NE series. Other than the four covers (inside and outside, front and back) and first two preliminary pages (including this one), all writing and editing have been performed by - and all credit for such writing and editing rightfully belongs to - the authors and those so noted in the "Acknowledgments" (page vii).

Species Names: The NMFS Northeast Region's policy on the use of species names in all technical communications is generally to follow the American Fisheries Society's (AFS) lists of scientific and common names for fishes (i.e., Robins et al. 1991) ${ }^{\mathrm{a}}$, mollusks (i.e., Turgeon et al. 1998) ${ }^{\mathrm{b}}$, and decapod crustaceans (i.e., Williams et al. 1989) ${ }^{\mathrm{c}}$, and to follow the Society for Marine Mammalogy's list of scientific and common names for marine mammals (i.e., Rice 1998)d. Exceptions to this policy occur when there are subsequent compelling revisions in the classifications of species, resulting in changes in the names of species (e.g., Cooper and Chapleau 1998).

Obtaining/Viewing Copies: Copies of the first report can be obtained from the NMFS Southeast Fisheries Science Center's headquarters (75 Virginia Beach Dr., Miami, FL 33149-1003; 305-361-4284). Copies of the second-throughfourth reports, as well as copies of this report, can be obtained from the NEFSC's headquarters ( 166 Water St., Woods Hole, MA 02543-1026; 508-495-2260). Additionally, all five reports are available online in PDF format at: http://www.wh.whoi.edu/psb/assesspdfs.htm.

[^0]${ }^{\text {e Cooper, J.A.; Chapleau, F. 1998. Monophyly and interrelationships of the family Pleuronectidae (Pleuronectiformes), with a revised classification. }}$ Fish. Bull. (U.S.) 96:686-726.

## TABLE OF CONTENTS

ACKNOWLEDGMENTS ..... vii
EXECUTIVE SUMMARY ..... viii
INTRODUCTION ..... 1
TABLE 1. A SUMMARY OF ATLANTIC MARINE MAMMAL STOCK ASSESSMENT REPORTS FOR STOCKS OF MARINE MAMMALS UNDER NMFS AUTHORITY THAT OCCUPY WATERS UNDER USA JURISDICTION. ..... 2
NORTHERN RIGHT WHALE (Eubalaena glacialis):
Western North Atlantic Stock ..... 5
HUMPBACK WHALE (Megaptera novaeangliae):
Gulf of Maine Stock ..... 14
FIN WHALE (Balaenoptera physalus):
Western North Atlantic Stock ..... 25
SEI WHALE (Balaenoptera borealis):
Nova Scotia Stock ..... 29
BLUE WHALE (Balaenoptera musculus): Western North Atlantic Stock ..... 32
MINKE WHALE (Balaenoptera acutorostrata):
Canadian East Coast Stock ..... 35
DWARF SPERM WHALE (Kogia simus):
Western North Atlantic Stock ..... 47
PYGMY SPERM WHALE (Kogia breviceps):Western North Atlantic Stock51
SPERM WHALE (Physeter macrocephalus):
North Atlantic Stock ..... 54
CUVIER'S BEAKED WHALE (Ziphius cavirostris):
Western North Atlantic Stock ..... 60
MESOPLODON BEAKED WHALES (Mesoplodon spp.):
Western North Atlantic Stock ..... 67
RISSO'S DOLPHIN (Grampus griseus):
Western North Atlantic Stock ..... 74
LONG-FINNED PILOT WHALE (Globicephala melas):
Western North Atlantic Stock ..... 81
SHORT-FINNED PILOT WHALE (Globicephala macrorhynchus): Western North Atlantic Stock ..... 92
WHITE-SIDED DOLPHIN (Lagenorhynchus acutus):
Western North Atlantic Stock ..... 100
COMMON DOLPHIN (Delphinus delphis):
Western North Atlantic Stock ..... 110
ATLANTIC SPOTTED DOLPHIN (Stenella frontalis):
Western North Atlantic Stock ..... 119
PANTROPICAL SPOTTED DOLPHIN (Stenella attenuata):
Western North Atlantic Stock ..... 125
STRIPED DOLPHIN (Stenella coeruleoalba):
Western North Atlantic Stock ..... 131
BOTTLENOSE DOLPHIN (Tursiops truncatus):
Western North Atlantic Offshore Stock ..... 137
BOTTLENOSE DOLPHIN (Tursiops truncatus):
Western North Atlantic Coastal Stock ..... 143
HARBOR PORPOISE (Phocoena phocoena):
Gulf of Maine/Bay of Fundy Stock ..... 152
HARBOR SEAL (Phoca vitulina):
Western North Atlantic Stock ..... 166
GRAY SEAL (Halichoerus grypus):
Western North Atlantic Stock ..... 172
HARP SEAL (Phoca groenlandica):
Western North Atlantic Stock ..... 177
BOTTLENOSE DOLPHIN (Tursiops truncatus):
Gulf of Mexico Bay, Sound, and Estuarine Stocks ..... 183
DWARF SPERM WHALE (Kogia simus):
Northern Gulf of Mexico Stock ..... 192
PYGMY SPERM WHALE (Kogia breviceps):
Northern Gulf of Mexico Stock ..... 195
APPENDIX 1. Observer Comments Relating to the Condition of Marine Mammals Observed Caught in 1992- 1998 by USA Pelagic Longline Vessels Operating in the North Atlantic ..... 198
APPENDIX II. West Indian manatees stock assessments - Florida and Antilles stocks ..... 203
APPENDIX III. Stock assessment reports not updated in the year 2000. ..... 210
KILLER WHALE (Orcinus orca):
Western North Atlantic Stock ..... 210
PYGMY KILLER WHALE (Feresa attenuata): Western North Atlantic Stock ..... 212
NORTHERN BOTTLENOSE WHALE (Hyperoodon ampullatus): Western North Atlantic Stock ..... 214
WHITE-BEAKED DOLPHIN (Lagenorhynchus albirostris): Western North Atlantic Stock ..... 216
SPINNER DOLPHIN (Stenella longirostris):
Western North Atlantic Stock ..... 219
HOODED SEAL (Cystophora cristata): Western North Atlantic Stock ..... 222
SPERM WHALE (Physeter macrocephalus): Northern Gulf of Mexico Stock ..... 227
BRYDE'S WHALE (Balaenoptera edeni):
Northern Gulf of Mexico Stock ..... 230
CUVIER'S BEAKED WHALE (Ziphius cavirostris): Northern Gulf of Mexico Stock ..... 233
BLAINVILLE'S BEAKED WHALE (Mesoplodon densirostris): Northern Gulf of Mexico Stock ..... 236
GERVAIS' BEAKED WHALE (Mesoplodon europaeus): Northern Gulf of Mexico Stock ..... 239
BOTTLENOSE DOLPHIN (Tursiops truncatus): Gulf of Mexico Outer Continental Shelf Stock ..... 242
BOTTLENOSE DOLPHIN (Tursiops truncatus): Gulf of Mexico Continental Shelf Edge and Continental Slope Stock ..... 245
BOTTLENOSE DOLPHIN (Tursiops truncatus):
Western Gulf of Mexico Coastal Stock ..... 248
BOTTLENOSE DOLPHIN (Tursiops truncatus): Northern Gulf of Mexico Coastal Stock ..... 252
BOTTLENOSE DOLPHIN (Tursiops truncatus):
Eastern Gulf of Mexico Coastal Stock ..... 256
ATLANTIC SPOTTED DOLPHIN (Stenella frontalis): Northern Gulf of Mexico Stock ..... 260
PANTROPICAL SPOTTED DOLPHIN (Stenella attenuata):
Northern Gulf of Mexico Stock ..... 264
STRIPED DOLPHIN (Stenella coeruleoalba): Northern Gulf of Mexico Stock ..... 267
SPINNER DOLPHIN (Stenella longirostris): Northern Gulf of Mexico Stock ..... 270
ROUGH-TOOTHED DOLPHIN (Steno bredanensis):
Northern Gulf of Mexico Stock ..... 273
CLYMENE DOLPHIN (Stenella clymene):
Northern Gulf of Mexico Stock ..... 276
FRASER'S DOLPHIN (Lagenodelphis hosei):
Northern Gulf of Mexico Stock ..... 279
KILLER WHALE (Orcinus orca): Northern Gulf of Mexico Stock ..... 282
FALSE KILLER WHALE (Pseudorca crassidens): Northern Gulf of Mexico Stock ..... 285
PYGMY KILLER WHALE (Feresa attenuata):
Northern Gulf of Mexico Stock ..... 288
MELON-HEADED WHALE (Peponocephala electra):
Northern Gulf of Mexico Stock ..... 291
RISSO'S DOLPHIN (Grampus griseus): Northern Gulf of Mexico Stock ..... 294
SHORT-FINNED PILOT WHALE (Globicephala macrorhynchus):
Northern Gulf of Mexico Stock ..... 297
INDEX ..... 300

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## 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 $3^{\text {rd }}$ edition of the SARs (1998 assessments) only contained reports for Atlantic stocks, and updated reports were identified by a 1998 date-stamp (Waring et al. 1999). The $4^{\text {th }}$ edition of the SARs (1999 assessments) only contained reports for Atlantic stocks, and updated reports were identified by a 1999 date-stamp (Waring et al. 1999). The current report contains only updated assessments for Atlantic strategic stocks, and for Atlantic and Gulf of Mexico stocks for which significant new information was available. These reports are identified by a September 2000 date-stamp at the beginning of each report.

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 November 1999 meeting of the Atlantic Scientific Review Group (ASRG), and subsequent revisions were based on their contributions and constructive criticism. Further, the Marine Mammal Commission, the Humane Society of the U.S., and the Center for Marine Conservation provided comments on earlier versions of this report.

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 1999 publication. A total of 28 of the 60 Atlantic and Gulf of Mexico stock assessment reports were revised for 2000. Most of the proposed changes incorporate new information into sections on population size and mortality estimates. The revised SARs include 15 strategic and 13 non-strategic stocks. For the first time, individual species abundance estimates are available for the Western North Atlantic Stocks of Atlantic spotted and Pantropical spotted dolphins. The $\mathrm{R}_{\text {max }}$ value for the Western North Atlantic Stock of Northern right whales has been set at zero, based on recent modeling that suggests the population is in decline. Information on human interactions (fishery and ship strikes) between the right whale, humpback whale, fin whale and minke whale stocks were re-reviewed and updated. The Western North Atlantic stock of long-finned pilot whales was changed to "strategic" based on the annual incidental mortality estimate. Further, the stock definition for humpback whale was changed from North Atlantic Stock to Gulf of Maine Stock based on recent genetic analysis.

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.

## 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), 1998 (Waring et al. 1999) and 1999 (Waring et al. 1999) 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 Atlantic Coast and Gulf of Mexico stocks for which significant new information were available. These are identified by the September 2000 date-stamp at the top right corner at the beginning of each report. The stock definition for humpback whale was changed from North Atlantic Stock to Gulf of Maine Stock based on recent genetic analysis. The western North Atlantic stock of long-finned pilot whale was changed to strategic.

## 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.
Waring, G. T., D. L. Palka, P, J. Clapham, S. Swartz, M. Rossman, T.V.N. Cole, K. D. Bisack and L. J. Hansen. 1999. U.S. Atlantic marine mammal stock assessments-1998. NOAA Tech. Memo. NMFS-NE-116, 182 pp.

Waring, G. T., D. L. Palka, P. J. Clapham, S. Swartz, M. C. Rossman, T. V. N. Cole, L .J. Hansen, K. D. Bisack, K. D. Mullin, R. S. Wells, D. K. Odell and N. B. Barros. 1999. U. S. Atlantic and Gulf of Mexico marine mammal stock assessments - 1999. NOAA Tech. Memo. NMFS-NE-153, 196 pp.

TABLE 1. A SUMMARY OF ATLANTIC MARINE MAMMAL STOCK ASSESSMENT REPORTS FOR STOCKS OF MARINE MAMMALS UNDER NMFS AUTHORITY THAT OCCUPY WATERS UNDER USA JURISDICTION. The "SAR revised" column indicates 2000 stock assessment reports that have been revised relative to the 1999 reports ( $\mathrm{Y}=$ yes $\mathrm{N}=\mathrm{no}$ ). If abundance, mortality or PBR estimates have been revised, they are indicated with the letters "a", "m" and "p" respectively.

| Species | Stock <br> Area | SRG <br> Region | NMFS <br> Center | Nmin | Rmax | Fr | PBR | Total <br> Annual Mort. | Annual <br> Fish. <br> Mort. | Strategic Status | SAR <br> Revised |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Harbor seal | Western North Atlantic | ATL | NEC | 30,990 | 0.12 | 1.0 | 1,859 | 873 | 873 | N | $\begin{aligned} & \mathrm{Y} \\ & \mathrm{~m} \end{aligned}$ |
| Gray seal | Western North <br> Atlantic | ATL | NEC | NA | NA | NA | NA | 75 | 75 | N | $\begin{gathered} \mathrm{Y} \\ \mathrm{~m} \end{gathered}$ |
| Harp seal | Western North Atlantic | ATL | NEC | N/A | N/A | N/A | N/A | 402 | 402 | N | $\begin{gathered} \mathrm{Y} \\ \mathrm{~m} \end{gathered}$ |
| Hooded seal | Western North Atlantic | ATL | NEC | N/A | N/A | N/A | N/A | 5.6 | 5.6 | N | N |
| Harbor porpoise | Gulf of Maine/Bay of Fundy | ATL | NEC | 48,289 | 0.04 | 0.5 | 483 | 1,578 ${ }^{1}$ | 1,521 | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{~m} \end{gathered}$ |
| Risso's dolphin | Western North Atlantic | ATL | NEC | 22,916 | 0.04 | 0.48 | 220 | 52 | 52 | N | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Atlantic whitesided dolphin | Western North Atlantic | ATL | NEC | 19,196 | 0.04 | 0.48 | 184 | 223 | 223 | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{~m} \end{gathered}$ |
| 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 | 23,655 | 0.04 | 0.48 | 227 | 612 | 612 | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Atlantic spotted dolphin | Western North Atlantic | ATL | NEC | 27,785 ${ }^{3}$ | 0.04 | 0.5 | 278 | $7.8^{2}$ | $7.8^{2}$ | N | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Pantropical spotted dolphin | Western North Atlantic | ATL | NEC | 8,450 | 0.04 | 0.5 | 84 | $7.8{ }^{2}$ | $7.8^{2}$ | N | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Striped dolphin | Western North <br> Atlantic | ATL | NEC | 44,500 | 0.04 | 0.5 | 445 | 7.3 | 7.3 | N | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Spinner dolphin | Western North Atlantic | ATL | NEC | N/A | N/A | N/A | N/A | 0.31 | 0.31 | N | N |


| Species | Stock <br> Area | SRG <br> Region | NMFS Center | Nmin | Rmax | Fr | PBR | Total Annual Mort. | Annual Fish. Mort. | Strategic Status | SAR <br> Revised |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Bottlenose dolphin | Western North Atlantic, offshore | ATL | SEC | 24,897 ${ }^{3}$ | 0.04 | 0.5 | 249 | 5.3 | 5.3 | N | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Bottlenose dolphin | Western North <br> Atlantic, coastal | ATL | SEC | 2,482 | 0.04 | 0.5 | 25 | 46 | 46 | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{~m} \end{gathered}$ |
| Dwarf sperm whale | Western North Atlantic | ATL | SEC | $373{ }^{4}$ | 0.04 | 0.5 | 3.7 | 0.25 | 0.25 | N | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Pygmy sperm whale | Western North Atlantic | ATL | SEC | $373{ }^{4}$ | 0.04 | 0.5 | 3.7 | 0.25 | 0.25 | N | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Killer whale | Western North Atlantic | ATL | NEC | N/A | 0.04 | N/A | N/A | 0.00 | 0.00 | N | N |
| $\underset{\text { Pygmy killer }}{\text { whale }}$ whale | Western North Atlantic | ATL | SEC | 6 | 0.04 | 0.5 | 0.1 | 0.00 | 0.00 | N | N |
| Northern bottlenose whale | Western North <br> Atlantic | ATL | NEC | N/A | 0.04 | N/A | N/A | 0.00 | 0.00 | N | N |
| Cuvier's beaked whale | Western North <br> Atlantic | ATL | NEC | 2,419 ${ }^{5}$ | 0.04 | 0.5 | 24 | 9.5 | $9.5{ }^{6}$ | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Mesoplodon beaked whale | Western North <br> Atlantic | ATL | NEC | $2,419^{5}$ | 0.04 | 0.5 | 24 | 9.5 | $9.5{ }^{6}$ | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Pilot whale, long-finned | Western North <br> Atlantic | ATL | NEC | $11,343$ | 0.04 | 0.5 | 113 | $146{ }^{8}$ | 137 | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Pilot whale, short-finned | Western <br> North <br> Atlantic | ATL | SEC | 11,343 ${ }^{7}$ | 0.04 | 0.5 | 113 | $146{ }^{8}$ | 137 | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Sperm whale | North <br> Atlantic | ATL | NEC | 3,505 | 0.04 | 0.1 | 7.0 | 0.00 | 0.00 | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{p} \end{gathered}$ |
| North Atlantic right whale | Western North Atlantic | ATL | NEC | 291 | 0 | 0.1 | 0.0 | 1.4 | $0.6{ }^{9}$ | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{a}, \mathrm{~m}, \mathrm{p} \end{gathered}$ |
| Humpback whale | Western North Atlantic | ATL | NEC | 10,019 | 0.065 | 0.1 | 33 | 3.7 | $2.7{ }^{10}$ | Y | $\begin{gathered} \mathrm{Y} \\ \mathrm{~m} \end{gathered}$ |
| Fin whale | Western North Atlantic | ATL | NEC | 1,803 | 0.04 | 0.1 | 3.6 | 0.8 | $0.2^{11}$ | Y | $\begin{aligned} & \mathrm{Y} \\ & \mathrm{~m} \end{aligned}$ |


| Species | Stock <br> Area | SRG <br> Region | NMFS <br> Center | Nmin | Rmax | Fr | PBR | Total <br> Annual <br> Mort. | Annual <br> Fish. <br> Mort. | Strategic <br> Status | SAR <br> Revised |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Sei whale | Nova <br> Scotia | ATL | NEC | N/A | 0.04 | 0.1 | N/A | 0.00 | 0.00 | Y | Y |
| Minke whale | Canadian <br> east coast | ATL | NEC | 3,097 | 0.04 | 0.5 | 31 | 2.7 | 2.7 | N | Y <br> a, m |
| Blue whale | Western <br> North <br> Atlantic | ATL | NEC | 308 | 0.04 | 0.1 | 0.6 | 0.00 | 0.00 | Y | Y |
| Bottlenose <br> dolphin | Gulf of <br> Mexico <br> bay, sound, <br> and | ATL | SEC | 3,933 | 0.04 | 0.5 | 39 | N/A | N/A | Y | Y |
| estuarine |  |  |  |  |  |  |  |  |  |  |  |
| Dwarf sperm <br> whale | Northern <br> Gulf of <br> Mexico | ATL | SEC | N/A | 0.04 | N/A | N/A | 0.00 | 0.00 | N | Y |
| Pygmy sperm <br> whale | Northern <br> Gulf of <br> Mexico | ATL | SEC | N/A | 0.04 | N/A | N/A | 0.00 | 0.00 | N | Y |

1. Total mortality includes 57 harbor porpoises from the Canadian sink gillnet and herring weir fisheries.
2. Mortality data are not separated by species; therefore, species-specific estimates are not available. The mortality estimate represents both Atlantic and Pantropical spotted dolphins
3. Estimates may include sightings of the coastal form.
4. This estimate may include both the dwarf and pygmy sperm whales.
5. This estimate includes Cuvier's beaked whales and undifferentiated Mesoplodon spp. beaked whales.
6. This is the average mortality of undifferentiated beaked whales (Mesoplodon spp.) based on 5 years of observer data. This annual mortality rate includes an unknown number of Cuvier's beaked whales.
7. This estimate may include both long-finned and short-finned pilot whales.
8. 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. Total annual mortality includes Nova Scotia 94-96 average of 9 long-finned pilot whales.
9. This is the average mortality of right whales based on 5 years of observer data ( 0.0 ) and additional fishery impact records ( 0.6 ).
10. This is the average mortality of humpback whales based on 5 years of observer data ( 0.25 ) and additional fishery impact records (2.4).
11. This is based on a review of NMFS anecdotal records from 1994-1998, that yielded an average of 0.8 human caused mortality - 0.6 ship strikes, 0.2 fishery interactions.

# NORTHERN 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 and nursery 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; in addition, recent resightings of photographically identified individuals have been made off Iceland and arctic Norway. The latter (in September 1999) represents one of only two sightings this century of a right whale in Norwegian waters, and the first since 1926. Together, these long-range matches indicate an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described. Similarly, records from the Gulf of Mexico (Moore and Clark 1963; Schmidly et al. 1972) represent either geographic anomalies or a more extensive historic range beyond the sole known calving and wintering ground in the waters of the southeastern United States. Whatever the case, the location of a large segment of the population is unknown 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 for western North Atlantic right whales; these are the coastal waters of the southeastern United States, the Great South Channel, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf. However, movements within and between habitats may be more extensive than is sometimes thought. Results from a few successfully attached satellite 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, including into deep water off the continental shelf (Mate et al. 1997). These findings cast new light on movements and habitat use, and raise questions about the purpose of 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 (Mayo and Marx 1990). These dense zooplankton patches are likely a primary characteristic of the spring, summer, and fall right whale habitats (Kenney et al. 1986, 1995). Acceptable surface copepod resources are 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 than in most areas, feeding by right whales has been observed elsewhere on the margins of 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 perhaps also as a mating ground.

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 et al. 1999). 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, a finding broadly replicated from sequence data by Malik et al. (2000) These findings 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. 2000). 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 250 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 reproductively active 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 1997) is 144 females and 143 males, not significantly different from parity (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); an updated analysis using the same method gave an estimate of 291 animals in 1998 (Kraus et al. 2000). Because this was a nearly complete census, it is assumed that this represents a minimum population size estimate. However, no estimate of abundance with an associated coefficient of variation has been calculated for this population. Calculation of a reliable point estimate is likely to be difficult given the known problem of heterogeneity of distribution in this population. An IWC workshop on status and trends of western North Atlantic right whales gave a minimum direct-count estimate of 263 right whales alive in 1996 and noted that the true population was unlikely to be substantially greater than this (IWC 2000).

## Historical Population Estimate

An estimate of pre-exploitation population size is not available. Basque whalers may have taken substantial numbers of right whales at times during the 1500s in the Strait of Belle Isle region (Aguilar 1986), 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 USA 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, Reeves and Mitchell (1987) could conclude only 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 291 individuals in 1998 (Kraus et al. 2000), 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 1998 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 population growth rate reported for the period 1986-92 by Knowlton et al. (1994) was $2.5 \%$ (CV=0.12); this suggested that the stock was showing signs of slow recovery. However, work by Caswell et al. (1999) has suggested that crude survival probability declined from about 0.99 in the early 1980's to about 0.94 in the late 1990's. The decline was statistically significant. Additional work conducted in 1999 was reviewed by the IWC workshop on status and trends in this population (IWC 2000); the workshop concluded based on several analytical approaches that survival had indeed declined. Although heterogeneity of capture could negatively bias survival estimates, the workshop concluded that this factor could not account for all of the observed decline, which appeared to be particularly marked in adult females.

## 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 5 to 17 , with a mean of $11.2(\mathrm{SE}=0.90)$. 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 $(\mathrm{P}=0.083)$ (Knowlton et al. 1994).

Since that report, total reported calf production in 92/93 was $6 ; 93 / 94,9 ; 94 / 95,7 ; 95 / 96,21 ; 96 / 97,19$ and $97 / 98,6$. The total calf production was reduced by reported calf mortalities: 2 mortalities in 1993, 3 in 1996, 1 in 1997, and 1 in 1998. Of the three calf mortalities in 1996, available data suggested one was not included in the reported 20 mother/calf pairs, resulting in a total of 21 calves born. Eleven of the 21 mothers in 1996 were observed with calves for the first time (i.e., were "new" mothers) that year. Three of these were 10 years old or younger, two were 9 years old, and six were of unknown age. An updated analysis of calving interval through the 1997/98 season suggests that mean calving interval increased since 1992 from 3.67 years to more than 5 years, a significant trend (Kraus et al. 2000). This conclusion is supported by modeling work reviewed by the IWC workshop on status and trends in this population (IWC 2000); the workshop agreed that calving intervals had indeed increased and further that the reproductive rate was half that reported from southern hemisphere populations of E. australis.

The annual population growth rate during 1986-1992 was estimated to be $2.5 \%$ ( $\mathrm{CV}=0.12$ ) using photoidentification 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). However, as noted above more recent work has suggested that the population is now in decline (Caswell et al. 1999, IWC 2000).

An analysis of the age structure of this population suggests that it contains a smaller proportion of juvenile whales than expected (Hamilton et al. 1998, IWC 2000), which may reflect lowered recruitment and/or high juvenile mortality. In addition, it is possible that the apparently low reproductive rate is due in part to unstable age structure or to reproductive senescence on the part of some females. However, data on either factor are poor; senescence has been demonstrated in relatively few mammals (including humans, pilot whales and killer whales) and is currently undocumented for any baleen whale.

The relatively low population size indicates 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 population growth rate reported by Knowlton et al. (1994) of $2.5 \%(\mathrm{CV}=0.12)$ was assumed to reflect the maximum net productivity rate for this stock for purposes of previous assessments. However, review by the IWC workshop of modeling and other work indicates that the population is now in decline; consequently, no growth rate can be used for western North Atlantic right whales.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) is specified as the product of minimum population size, one-half the maximum net productivity rate 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 for right whales is 0.10 because this species is listed as endangered under the Endangered Species Act (ESA). However, in view of the apparent decline in this population (Caswell et al. 1999, IWC 2000), the PBR for this population is set to zero.

## ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 1994 through 1998, the total estimated human-caused mortality and serious injury to right whales is estimated at 2.4 per year (USA waters, 1.4; Canadian waters, 1.0). This is derived from two components: 1) nonobserved fishery entanglement records (USA waters, 0.8 ; Canadian waters, 0.6 ), and 2 ) ship strike records (USA waters, 0.6; Canadian waters, 0.4 ). Note that in past stock assessment reports, a six-year time frame was used to calculate these averages. A five year period was used for this report to be consistent with the time frames used for calculating the averages for other species. It is also important to stress that serious injury determinations are made based upon the best available information; these determinations may change with the availability of new information. For the purposes of this report, discussion is primarily limited to those records considered confirmed human-caused mortalities or serious injuries.

## Background

Approximately one-third of all right whale mortality is caused by human activities (Kraus 1990). The details of a particular mortality or serious injury record often require a degree of interpretation. The assigned cause is based on the best judgement of the available data; additional information may result in revisions. When reviewing Table 1 below, several factors should be considered: 1) a ship strike or entanglement may occur at some distance from the reported location; 2) the mortality or injury may involve multiple factors; for example, whales that have been both struck and entangled are not uncommon; 3) the actual vessel or gear type/source is often uncertain; and 4) in entanglements, several types of gear may be involved.

The serious injury determinations are most susceptible to revision. There are several records where a struck and injured whale was re-sighted later, apparently healthy, or an entangled or partially disentangled whale was re-sighted later free of gear. The reverse may also be true: a whale initially appearing in good condition after being struck or entangled is later re-sighted and found to have been seriously injured by the event. Entanglements of juvenile whales are typically considered serious injuries because the constriction on the animal is likely to become increasingly harmful as the whale grows.

We have limited the serious injury designation to only those reports that had substantial evidence that the injury, whether from entanglement or vessel collision, was likely to significantly impede the whale's locomotion or feeding in the immediate future. There was no forecasting of how the injury may affect the whale over a longer term, namely from infection or susceptibility to further injury, such as additional entanglement. This conservative approach likely underestimates serious injury rates.

With these caveats, the total estimated annual average human-induced mortality and serious injury within USA Atlantic waters (including fishery and non-fishery related causes) was 2.4 right whales per year (USA waters 1.4; Canadian waters, 1.0). As with entanglements, some injury or mortality due to ship strikes almost certainly passes undetected, particularly in offshore waters. 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 figure of 2.4 right whales per year must be regarded as a minimum estimate.

There was one USA record of a right whale serious injury that did not fall into the 1994-1998 annual average, but is mentioned here since it was overlooked in previous stock assessment reports. The whale was a juvenile sighted off the southeastern USA on 11 January 1992, apparently the victim of an entanglement. It had a long, deep gash on its fluke and entanglement scars on its tail. It appeared emaciated and in poor health.

While this assessment relates to USA fisheries and/or USA waters, there are additional records for Canadian waters within the same time frame. Six Canadian records of mortalities or serious injuries are included in Table 1. In addition to these records, there was one Canadian record examined that is probably a serious injury, but currently for which there is insufficient information to confirm this. This animal, \#1705, was initially seen in mid-July 1997 in the Bay of Fundy with a small amount of line with several small, oval black buoys attached coming out of the right side of its mouth. The whale was also seen on 7/18/97, 8/25/97, and 9/6/97, still trailing the line and floats in each sighting. Although the injury resulting from the gear appeared minimal, it may have the potential to impair the animal's feeding. Future observations of the whale may help determine whether the gear has resulted in serious injury.

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 recovery of the population are ship strikes and entanglement with fishing gear. Between 1970 and 1999, a total of 45 right whale mortalities were recorded (IWC 1999, Knowlton and Kraus 2000). Of these, 13 (28.9\%) were neonates which are believed to have died from perinatal complications or other natural causes. Of the remainder, $16(35.6 \%)$ were determined to be the result of ship strikes, two (4.4\%) were related to entanglement in fishing gear (in both cases lobster gear), and 14 ( $31.1 \%$ ) were of unknown cause. At a minimum, therefore, $40 \%$ of the observed total for the period, and $56.3 \%$ of the 32 non-calf deaths, were attributable to human impacts.

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), as well as \#2220, discussed above.

For waters of the northeastern USA, 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 due to come on-line in 2000.

Awareness and mitigation programs for reducing anthropogenic injury and mortality to right whales have been set up in two areas of concern. The first was initiated in 1992 off the coastal waters of the southeastern USA, and it has
been upgraded and expanded annually. It involves both government and non-government organizations, including the Navy, Army Corps of Engineers, U.S. Coast Guard, and Florida and Georgia state agencies. In 1996, a program was established in the northeastern USA, largely in cooperation with the U.S. Coast Guard and the State of Massachusetts. In July 1999, a Mandatory Ship Reporting System was implemented in both the southeastern United States and in the Great South Channel/Cape Cod Bay/Massachusetts Bay critical habitats. This system requires vessels over 300 tons to report information about their identity, location, course and speed; in return, they receive information on right whale occurrence and recommendations on measures to avoid collisions with whales. This system is expected to provide muchneeded information on patterns of vessel traffic in critical habitat areas.

## Fishery-Related Serious Injury and Mortality

Reports of mortality and serious injury relative to 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). From 1994-1998, 8 of 12 records of mortality or serious injury (including records from both USA and Canadian waters) involved entanglement or fishery interactions. The reports often do not contain the detail necessary to assign the entanglements to a particular fishery or location. However, 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 USA 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. 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 (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 USA midAtlantic lobster pot fisheries from Category III to Category I based on examination of stranding and entanglement records of large whales from 1990 to 1994.

## Fishery Information

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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. Bycatch 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 bycatch of a right whale by NMFS Sea Samplers was female released from a pelagic drift gillnet as noted 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 USA 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, Knowlton \& Kraus 2000). Records from 1994 through 1998 have been summarized in Table 1. For this time frame, the average reported mortality and serious injury to right whales due to ship strikes was 1.0 whales per year (USA waters, 0.6 ; Canadian waters, 0.4).

In the period January to March 1996, an 'unusual mortality event' was declared for right whales in southeastern USA 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 ( $1 / 2 / 96$ 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.

Table 1. Summarized records of mortality and serious injury likely to result in mortality, North Atlantic right whales, January 1994 - December 1998. Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NMFS/NER and NMFS/SER.

| Date | Report Type | Sex, age, ID | Location | Assigned Cause: <br> $\mathrm{P}=$ primary, S=secondary |  | Notes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Ship strike | Entang./ <br> Fsh inter |  |
| 2/22/94 | serious injury | calf, sex unknown \#2404 | offshore NE FL | S | P | deep wounds from line or cable on head, probable propeller gashes on flukes |
| 9/21/94 ${ }^{1}$ | serious injury | 12 y.o. male \#1247 | Bay of Fundy |  | P | line of unknown gear type wrapped tightly around tail stock; has not been sighted since |
| 11/17/94 | serious injury | $\begin{aligned} & 3 \text { y.o., } \\ & \# 2151 \end{aligned}$ | $\begin{aligned} & \text { near Plum I., } \\ & \text { MA } \end{aligned}$ |  | P | line tightly wrapped around rostrum and deeply embedded in gums |
| 7/17/95 | mortality, beached | 2 y.o. male \#2366 | Middletown, RI |  | P | lobster line through mouth, embedded deeply into bone at base of right flipper |
| 8/13/95 |  | adult female, \#1045 | S. Georges Bank | P |  | large head wound exposing bone |
| 10/20/95 ${ }^{1}$ | mortality, beached | male, age unknown \#2250 | Long I., Nova Scotia | P |  | large gash on back, broken vertebrae |
| 1/30/96 | mortality, offshore | adult male, \#1623 | offshore GA | P |  | shattered skull, broken vertebrae and ribs |
| 3/9/96 | mortality, <br> beached | male, age unknown \#2220 | Cape Cod MA | P | S | 3.3 meter gash on back, broken skull, Canadian lobster gear wrapped through mouth and around tail |


| Date | Report Type | Sex, age, ID | Location | $\begin{aligned} & \text { Assigned Cause: } \\ & \text { P=primary, } \\ & \mathrm{S}=\text { secondary } \end{aligned}$ |  | Notes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Ship strike | Entang./ <br> Fsh inter |  |
| 8/5/96 | serious injury | unknown | SE of Gloucester, MA |  | P | unknown type of gear entangled around head |
| 8/19/97 ${ }^{1}$ | mortality | female, age unknown \#2450 | Bay of Fundy | P |  | necropsy found evidence of traumatic impact on left side and lower jaw |
| 8/23/97 ${ }^{1}$ | serious injury | 5 y.o. male \#2212 | Bay of Fundy |  | P | reports from subsequent observations indicate the whale ingested some gear of an unknown type |
| 8/29/97 ${ }^{1}$ | serious injury | 2 yr old female \#2557 | Bay of Fundy |  | P | Line of unknown origin tightly wrapped on body and one flipper, whale emaciated |

${ }^{1}$ Record was not included in the text's calculations of estimated annual average human-induced mortality and serious injury within USA Atlantic waters

## STATUS OF STOCK

The size of this stock is considered to be extremely low relative to OSP in the USA Atlantic EEZ, and this species is listed as endangered under the ESA. The North Atlantic right whale is considered one of the most critically endangered populations of large whales in the world (Clapham et al. 1999). 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 USA, were designated by NMFS (59 FR 28793, June 3, 1994). The NMFS ESA 1996 Northern Right Whale Status Review concluded that the status of the western North Atlantic population of the northern right whale remains endangered; this conclusion was reinforced by the International Whaling Commission in 1998 (IWC 1998), which expressed grave concern regarding the status of this stock. 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 2.4 (USA waters, 1.4; Canadian waters, 1.0) right whales per year since 1994. Given that PBR has been set to zero, no mortality or serious injury for this stock can be considered insignificant. 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

Aguilar, A. 1986.A review of old Basque whaling and its effect on the right whales of the North Atlantic. Rep. int. Whal. Commn, Special Issue 10: 191-199.
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. Mammal Sci. 10(3): 253265.

Caswell, H., Fujiwara, M. and Brault, S. 1999. Declining survival probability threatens the North Atlantic right whale. Proc. Natl. Acad. Sci. USA 96: 3308-3313.

Clapham, P. J., S. B. Young and R. L. Brownell, Jr. 1999. Baleen whales: conservation issues and the status of the most endangered populations. Mammal Review 29: 35-60.
Hain, J. H. W. 1975. The international regulation of whaling. Marine Affairs J. 3: 28-48.
Hamilton, P. K., A. R. Knowlton, M. K. Marx and S. D. Kraus. 1998. Age structure and longevity in North Atlantic right whales Eubalaena glacialis and their relation to reproduction. Marine Ecology Progress Series 171: 285292.

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.
IWC. 1999. Report of the workshop on the comprehensive assessment of right whales worldwide. J. Cetacean Res. Manage. 1 (supplement): 119-120.
IWC. (in press). Report of the Scientific Committee, subcommittee on Comprehensive Assessment of Whale Stocks. J. Cetacean Res. Manage.

IWC. (in press). Report of the Workshop on status and trends in western North Atlantic right whales. Rep. int. Whal. Commn., Special Issue 18.
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. Mammal Sci. 2(1): 1-13.
Kenney, R. D. and S. D. Kraus. 1993. Right whale mortality - a correction and an update. Mar. Mammal Sci. 9:445446.

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. Mammal Sci. 8(4): 397-405.
Knowlton, A. R. and S. D. Kraus. (in press). Mortality and serious injury of North Atlantic right whales (Eubalaena glacialis) in the North Atlantic Ocean. J. Cetacean Res. Manage.
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. Mammal Sci. 6(4): 278-291.
Kraus, S. D., P. K. Hamilton, R. D. Kenney, A. Knowlton and C. K. Slay. (in press). Status and trends in reproduction of the North Atlantic right whale. J. Cetacean Res. Manage.
Malik, S., M. W. Brown, S. D. Kraus, A. Knowlton, P.Hamilton and B. N. White. 1999. Assessment of genetic structuring and habitat philopatry in the North Atlantic right whale (Eubalaena glacialis). Can. J. Zool. 77:1217-1222.
Malik, S., M. W. Brown, S. D. Kraus and B. N. White. 2000. Analysis of mitochondrial DNA diversity within and between North and South Atlantic right whales. Mar. Mammal Sci. 16:545-558.
Mate, B. M., S. L. Nieukirk and S. D. Kraus. 1997. Satellite-monitored movements of the northern right whale. J. Wildl. Manage. 61: 1393-1405.
Mayo, C. A. and M.K. Marx. 1990. Surface foraging behaviour of the North Atlantic right whale, Eubalaena glacialis, and associated zooplankton characteristics. Can. J. Zool. 68: 2214-2220.
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. NEFSC Reference Document No. 92-05. NOAA/NMFS, Northeast Fisheries Science Center, Woods Hole, Massachusetts, 88 pp.
Rosenbaum, H. C., M. Egan, P. J. Clapham, R. L. Brownell Jr. and R. DeSalle. 1997. An effective method for isolating DNA from non-conventional museum specimens. Mol. Ecol. 6: 677-681.

Rosenbaum, H. C., M. G. Egan, P. J. Clapham, R. L. Brownell Jr., S. Malik, M. Brown, B. White, P. Walsh and R. DeSalle. (in press). Assessing a century of genetic change in North Atlantic right whales (Eubalaena glacialis). Cons. Biol.
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.
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.
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): Gulf of Maine 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). 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).

Previously, the North Atlantic humpback whale population was treated as a single stock for management purposes (Waring et al. 1999). Indeed, earlier genetic analyses (Palsbøll et al. 1995), based upon relatively small sample sizes, had failed to discriminate among the four western North Atlantic feeding areas. However, genetic analyses often reflect a timescale of thousands of years, well beyond those commonly used by managers. Accordingly, the decision was recently made to reclassify the Gulf of Maine as a separate feeding stock; this was based upon the strong fidelity by individual whales to this region, and the attendant assumption that, were this subpopulation wiped out, repopulation by immigration from adjacent areas would not occur on any reasonable management timescale. This reclassification has subsequently been supported by new genetic analysis based upon a much larger collection of samples than those utilized by Palsbøll et al. (1995). These analyses have found significant differences in mtDNA haplotype frequencies of the four western feeding areas, including the Gulf of Maine (Palsbøll et al. in prep.)

In winter, whales from all six feeding areas (including the Gulf of Maine) 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 USA 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 USA (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.

A key question with regard to humpback whales off the southeastern and mid-Atlantic states is their population identity. Given the relative proximity of this region to the Gulf of Maine, a working hypothesis would be that these whales belong to a single population that ranges from the southeastern USA to Nova Scotia. However, a determination of their stock identity awaits the completion of an ongoing project (funded by NMFS in 1999) to collect and compare photographs and tissue samples from this region. This work is expected to be completed in 2000, at which time this portion of the Stock Assessment Report will be revised as necessary.

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 piscivorous when in these
waters, feeding on herring (Clupea harengus), sand lance (Ammodytes spp.), 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) (Smith et al. 1999) 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

It is not possible to produce a reliable estimate of abundance for the Gulf of Maine humpback whale population at at this time. Available data are too limited in geographic scope to yield a precise estimate, and additional data from the northern Gulf of Maine and perhaps elsewhere are required. In addition, the issue of whether humpback whales on the Scotian Shelf are part of this stock must be resolved. Humpback whales are known to inhabit banks on the Scotian Shelf to the east of the Gulf of Maine, but the rate of exchange between these habitats and the Gulf region is presently unknown. Numerous humpback whales were individually identified in this region by NMFS large whale surveys in 1998 and 1999; comparison of these photos to the Gulf of Maine catalogue (to be completed in 2000) should resolve this issue. In the meantime, this report will again use the North Atlantic abundance estimate given below.

The overall North Atlantic population (including the Gulf of Maine) 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 sexspecific 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 $10,600(\mathrm{CV}=0.067)$ 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.

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally distributed best abundance estimate. This is equivalent to the 20 th 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 ( $\mathrm{CV}=0.067$ ).

Table 1. Summary of abundance estimates for North Atlantic humpback whales. Period and area covered during each abundance survey, and resulting abundance estimate $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV). MR = Markrecapture.

| Month/Year | Area | Type | $\mathrm{N}_{\text {best }}$ | CV | Source |
| :--- | :--- | :--- | ---: | ---: | :--- |
| $1979-90$ | N. Atlantic Ocean <br> W and SW of <br> 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 <br> 2,804 females | 0.180 <br> 0.218 | Palsbøll et al. 1997 |

## Current Population Trend

As detailed below, current data strongly suggest that the Gulf of Maine humpback whale stock is steadily increasing in size. This is consistent with the trend in the North Atlantic population overall (Smith et al. 1999) although there are no other feeding-area-specific estimates.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Barlow and Clapham (1997) applied an interbirth interval model to photographic mark-recapture data and estimated the population growth rate of the Gulf of Maine humpback whale stock at $6.5 \%$ ( $\mathrm{CV}=0.012$ ). Maximum net productivity is unknown for this population, although a theoretical maximum for any humpback population can be calculated using known values for biological parameters (Brandão et al. 1999). For the Gulf of Maine, data supplied by Barlow and Clapham (1997) and Clapham et al. (1995) gives values of 0.96 for survival rate, 6 y as mean age at first parturition, 0.5 as the proportion of females, and 0.42 for annual pregnancy rate. From this, a maximum population growth rate of 0.072 is obtained according to the method described by Brandão et al. (1999). This suggests that the observed rate of $6.5 \%$ (Barlow and Clapham 1997) is close to the maximum for this stock.

Current and maximum net productivity rates are unknown for the North Atlantic population overall. 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).

## 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 33 whales.

## ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 1994 through 1998, the total estimated human-caused mortality and serious injury to humpback whales is estimated as 3.65 per year. This average is derived from three components: 1) the 1994-1998 observed fishery, $0.25 ; 2$ ) additional fishery interaction records from USA waters, 2.4 ; and 3) vessel collisions from USA waters, 1.0. 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. Note that in past stock assessment reports, a six-year time frame was used to calculate the averages for additional fishery interactions and
vessel collisions. A five-year period was used for this report to be consistent with the time frames used for calculating the averages for the observed fishery and for other species. It is also important to stress that serious injury determinations are made based upon the best available information at the time of writing; these determinations may change with the availability of new information. For the purposes of this report, discussion is primarily limited to those records considered confirmed human-caused mortalities or serious injuries.

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. The literature and review of records described here suggest that there are significant human impacts beyond those recorded in the fishery observer data. For example, a study of entanglementrelated scarring on the caudal peduncle of 134 individual humpback whales in the Gulf of Maine suggested that between $48 \%$ and $78 \%$ had experienced entanglements (Robbins and Mattila 1999). 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.

In addition, we have limited the serious injury designation to only those reports that had substantial evidence that the injury, whether from entanglement or vessel collision, was likely to significantly impede the whale's locomotion or feeding in the immediate future. There was no forecasting of how the injury may affect the whale over a longer term, namely from infection or susceptibility to further injury, such as additional entanglement. This conservative approach likely underestimates serious injury rates. For these reasons, the human impacts listed in this report must be considered a minimum estimate.

One notable entanglement record was not included in the estimate. It involved a whale seen off Massachusetts on several occasions in June and July of 1998. The whale was initially seen severely entangled, but was largely freed of the gear by the Center for Coastal Studies' disentanglement team. Only one length of line remained, trailing from its mouth. The whale appeared in poor health at the time, and the line in the mouth indicates it may have injested some gear. Since the whale was largely disentangled, it was not considered a serious injury; however, future sightings of the whale, identified as "Putter", may allow an assessment of whether the entanglement still resulted in a serious injury. There was also one Canadian record of a whale seen entangled in the Bay of Fundy on 7/19/98. The whale was partially disentangled by researchers, but the effort was cut short by nightfall. The whale reportedly swam off with a "potentially life threatening" amount of gear still wrapped on its body.

## 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 1994 to 1998 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 probable, and 9 records where serious injury attributable to fishery interaction was probable-for a total of 12 records in the five-year period (Table 3). While these records are not statistically quantifiable in the same way as the observed fishery records, they provide some indication of the frequency of entanglements.

## Fishery Information

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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 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. Bycatch 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.

In January 1997 (62 FR 33, Jan. 2, 1997), NMFS changed the classification of the Gulf of Maine and USA midAtlantic 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).

## Pelagic Drift Gillnet

In 1996 and 1997, the NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery was active during 1998. Then, in January 1999 NMFS issued a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery ( 50 CFR Part 630). 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 to 1998 , there were $12,1110,0$, and 11 vessels, respectively, in the fishery (Table 2). 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, $64 \%$ in 1996, no fishery in 1997, and $99 \%$ coverage during 1998 (Table 2). Observer coverage dropped during 1996 because some vessels were deemed too small or unsafe by the contractor that provided observer coverage to NMFS. 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 bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Total annual bycatch after 1993 were estimated separately for each year by summing the observed caught with the product of the average bycatch 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 in 1994 (0), 1.0 in 1995 (0), 0 in 1996 (0), and 0 in 1998 (0). The total average annual estimated fishery-related mortality and serious injury in fisheries monitored by NMFS in 1994-1998 was 0.25 humpback whale (CV=0) (Table 2).

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).
\(\left.$$
\begin{array}{|l|c|c|c|c|c|c|c|c|}\hline \text { Fishery } & \text { Years } & \text { Vessels } & \text { Data Type }^{1} & \begin{array}{c}\text { Observer } \\
\text { Coverage }^{2}\end{array} & \begin{array}{c}\text { Observed } \\
\text { Mortality }\end{array} & \begin{array}{c}\text { Estimated } \\
\text { Mortality }\end{array} & \begin{array}{c}\text { Estimated } \\
\text { CVs }\end{array} & \begin{array}{c}\text { Mean Annual } \\
\text { Mortality }\end{array} \\
\hline \begin{array}{l}\text { Pelagic } \\
\text { Drift } \\
\text { Gillnet }\end{array} & 94-98 & & \begin{array}{l}1994=12 \\
1995=11 \\
1996=10 \\
1998=11\end{array} & \begin{array}{c}\text { Obs. Data } \\
\text { Logbook }\end{array} & \begin{array}{c}.87, .99, \\
.64, \text { NA, } \\
.99\end{array} & \begin{array}{c}0,1,0, \\
\text { NA, } 0\end{array}
$$ \& 0,1.0^{3}, 0, \& 0,0,0, <br>

NA, 0\end{array}\right]\) NA, 0 | $0.25(0)$ |
| :---: |
| TOTAL |

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).
2 The observer coverage and unit of effort for the pelagic drift gillnet fishery is a set.
${ }^{3}$ 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, January 1994 - December 1998. This listing includes only records related to USA commercial fisheries and/or ship strikes in USA waters. Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NMFS/NER and NMFS/SER.

| Date | Report Type | Sex, age, ID | Location | Assigned Cause: $\mathrm{P}=$ primary, $\mathrm{S}=$ secondary |  | Notes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Ship strike | Entang./ <br> Fsh.inter |  |
| 7/14/94 | serious injury | unknown | 15 mi SE of Cape Elizabeth, Maine (43 ${ }^{\circ} 23^{\prime}$ $\left.68^{\circ} 59^{\prime}\right)$ |  | P | CG helicopter crew reported animal with gillnet wrapped around head and swimming at surface |
| 2/28/95 | mortality | unknown | Cape <br> Hatteras, North Carolina ( $35^{\circ} 17^{\prime}$ $\left.75^{\circ} 31^{\prime}\right)$ |  | P | stranded dead with gear wrapped around tail region |


| Date | Report Type | Sex, age, ID | Location | Assigned Cause: <br> $\mathrm{P}=$ primary, <br> $\mathrm{S}=$ secondary |  | Notes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Ship strike | Entang./ <br> Fsh.inter |  |
| 5/26/95 | serious injury | $\begin{aligned} & \text { length (est.) = } \\ & 10 \mathrm{~m} \end{aligned}$ | Great South Channel <br> ( $41^{\circ} 16^{\prime}$ <br> $\left.69^{\circ} 20^{\prime}\right)$ |  | P | net and monofilament around tail region; whale anchored; mesh visible and gear trailing |
| 6/4/95 | mortality | 8.9 mmale | Virginia <br> Beach, <br> Virginia | P |  | floater off inlet; lacerations along peduncle, probable ship strike |
| 1/30/96 | serious injury | juvenile | Northern <br> Edge of Georges Bank ( $42^{\circ} 26^{\prime}$ $\left.67^{\circ} 30^{\prime}\right)$ |  | P | gear wrapped on body, some gear removed |
| 2/22/96 | serious injury | $\begin{aligned} & \text { length (est.) }= \\ & 8 \mathrm{~m} \end{aligned}$ | 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, <br> Virginia <br> Beach, <br> Virginia | P |  | fresh dead; fractured left mandible; emaciated |
| 5/9/96 | mortality | 6.7 m female | mouth of <br> Delaware <br> Bay | P |  | propeller cuts behind blowhole, moderate decomposition; ship strike |
| 7/18/96 | serious injury | $\begin{aligned} & \text { length (est.) = } \\ & 10 \mathrm{~m} \end{aligned}$ | 25 mi S of <br> Bar Harbor <br> Maine <br> ( $44^{\circ} 01^{\prime}$ <br> $\left.68^{\circ} 00^{\prime}\right)$ |  | P | disentanglement unsuccessful; weighted gear wrapped around tail stock; whale swimming abnormally |
| 7/28/96 | serious injury | $\begin{aligned} & \text { length (est.) = } \\ & 10 \mathrm{~m} \end{aligned}$ | 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 ( $41^{\circ} 04^{\prime}$ $\left.69^{\circ} 10^{\prime}\right)$ |  | P | gear wrapped around tail and trailing 30 m behind whale |


| Date | Report Type | Sex, age, ID | Location | Assigned Cause: $\mathrm{P}=$ primary, $\mathrm{S}=$ secondary |  | Notes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Ship strike | Entang./ <br> Fsh.inter |  |
| 10/18/96 | serious injury | unknown | Great South <br> Channel <br> ( $41^{\circ} 00^{\prime}$ <br> $\left.69^{\circ} 10^{\prime}\right)$ |  | 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 |
| 12/10/97 | mortality | 9.0 m male | Beaufort <br> Inlet, NC | P |  | massive hemorrhage consistent with forceful blunt trauma |
| 3/4/98 | mortality | 8.6 m female | Ocracoke <br> Island, NC $\left(35^{\circ} 12^{\prime}\right.$ $\left.75^{\circ} 40^{\prime}\right)$ |  | P | Coast Guard present when whale drowned entangled in croaker gillnet gear |
| 8/23/98 | serious injury | adult, sex unknown | $\begin{aligned} & \text { Montauk Pt., } \\ & \text { NY } \\ & \left(40^{\circ} 36^{\prime}\right. \\ & \left.70^{\circ} 43^{\prime}\right) \end{aligned}$ |  | P | whale anchored by offshore lobster gear, struggling to breath; not relocated by Coast Guard search |
| 11/5/98 | mortality | 8.9 m male | Nags Head, <br> NC ( $35^{\circ} 59^{\prime}$ <br> $\left.75^{\circ} 38^{\prime}\right)$ |  | P | Deep abrasions around tail stock with subdermal hemorrhaging |

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 the 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 (Geraci et al. 1989). 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 probably more serious than those from entanglements. In the NER/NMFS records examined, several contained notes about
wounds or probable/possible vessel collision. Five of these records were mortalities resulting from the collision. One record, on 7 October 1993, involving a 33 ft sport-fishing vessel, resulted in a serious injury to the whale.

Another collision occurred on $8 / 2 / 98$, involving a whale watch vessel. The whale was sighted after the collision with a large gash in its back, however the seriousness of the injury could not be assessed. The whale was reportedly breathing normally.

## STATUS OF STOCK

Although the most recent estimates of abundance indicate continued population growth, the size of the humpback whale stock may be below OSP in the USA Atlantic EEZ. This is a strategic stock because the humpback whale is listed as an endangered species 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 in the North Atlantic overall. 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 for the Gulf of Maine 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 fisheryrelated 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.

Disturbance by whalewatching may prove to be an important habitat issue in some areas of this population's range, notably the coastal waters of New England where the density of whalewatching traffic is seasonally high. No studies have been conducted to address this question, and its impact (if any) on habitat occupancy and reproductive success is unknown.

## REFERENCES

Balcomb, K. C. and G. Nichols. 1982. Humpback whale censuses in the West Indies. Rep. int. Whal. Commn. 32: 401406.

Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. Ecology 78 (2): 535-546.
Brandão, A., D. S. Butterworth and M.R. Brown. (in press). Maximum possible humpback whale increase rates as a function of biological parameter values. J. Cetacean Res. Manage.
CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the USA 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 J. Mar. Sci. 49: 341-355.
Clapham, P. J. and C. A. Mayo. 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.
Geraci, J. R., D. M. Anderson., R. J. Timperi, D. J. St. Aubin., G. A. Early, J. H. Prescott and C. A. Mayo. 1989 Humpback whales (Megaptera novaeangliae) fatally poisoned by dinoflagellate toxins. Can. J. Fish. Aquat. Sci. 46: 1895-1898.
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: 295306.

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. and P. J. Clapham. 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., P. J. Clapham, S. K. Katona and G. S. Stone. 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 USA Atlantic swordfish and tuna drift gillnet and pair trawl fisheries. Draft final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500160.
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., J. Allen,, M. Bérubé, P. J. Clapham, T. P. Feddersen, P. Hammond, H. Jørgensen, S. Katona, A. H. Larsen, F. Larsen, J. Lien, D. K. Mattila, J. Sigurjónsson, R. Sears, T. Smith, R. Sponer, P. Stevick and N. Øien. 1997. Genetic tagging of humpback whales. Nature 388: 767-769.
Palsbøll, P.J., P. J. Clapham, D. K. Mattila, F. Larsen, R. Sears, H. R. Siegismund, J. Sigurjónsson, O. Vásquez and P. Arctander. 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. Mammal Sci. 12: 434-443.
Robbins, J. and D. K. Mattila. 1999. Monitoring entanglement scars on the caudal peduncle of Gulf of Maine humpback whales. Final Report to the National Marine Fisheries Service. Available from Center for Coastal Studies, Provincetown, MA.
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. Mammal 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. Mammal 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. Mammal 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.
Waring, G. T., D.L. Palka, P. J. Clapham, S. Swartz, M. C. Rossman, T. V. N. Cole, K. D. Bisack and L. J. Hansen. 1999. U.S. Atlantic marine mammal stock assessment reports - 1998. NOAA Tech. Memo. NMFS-NE-116, 182 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., R. K. Edel and A. G. Taruski. 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 USA, 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).

Fin whales are common in waters of the USA 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


> Figure 1. Distribution of fin whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m. 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 (Kenney et al. 1997; 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 USA mid-Atlantic region; however, it is unknown where calving, mating, and wintering for most of the population occurs. Preliminary results from the Navy's SOSUS program (Clark 1995) indicate a substantial deep-ocean component to fin whale distribution. It is likely that fin whales occurring in the USA Atlantic EEZ undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions.

## POPULATION SIZE

An abundance of 2,200 (CV=0.24) fin 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; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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. Data collection and analysis methods used were described in Palka (1996).

This is the best available current abundance estimate for the western North Atlantic fin whale because it is relatively recent and covers the largest portion of the known habitat. However, this estimate must be considered conservative in view of the known range of the fin whale in the entire western North Atlantic, and uncertainties regarding population structure and exchange between surveyed and unsurveyed areas.

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally 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 2,200 ( $\mathrm{CV}=0.24$ ). The minimum population estimate for the western North Atlantic fin whale is 1,803 .

## 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 1803 . 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 3.6.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The number of fin whales taken at three whaling stations in Canada from 1965 to 1971 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 1994-1998. A review of NER/NMFS anecdotal records from 1994-1998 yielded an average of 0.8 human caused mortalities per year--0.2 per year resulting from fishery interactions/entanglements, and 0.6 due to vessel collisions.

## Fishery-Related Serious Injury and Mortality

No confirmed fishery-related mortality or serious injury of fin whales was reported in the Sea Sampling bycatch database; therefore, no detailed fishery information is presented here. A review of the records of stranded, floating or injured fin whales for the period 1994-1998 on file at NER/NMFS found four records with evidence of fishery interactions. There was a live fin whale sighted entangled on $6 / 24 / 97$ with line wrapped over its back. The animal appeared emaciated, but whether this was a result of the entanglement could not be determined. New information is currently being reviewed for the 2001 stock assessment report. Two stranded fin whales had net or rope marks, but the evidence on hand was not sufficient to confirm entanglement as the cause of death. The fourth 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 confirmed entanglement mortality 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. A Canadian record, involving a whale found dead, wrapped in fishing gear, was omitted from the estimate.

## Other Mortality

After reviewing NER/NMFS records, three 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 caudal area. The animal's full stomach indicated it had been feeding not long before the collision. 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. The third reported ship strike was a mortality in Salvo, North Carolina, discovered on $3 / 21 / 98$. The whale had a large hemotoma, a disarticulated spine and numerous broken vertebrae. 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 USA Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine the population trend 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. This is a strategic stock because the fin whale is listed as an endangered species under the ESA. A Recovery Plan for fin whales will be in effect early in 2000 (NMFS In press).

## 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. 15: 585-599.
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. and I. E. Seipt. 1991. Resightings of independent fin whales, Balaenoptera physalus, on maternal summer ranges. J. Mamm. 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. 1993. 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.
Kenney, R. D., G. P. Scott, T. J. Thompson, and H. E. Winn. 1997. Estimates of prey consumption and trophic impacts of cetaceans in the USA northeast continental shelf ecosystem. J. Northw. Atl. Fish. Sci. 22: 155-171.
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 (ed), The whale problem: A status report. Harvard University Press, Cambridge, Massachusetts, 419 pp.
NMFS. Draft recovery plan for the fin whale Balaenoptera physalus and sei whale Balaenoptera borealis. (in press). Prepared by R. R. Reeves, G. K. Silber, and P. M. Payne for the National Marine Fisheries Service, Silver Spring, MD. 60 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. 1993. Cetaceans associated with Gulf Stream features off the northeastern USA shelf. ICES Marine Mammals Comm. CM 1993/N:12. 29 pp.

## SEI WHALE (Balaenoptera borealis): Nova Scotia 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 USA 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 $2,000 \mathrm{~m}$ 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. 1993). 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 USA, 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, and the "Nova Scotia stock" is used here as the management unit for this Stock Assessment. The IWC boundaries for this stock are from the USA east coast to Cape Breton, Nova Scotia, thence east to longitude $42^{\circ} \mathrm{W}$.

## POPULATION SIZE

The total number of sei whales in the USA 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 USA 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.

An abundance 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 USA coast appeared in the study area. This estimate does not include a correction for divetime 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 (i.e., 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 Nova Scotia stock of the sei whale. Month, year, and area covered during each abundance survey, and resulting abundance estimate $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathbf{N}_{\text {best }}$ | CV |
| :---: | :--- | ---: | ---: |
| $1966-1972$ | Nova Scotia, <br> Canada | 1,393 to 2,248 | None reported |
| spring 1978-82 | Cape Hatteras, NC <br> 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 lognormally 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 Nova Scotia stock of the 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 1994-1998. 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.

## 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 USA 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 the rarity of mortality reports for this species suggests that this level is insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the sei whale is listed as an endangered species under the ESA. A Recovery Plan for sei whales will be in effect early in 2000 (NMFS in press).

## 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.
NMFS. Draft recovery plan for the fin whale Balaenoptera physalus and sei whale Balaenoptera borealis. (in press). Prepared by R. R. Reeves, G. K. Silber, and P. M. Payne for the National Marine Fisheries Service, Silver Spring, MD. 60 pp.
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. 1993. 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.

## 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 USA 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 USA 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 ( $\mathrm{CV}=$ 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 USA Atlantic EEZ. However, in March 1998 a dead 20-m ( $66-\mathrm{ft}$ ) male blue whale was brought into Rhode Island waters on the bow of a tanker. The cause of death was determined to be ship strike. Although it appears likely that the vessel concerned was responsible, the necropsy revealed some injuries that were difficult to explain in this context. The location of the strike was not determined; given the known rarity of blue whales in USA 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 USA EEZ.

## Fishery Information

No fishery information is presented because there are no observed fishery-related mortalities or serious injury.

## STATUS OF STOCK

The status of this stock relative to OSP in the USA 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. This is a strategic stock because the blue whale is listed as an endangered species under the ESA. A Recovery Plan has been published (Reeves et al. 1998) and is in effect.

## 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 (ed), The whale problem: A status report. Harvard University Press, Cambridge, Massachusetts, 419 pp .
Reeves, R. R., P. J. Clapham, R. L. Brownell, Jr. and G. K. Silber. 1998. Recovery Plan for the blue whale (Balaenoptera musculus). Office of Protected Resources, National Marine Fisheries Service, Silver Spring, MD 20910. 39 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. Mammal 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.

## 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 stock, which inhabits the area from the eastern half of the Davis Strait out to $45^{\circ} \mathrm{W}$ and south to the Gulf of Mexico. The relationship between this and the other three stocks is uncertain. It is also uncertain if there are separate stocks within the Canadian east coast stock.

The minke whale is common and widely distributed within the USA 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.


Figure 1. Distribution of minke whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$.

## POPULATION SIZE

The total number of minke whales in the Canadian East Coast population is unknown. However, six 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, an estimate made from a combination of a shipboard and aerial surveys conducted during July to September 1995, an aerial survey estimate of the entire Gulf of St. Lawrence conducted in August to September 1995, and an aerial survey estimate from the northern Gulf of St. Lawrence conducted during July and August 1996 (Table 1; Figure 1).

An abundance of 320 minke whales $(\mathrm{CV}=0.23)$ 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).

An abundance of $2,650(\mathrm{CV}=0.31)$ 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, using methods as described in Palka (1995).

An abundance 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 $2,000 \mathrm{~m}$ isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993).

An abundance of $2,790(\mathrm{CV}=0.32)$ 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; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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. Data collection and analysis methods used were described in Palka (1996).

Kingsley and Reeves (1998) estimated there were $1,020(C V=0.27)$ minke whales in the entire Gulf of St. Lawrence in 1995 and $620(C V=0.52)$ in the northern Gulf of St. Lawrence in 1996. During the 1995 survey, 8427 km of track lines were flown in an area of $221,949 \mathrm{~km}^{2}$ during August and September. During the 1996 survey, $3,993 \mathrm{~km}$ of track lines were flown in an area of $94,665 \mathrm{~km}^{2}$ during July and August. Data were analyzed using Quenouille's jackknife bias reduction procedure on line transect methods that model the left truncated sighting curve. These estimates were uncorrected for visibility biases, such as $g(0)$.

The best available current abundance estimate for minke whales is the sum of the 1995 USA and Canadian surveys: $3,810(\mathrm{CV}=0.25)$ because these surveys are 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 $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| Jul -Sep 1991-92 | N. Gulf of Maine and Bay of <br> Fundy | 2,650 | 0.31 |
| Jun-Jul 1993 | Georges Bank to Scotian <br> shelf, shelf edge only | 330 | 0.66 |
| Jul-Sep 1995 | Virginia to mouth of Gulf of <br> St. Lawrence | 2,790 | 0.32 |
| Aug-Sep 1995 | Gulf of St. Lawrence | 1,020 | 0.27 |
| Jul-Sep 1995 | Virginia to Gulf of St. <br> Lawrence <br> (SUM OF ABOVE 2 ROWS) | 3,810 | 0.25 |
| Jul-Aug 1996 | northern Gulf of St. Lawrence | 620 | 0.52 |

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally distributed best abundance estimate. This is equivalent to the 20 th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for minke whales is $3,810(\mathrm{CV}=0.25)$. The minimum population estimate for the Canadian East Coast minke whale is $3,097(\mathrm{CV}=0.25)$.

## 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 $3,097(\mathrm{CV}=0.25)$. 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 31 .

## ANNUAL HUMAN-CAUSED MORTALITY AND INJURY

Data to estimate the mortality and serious injury of minke whales come from the USA Sea Sampling Program and from records of strandings and entanglements in USA waters. Estimates using the Sea Sampling Program data are discussed by fishery under the Fishery Information section below (Tables 2 and 3). Strandings and entanglement records are discussed under the lobster trap fishery, mid-Atlantic coastal gill net fishery, and "Unknown Fisheries" within the Fishery Information section and under the Other Mortality section (Tables 4 and 5). For the purposes of this report, only those strandings and entanglement records considered confirmed human-caused mortalities or serious injuries are discussed.

After USA strandings and entanglement records are completely audited the mortality and serious injury estimate will be updated. Using the data presently available and audited (1994, 1996 to 1998) , the USA total annual estimated average human-caused mortality is 3.0 minke whales per year. This is derived from three components: 1.1 minke whales per year ( $\mathrm{CV}=0.0$ ) from USA observed fisheries, 1.6 minke whales per year from USA fisheries using strandings and entanglement data, and 0.3 minke whales per year from ship strikes.

## Fishery Information

Recent minke whale takes have been observed or attributed to the Atlantic pelagic drift gillnet, bluefin tuna purse seine, Gulf of Maine and mid-Atlantic lobster trap/pot, mid-Atlantic coastal gill net and unknown fisheries; though all takes have not resulted in a mortality (Tables 2 and 3).

## USA

Data on current incidental takes in USA 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.

## Earlier Interactions

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 bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA. 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 bycatch 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 USA 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 $100 \%$.

Two minke whales were observed taken in the Northeast multispecies sink gillnet fishery between 1989 and the present. 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. There were approximately 349 vessels (full and part time) in the Northeast multispecies sink gillnet fishery in 1993 (Walden 1996) and 301 full and part time vessels in 1998. Observer coverage as a percentage of trips has been $1 \%, 6 \%, 7 \%, 5 \%, 7 \%, 5 \%, 4 \%, 6 \%$, and $5 \%$ for years 1990 to 1998. Because no mortalities have been observed since 1991, the annual estimated average Northeast multispecies sink gillnet fishery-related mortality for minke whales is zero.

A minke whale was trapped and released alive in a herring weir off northern Maine in 1990. In USA and Canadian waters the herring weir fishery occurred 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 56 active weirs in Maine (Read 1994). According to state of Maine officials, in 1998, the number of weirs in Maine waters dropped to nearly nothing due to the limited herring market (Jean Chenoweth, pers. comm.). The actual number of active weirs in the USA is unknown.

## Pelagic Drift Gillnet

In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery was active during 1998. Then, in January 1999 NMFS issued a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery ( 50 CFR Part 630). 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 to 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 to 1998, there were $12,1110,0$, and 11 vessels, respectively, in the fishery (Table 2). 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 $1995,64 \%$ in 1996 , no fishery in 1997, and $99 \%$ coverage during 1998 (Table 2). Observer coverage dropped during 1996 because some vessels were deemed too small or unsafe by the contractor that provided observer coverage to NMFS. 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 bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Total annual bycatch after 1993 was estimated separately for each year by summing the observed caught with the product of the average bycatch 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, 0 for 1996 (Bisack 1997), and 0 for 1998. The fishery was closed during 1997. Estimated average annual mortality and serious injury related to this fishery during 1994 to 1996, and 1998 was 1.1 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 were used to locate fish schools. The official start date, set by regulation, was 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. No trips were observed during 1997 and 1998.
Gulf of Maine and Mid-Atlantic Lobster Trap/Pot Fishery

The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, reported seven minke whale mortalities and serious injuries that were attributed to the lobster fishery during 1990 to 1994, 1 in 1990 (may be serious injury), 2 in 1991 (one mortality and one a serious injury), 2 in 1992 (both mortalities), 1 in 1993 (serious injury) and 1 in 1994 (mortality) (1997 List of Fisheries 62FR33, January 2, 1997). The 1995 entanglement records have not been completely audited. No mortalities or serious injuries of minke whales in 1996 were confirmed. From the four confirmed 1997 records one minke whale mortality was attributed to the lobster trap fishery (Tables 4 and 5). No fishery could be attributed to the other three 1997 minke mortalities(see unknown fisheries). No minke whale mortalities were attributed to a fishery for 1998 (Table 4).

There are three distinctly identified stock areas for the American lobster: 1) Gulf of Maine, 2) south of Cape Cod to Long Island Sound, and 3) Georges Bank and south to Cape Hatteras. In 1997, there were 3,431 vessels holding licenses to harvest lobsters in federal waters, 2,674 vessels licensed to use lobster pot gear in state waters, 675 vessels licensed to use bottom trawls and approximately 100 licenses to use dredge gear to harvest lobsters. Lobsters are taken primarily by traps, with about $2-3 \%$ of the harvest being taken by mobile gear (trawlers and dredges). About $80 \%$ of lobsters are harvested from state waters. The offshore fishery in federal waters has developed in the past 10 to 15 years, largely due to technological improvements in equipment and lower competition in the offshore areas. In January 1997, NMFS changed the classification of the Gulf of Maine and USA mid-Atlantic lobster pot fisheries from Category III to Category I (1997 List of Fisheries 62FR33, January 2, 1997) based on examination of 1990 to 1994 stranding and entanglement records of large whales (including right whales, humpback and minke whales). Annual mortalities due to this fishery, as determined from strandings and entanglement records that have been audited, were 1 in 1991, 2 in 1992, 1 in 1994, 0 in 1996, 1 in 1997, and 0 in 1998. Estimated average annual mortality related to this fishery during 1994 to 1998 (excluding 1995 because these data were not audited) was 0.5 minke whales per year (Table 4). The mortality estimate will be updated when all strandings and entanglement records have been audited.

## Mid-Atlantic Coastal Gillnet

One minke whale, reported in the strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, was taken in a 6-inch gill net on 06 July 1998 off Long Island, New York (Tables 4 and 5). This take is being assigned to the mid-Atlantic coastal gillnet fishery. No minke whales have been taken from this fishery during observed trips in 1993 to 1998. In July 1993, an observer program was initiated in the USA 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 these vessels operate right off the beach. During 1998, it was estimated there were 302 full and part-time vessels participating in this fishery. This is the number of unique vessels in the commercial landings database (Weighout) that report catch from fisheries during 1998 from the states of Connecticut to North Carolina. This does not include a small percentage of records where the vessel number was missing. Observer coverage, expressed as percent of tons of fish landed, was 5\%, $4 \%, 3 \%$, and $5 \%$ for 1995 to 1998, respectively. Observed fishing effort was concentrated off New Jersey and scattered between Delaware and North Carolina from the beach to 50 miles off the beach.

Annual mortalities due to this fishery, as determined from strandings and entanglement records that have been audited, were 0 in 1991, 1992, 1994, 1996, and 1997 and 1 in 1998. Estimated average annual mortality related to this fishery during 1994 to 1998 (excluding 1995 because these data were not audited) was 0.3 minke whales per year (Table 4). The mortality estimate will be updated when all strandings and entanglement records have been audited.

## Unknown Fisheries

The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, included 36 records of minke whales within USA waters for 1975-1992. The gear included unspecified fishing net, unspecified cable or line, fish trap, weirs, seines, gillnets, and lobster gear. A review of these records is not complete. One confirmed entanglement was an immature female minke whale, entangled with line around the tail stock that came ashore on the Jacksonville, Florida, jetty on 31 January 1990 (R. Bonde, USFWS, Gainesville, FL, pers. comm.). The NE Regional Office entanglement/stranding database for 1993 to 1997 also contains records of minke whales. At this time the 1994, and 1996-1998 records have been audited (Tables 4 and 5). Other years will be available later. The examination of the minke entanglement records from 1997 indicate that 4 out of 4 confirmed records of mortality are likely a result of fishery interactions, one attributed to the lobster pot fishery (see above), and three not attributed to any particular fishery because the reports do not contain the necessary details.

In general, an entangled or stranded cetacean could be an animal that is part of a expanded bycatch estimate from an observed fishery and thus it is not possible to know if an entangled or stranded animal is an additional mortality.

During 1997, there were no minke whales observed taken in any fishery that participated in the Sea Sampling Program, however, there were three confirmed minke whale mortalities due to some unknown fishery. Thus, for 1997, three is the best minimum estimate of mortality due to one or more fisheries.

During 1994 to 1998 (excluding 1995 because the data have not been audited), the estimated average annual mortality in unknown fisheries, as determined from strandings and entanglement records, is 0.8 minke whales per year (Table 4). The mortality estimate will be updated when all strandings and entanglement records have been audited.

## CANADA

In Canadian waters, information about minke whale interactions with fishing gear is not well quantified or recorded, 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. Hooker et al. (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on between 25 and $40 \%$ of large Canadian fishing vessels (greater than 100 feet long), and on approximately $5 \%$ of smaller Canadian fishing vessels. During 1991 through 1996, no minke whales were observed taken.

## Herring Weirs

During 1980 and 1990, 15 of 17 minke whales were released alive from herring weirs in the Bay of Fundy. Due to the formation of a cooperative program between Canadian fishermen and biologists it is expected that now most minke whales will be able to be released alive (A. Westgate, pers. comm.).

In USA and Canadian waters the herring weir fishery occurred 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 (Read 1994). According to Canadian DFO officials, for 1998, there were 225 weir licenses for herring weirs on the New Brunswick and Nova Scotia sides of the Bay of Fundy (60 from Grand Manan Island, 95 from Deer and Campobello Islands, 30 from Passamaquoddy Bay, 35 from East Charlotte area, and 5 from the Saint John area). The number of licenses has been fairly consistent since 1985 (Ed Trippel, pers. comm.). The number of active weirs is less than the number of licenses, and the number of active weirs is less each year (A. Read, pers. comm.).

## Other Fisheries

Six minke whales were reported entangled during 1989 in the now non-operational groundfish gillnet fishery in 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. From data collected during observed trips, 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 <br> Mortality | Estimated <br> Mortality | $\begin{gathered} \text { Estimated } \\ \text { CVs } \end{gathered}$ | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pelagic Drift Gillnet | 94-98 | $\begin{gathered} 1994=12 \\ 1995=11 \\ 1996=10 \\ 1997=\text { NA }^{4} \\ 1998=13 \end{gathered}$ | Obs. Data Logbook | $\begin{gathered} .87, .99 \\ .64, \mathrm{NA}^{4}, \\ .99 \end{gathered}$ | $\begin{aligned} & 0,4,0, \\ & \mathrm{NA}^{4}, 0 \end{aligned}$ | $\begin{gathered} 0,4.5^{3}, 0 \\ \mathrm{NA}^{4}, 0 \end{gathered}$ | 0 | $\begin{gathered} 1.1^{4} \\ (0) \end{gathered}$ |
| TOTAL |  |  |  |  |  |  |  | $1.1^{4}$ (0) |

Observer data (Obs. Data), used to measure bycatch rates, are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data, used to measure total effort for the pelagic drift gillnet fishery, are collected at the Southeast Fisheries Science Center (SEFSC).
2 The unit of effort for the observer coverage of the pelagic drift gillnet fishery is sets.
3 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.
$4 \quad$ Fishery closed during 1997. So average bycatch is for 1994 to 1996, and 1998.

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 |
| :---: | :---: | :---: | :---: | :---: |
| Tuna purse <br> seine | $96-98$ | $0 / 0, \mathrm{NA}^{2}, \mathrm{NA}^{2}$ | $0, \mathrm{NA}^{2}, \mathrm{NA}^{2}$ | $1^{1}, \mathrm{NA}^{2}, \mathrm{NA}^{2}$ |

NA=Not Available.
1 The minke whale escaped by diving beneath the net.
$2 \quad$ No observer coverage during 1997 and 1998.

Table 4. From strandings and entanglement data, summary of confirmed incidental mortality of minke whales (Balaenoptera acutorostrata) by commercial fishery: includes years sampled (Years), number of vessels active within the fishery (Vessels), type of data used (Data Type), mortalities assigned to this fishery (Mortality), and mean annual mortality.

| Fishery | Years | Vessels | Data Type ${ }^{1}$ | Observed <br> Mortality | Mean Annual <br> Mortality |
| :--- | :--- | :---: | :---: | :---: | :---: |
| GOM and mid-Atlantic <br> Lobster Trap/Pot | $94-98$ | $1997=6880$ <br> licenses ${ }^{2}$ | Entanglement <br> $\&$ Strandings | $1, \mathrm{NA}^{3}$, <br> $0,1,0$ | $0.5^{3}$ <br> $(0)$ |
| Mid-Atlantic coastal gillnet | $94-98$ | $1998=302$ | Entanglement <br> $\&$ Strandings | $0, \mathrm{NA}^{3}$, <br> $0,0,1$ | $0.3^{3}$ |
| Unknown Fisheries | $94-98$ | NA | Entanglement <br> $\&$ Strandings | $0, \mathrm{NA}^{3}$, <br> $0,3,0$ | $0.8^{3}$ <br> $(0)$ |
| TOTAL | $1.6^{3}$ <br> $(0)$ |  |  |  |  |

NA=Not Available.
1 Data from records in the entanglement and strandings data base maintained by the New England Aquarium and the Northeast Regional Office/NMFS (Entanglement and Strandings).
2 Number of vessels licensed to harvest lobsters in federal and state waters, with lobster traps/pots, bottom trawls, and dredge gear.
31995 stranding and entanglement records have not been audited, so average bycatch is an average of 1994, 1996, 1997, and 1998.

Table 5. Summarized records of mortality and serious injury likely to result in mortality. Canadian East Coast stock of minke whales, January 1994 - December 1998 (excluding 1995). This listing includes only confirmed records related to USA commercial fisheries and/or ship strikes in USA waters. Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NMFS/NER and NMFS/SER.

| Date | Report Type | Sex, age, ID | Location | Assigned Cause: $\mathrm{P}=$ primary, $\mathrm{S}=$ secondary |  |  | Notes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | Ship strike | Entang./ <br> Fsh.inter | Unknown uncertain |  |
| 7/2/94 | mortality | NA | off NH |  | P |  | Lobster lines (3 pair traps involved; line through mouth; one line around lower jaw; chafing on tail; whale brought up dead with traps. |
| 5/15/97 | mortality | female 5.5 m (est) | $\begin{aligned} & \text { Gloucester, } \\ & \text { MA } \\ & \left(42^{\circ} 36\right. \\ & \left.70^{\circ} 38^{\prime}\right) \end{aligned}$ |  | P |  | Deep lacerations around tail stock, abrasions around flukes and mouth |
| 5/16/97 | mortality | female 5.5 m (est) | $\begin{aligned} & \text { Rockport, } \\ & \text { MA } \\ & \left(42^{\circ} 40\right. \\ & \left.70^{\circ} 35^{\prime}\right) \end{aligned}$ |  | P |  | Abrasions around flukes; feeding prior to entanglement |
| 8/14/97 | mortality | female <br> 2.8 m | Jewell <br> Island, ME <br> (43³9' <br> $\left.70^{\circ} 02^{\prime}\right)$ |  | P |  | Fresh lacerations on flukes and pectoral fins |
| 8/30/97 | mortality | female <br> 8m (est) | $\begin{aligned} & \text { Cape Small, } \\ & \text { ME } \\ & \left(43^{\circ} 40^{\prime}\right. \\ & \left.69^{\circ} 57^{\prime}\right) \end{aligned}$ |  | P |  | Observed entangled in lobster gear by ME Marine Patrol |
| 6/24/98 | mortality | male <br> 3.4 m | Long Beach, <br> NY <br> ( $40^{\circ} 34^{\prime}$ <br> $\left.73^{\circ} 42^{\prime}\right)$ |  | P |  | Alive initially, then died in a 6-inch mesh gillnet. |
| 12/12/98 | mortality | unk sex and size | Cape Cod <br> Bay, MA | P |  |  | Body of whale seen in wake of a whale watching vessel. |

## 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.

## USA

Minke whales inhabit coastal waters during much of the year and are subject to collision with vessels. According to the NE marine mammal entanglement and stranding database, on 7 July 1974, a necropsy on a minke whale suggested a vessel collision occurred; 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 of Massachusetts. After reviewing this record, it was concluded the animal struck was not a serious injury or mortality. On 12 December 1998, a minke whale was struck and presumed killed by a whale watching vessel in Cape Cod Bay off Massachusetts.

During the past five years, fours years of stranding and entanglement records have been audited (1994, and 1996 to 1998). During these four years, one minke whale was confirmed struck by a ship, thus, there is an annual average of 0.3 minke whales per year struck by ships.

All entangled and stranded minke whalesthat had injuries suggestive of a vessel collision or fishery interactions will be audited and summarized in the next stock assessment report.

## CANADA

Whales and dolphins stranded between 1991 and 1996 on the coast of Nova Scotia were documented by the Nova Scotia Stranding Network (Hooker et al. 1997). Strandings on the beaches of Sable Island were documented by researchers with Fisheries and Oceans, Canada (Lucas and Hooker 1997). Sable Island is approximately 170 km southeast of mainland Nova Scotia. No minke whales were recorded stranded on Sable Island. On the mainland of Nova Scotia, a total of seven reported minke whales stranded during 1991 to 1996 (Table 6). The 1996 stranded minke whale was released alive off Cape Breton on the Atlantic Ocean side, the rest were found dead. All the minke whales stranded between July and October. One was from the Atlantic Ocean side of Cape Breton, one from Minas Basin, one was at an unknown location, and the rest stranded in the vicinity of Halifax, Nova Scotia. It is unknown how many of the strandings can be attributed to fishery interactions.

Table 6. Documented number of stranded minke whales along the coast of Nova Scotia by month and year, according to Hooker et al. (1997).

| Year | Month | Number of <br> strandings |
| :--- | :--- | :--- |
| 1991 | Sept | 1 |
| 1992 | July | 1 |
| 1993 | July | 1 |
|  | Oct | 2 |
| 1994 | Aug | 1 |
| 1995 | - | 0 |
| 1996 | July | 1 |
| TOTAL |  | 7 |

## STATUS OF STOCK

The status of minke whales, relative to OSP, in the USA 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.
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.
Hooker, S. K., R. W. Baird and M. A. Showell. 1997. Cetacean strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Meeting document SC/49/O5 submitted to the 1997 International Whaling Commission meeting in Bournemouth, UK.
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.
Kingsley, M.C.S. and R.R. Reeves. 1998. Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. Can. J. Zool. 76:1529-1550.
Lucas, Z. N. and S. K. Hooker. 1997. Cetacean strandings on Sable Island, Nova Scotia, 1990-1996. Meeting document SC/49/O6 submitted to the 1997 International Whaling Commission meeting in Bournemouth, UK.
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. 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.
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., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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.

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

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The dwarf sperm whale (Kogia simus) appears to be distributed worldwide in temperate to tropical waters (Caldwell and Caldwell 1989). There are no stranding records for the east Canadian coast (Willis and Baird 1998). Sightings of these animals in the western North Atlantic occur primarily along the continental shelf edge and over the deeper waters off the continental shelf (Hansen et al. 1994; NMFS unpublished data). Dwarf sperm whales and pygmy 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. In a recent study using hematological and stable-isotope data, Barros et al. (1998) speculated that dwarf sperm whales may have a more pelagic distribution than pygmy sperm whales, and/or dive deeper during feeding bouts.

## POPULATION SIZE

An abundance of $115(\mathrm{CV}=0.61)$ for Kogia sp.was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland $\left(38^{\circ}\right.$ N) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of $421(\mathrm{CV}=0.55)$ for Kogia sp. was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed $5,570 \mathrm{~km}$ of track line in waters south of Maryland $\left(38^{\circ} \mathrm{N}\right)$ (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for Kogia sp. is the sum of the estimates from the two 1998 USA Atlantic surveys, 536 ( $\mathrm{CV}=0.45$ ), where the estimate from the northern USA Atlantic is $115(\mathrm{CV}=0.61)$ and from the southern USA Atlantic is 421 ( $\mathrm{CV}=0.55$ ). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally 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 Kogia sp. is 536 ( $\mathrm{CV}=0.45$ ). The minimum population estimate for Kogia sp. is 373 .


Figure 1. USA Gulf of Mexico bays and sounds. Each of the alpha-numerically designated blocks corresponds to one of the NMFS Southeast Fisheries Science Center logistical aerial survey areas listed in Table 1. The bottlenose dolphins inhabiting each bay and sound are considered to comprise a unique stock for purposes of this assessment.

## Current Population Trend

The available information is insufficient to evaluate trends in population size for this species in the western North Atlantic.

## 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 373. 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 Kogia sp. is 3.7.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of dwarf sperm whales in the USA Atlantic EEZ is unknown. Available information indicates there is likely little fisheries interaction with dwarf sperm whales in the USA Atlantic EEZ. Total annual estimated average fishery-related mortality or serious injury to this stock during 19941998 was 0.25 dwarf sperm whales ( $\mathrm{CV}=0$ ); Table 1).

## Fishery Information

Data on current incidental takes in USA 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 provides observer coverage of vessels fishing south of Cape Hatteras.

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in other 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, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10- and 13 vessels have participated in the fishery (Table 1). 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, $64 \%$ in 1996, and $99 \%$ in 1998. 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 bycatch, from 1989 to 1993, were obtained using the aggregated (pooled 19891993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch 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 fisheries information. Variances were estimated using bootstrap re-sampling techniques. There was one report of mortality or serious injury to dwarf sperm whales attributable to this fishery. Estimated annual fisheryrelated mortality and serious injury (CV in parentheses) was 0 dwarf sperm whales from 1991-1994,1.0 in 1995 (CV=0), and 0 from 1996-1998; estimated average annual mortality and serious injury related to this fishery during 1994-1998 was 0.25 dwarf sperm whales $(\mathrm{CV}=0)($ Table 1$)$.

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 <br> Type ${ }^{2}$ | Observer <br> Covȩrage | Observed <br> Serious <br> Injury | Observe <br> d <br> Mortality | Estimated <br> Mortality | Estimated <br> CVs | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pelagic <br> Drift <br> Gillnet | $94-98$ | $1994=11$ <br> $1995=12$ <br> $1996=10$ <br> $1998=13$ | Obs. <br> Data <br> Logbook | $.87, .99$, <br> .64, NA, <br> .99 | $0,0,0,0$, | $0,1,0$, | $0,1.0^{4}, 0$, | 0 | 0.25 |
| 0 | NA, 0 | NA, 0 |  | $(0)$ |  |  |  |  |  |
| TOTAL |  |  |  | 0.25 |  |  |  |  |  |

1994, 1995, 1996 and 1998 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 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 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 0.01 animals.
5 The fishery did not operate in 1997; the average annual mortality is based on the number of years (4; 1994$1996,1998)$ that the fishery operated.

## Other Mortality

Historical stranding records (1883-1988) of dwarf sperm whales in the southeastern USA (Credle 1988), and strandings recorded during 1988-1997 (Barros et al. 1998) indicate that this species accounts for about 17\% of all Kogia strandings in this area. During the period 1990-October 1998, three dwarf sperm whale strandings occurred in the northeastern USA (Maryland, Massachusetts, and Rhode Island), whereas 43 strandings were documented along the USA Atlantic coast between North Carolina and the Florida Keys in the same period. A pair of latex examination gloves was retrieved from the stomach of a dwarf sperm whale stranded in Miami in 1987 (Barros et al. 1990). In the period 19871994, one animal had possible propeller cuts on or near the flukes.

## STATUS OF STOCK

The status of this stock relative to OSP in the USA 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. Total fishery-related mortality and serious injury for this stock is less than $10 \%$ of PBR and therefore can be 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. Nearshore vs. offshore ecotype differentiation of Kogia breviceps and K. simus based on hemoglobin, morphometric and dietary analyses. Abstracts. World Marine Mammal Science Conference. Monaco. 20-24 January.

Barros, N. B., D. K. Odell and G. W. Patton. 1990. Ingestion of plastic debris by stranded marine mammals from Florida. Page 746 in: Shomura, R.S. and M.L. Godfrey (eds). Proceedings of the Second International Conference on Marine Debris. NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-154.
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.
Credle, V. R. 1988. Magnetite and magnetoreception in dwarf and pygmy sperm whales, Kogia simus and Kogia breviceps. MSc. Thesis. University of Miami. Coral Gables, FL.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1994. Preliminary estimates of cetacean abundance in the U.S. Atlantic Exclusive Economic Zone from 1992 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. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

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. Rep. int Whal. Commn. Special Issue 16: 27-50.
Palka, D., G. Waring, and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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.
Willis, P. M., and R. W. Baird. 1998. Status of the dwarf sperm whale, Kogia simus, with special reference to Canada. Can. Field Nat., 112:114-125.

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

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The pygmy sperm whale (Kogia breviceps) appears to be distributed worldwide in temperate to tropical waters (Caldwell and Caldwell 1989). Sightings of these animals in the Western North Atlantic occur primarily along the continental shelf edge and over the deeper waters off the continental shelf (Hansen et al. 1994; Southeast Fisheries Science Center unpublished data). 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. In a recent study using hematological and stable-isotope data, Barros et al. (1998) speculated that dwarf sperm whales may have a more pelagic distribution than pygmy sperm whales, and/or dive deeper during feeding bouts.

## POPULATION SIZE

An abundance of 115 (CV=0.61) for Kogia sp.was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of $421(\mathrm{CV}=0.55)$ for Kogia sp. was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed $5,570 \mathrm{~km}$ of track line in waters south of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for Kogia sp. is the sum of the estimates from the two 1998 USA Atlantic surveys, 536 (CV=0.45), where the estimate from the northern USA Atlantic is 115 ( $\mathrm{CV}=0.61$ ) and from the southern USA Atlantic is 421 ( $\mathrm{CV}=0.55$ ). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.


Figure 1. Distribution of Kogia sp. whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer 1990-1998. Isobaths are at 100 m and 1,000 m.

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally 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 Kogia sp. is 536 (CV=0.45). The minimum population estimate for Kogia sp. is 373.

## Current Population Trend

The available information is insufficient to evaluate trends in population size for this species in the western North Atlantic.

## 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 373. 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 Kogia sp. is 3.7.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

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

There were no documented strandings of pygmy sperm whales along the USA Atlantic coast during 1987present 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 fisheryinteraction. 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 USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reporting fisheries 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 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, Northeast multispecies sink gillnet, mid-Atlantic coastal sink gillnet, nor North Atlantic bottom trawl fisheries.

## Other Mortality

Historical stranding records (1883-1988) of pygmy sperm whales in the southeastern USA (Credle 1988), and strandings recorded during 1988-1997 (Barros et al. 1998) indicate that this species accounts for about 83\% of all Kogia strandings in this area. During the period 1990-October 1998, 21 pygmy sperm whale strandings occurred in the northeastern USA (Delaware, New Jersey, New York and Virginia), whereas 194 strandings were documented along the USA Atlantic coast between North Carolina and the Florida Keys in the same period. Remains of plastic bags and other marine debris have been retrieved from the stomachs of 13 stranded pygmy sperm whales in the southeastern USA (Barros et al. 1990, 1998), and at least on one occasion the ingestion of plastic debris is believed to have been the cause of death. During the period 1987-1994 one animal had possible propeller cuts on its flukes.

## STATUS OF STOCK

The status of this stock relative to OSP in the USA 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. Total fishery-related mortality and serious injury for this stock is less than $10 \%$ of PBR and therefore, cant be 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. Nearshore vs. offshore ecotype differentiation of Kogia breviceps and K. simus based on hemoglobin, morphometric and dietary analyses. Abstracts. World Marine Mammal Science Conference. Monaco. 20-24 January.
Barros, N. B., D. K. Odell and G. W. Patton. 1990. Ingestion of plastic debris by stranded marine mammals from Florida. Page 746 in Shomura, R.S. and M.L. Godfrey (eds). Proceedings of the Second International Conference on Marine Debris. NOAA Tech. Memo. NOAA-TM-NMFS-SWFSC-154.
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.
Credle, V. R. 1988. Magnetite and magnetoreception in dwarf and pygmy sperm whales, Kogia simus and Kogia breviceps. MSc. Thesis. University of Miami. Coral Gables, FL.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1994. Preliminary estimates of cetacean abundance in the U.S. Atlantic Exclusive Economic Zones from 1992 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. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull.

Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Rep. int Whal. Commn. Special Issue 16: 27-50
Palka, D., G. Waring, and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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.

## SPERM WHALE (Physeter macrocephalus): North Atlantic Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of the sperm whale in the USA 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 USA EEZ likely represent only a fraction of the total stock. The nature of linkages of the USA 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 USA, 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 northwestern Atlantic population is discrete from northeastern Atlantic is currently unresolved. The International Whaling Commission recognizes one stock for the North Atlantic. Based on reviews of many types of stock studies, (i.e., tagging, genetics, catch data, mark-recapture, biochemical markers, etc.) Reeves and Whitehead (1997) and Dufault et al. (1999) suggest that sperm whale populations have no clear geographic structure. There exists one tag return of a male tagged off Browns Bank (Nova Scotia) in 1966 and returned from Spain in 1973 (Mitchell 1975). Another male taken off northern Denmark in August 1981 had been wounded the previous summer by whalers off the Azores (Reeves and Whitehead 1997).

In the USA 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


Figure 1. Distribution of sperm whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$. 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 ( $<200 \mathrm{~m}$ ) observations have been made on the southwestern (Kenney, pers. comm) and eastern Scotian Shelf, particularly in the region of "the Gully" (Whitehead et al. 1991).

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. Male sperm whales are present off and sometimes on the continental shelf along the entire east coast of Canada south of Hudson Strait, whereas, females rarely migrate north of the southern limit of the Canadian EEZ
(Reeves and Whitehead 1997). However off the northeast USA, 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 numbers of sperm whales off the USA or Canadian Atlantic coast are unknown, although eight estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of $219(\mathrm{CV}=0.36)$ sperm whales 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 (CETAP 1982). An abundance 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 (Anon. 1990; Waring et al. 1992). An abundance 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 (Waring et al. 1992; Waring 1998). An abundance of $705(\mathrm{CV}=0.66)$ and $337(\mathrm{CV}=0.50)$ sperm whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of $116(\mathrm{CV}=0.40)$ sperm whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and $2,000 \mathrm{~m}$ 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 $25 \times 150$ 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.

An abundance of $623(\mathrm{CV}=0.52)$ 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 $25 \times 150$ 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.

An abundance of $2,698(\mathrm{CV}=0.67)$ 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; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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. Data collection and analysis methods used were described in Palka (1996).

An abundance of $2,848(\mathrm{CV}=0.49)$ for sperm whales was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of $1,854(\mathrm{CV}=0.53)$ for sperm whales was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed $5,570 \mathrm{~km}$ of track line in waters south of Maryland $\left(38^{\circ} \mathrm{N}\right)$ (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for sperm whales is the sum of the estimates from the two 1998 USA Atlantic surveys, $4,702(\mathrm{CV}=0.36)$, where the estimate from the northern USA Atlantic is $2,848(\mathrm{CV}=0.49)$ and from the southern USA Atlantic is $1,854(\mathrm{CV}=0.53)$. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

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. The average dive-time of sperm whales is approximately 45 min (Whitehead et al. 1991; Watkins et al. 1993), therefore, the proportion of time that they are at the surface and available to visual observers is assumed to be low.

Although the stratification schemes used in the 1990-1998 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 USA coast. The collective 1990-1998 data suggest that, seasonally, at least several thousand sperm whales are occupying these waters. The 1998 estimate is 1.7 times greater than the 1995 estimate, reflecting the contribution from the southern USA Atlantic. 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.

Table 1. Summary of abundance estimates ${ }^{1}$ for the western North Atlantic sperm whale. Month, year, and area covered during each abundance survey, and resulting abundance estimate $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| Jun-Jul 1993 | Georges Bank to <br> Scotian shelf, shelf <br> edge only | 116 | 0.40 |
| Aug 1994 | warm-core ring SE of <br> Georges Bank | 623 | 0.52 |
| Jul-Sep 1995 | Virginia to Gulf of St. <br> Lawrence | 2,698 | 0.67 |
| Jul-Sep 1998 | Maryland to Gulf of St. <br> Lawrence | 2,848 | 0.49 |
| Jul-Aug 1998 | Florida to Maryland | 1,854 | 0.53 |
| Jul-Sep 1998 | Gulf of St. Lawrence to <br> Florida (COMBINED) | 4,702 | 0.36 |

${ }^{1}$ As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore are not reported in this table.

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally 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 $4,702(\mathrm{CV}=0.36)$. The minimum population estimate for the western North Atlantic sperm whale is $3,505(\mathrm{CV}=0.36)$.

## 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 4-6 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 4.0 m , length at sexual maturity 11.0-12.5 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; Best et al. 1984; Rice 1989).

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 $3,505(\mathrm{CV}=0.36)$. 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 7.0.

## ANNUAL HUMAN-CAUSED MORTALITY

Four hundred twenty-four sperm whales were harvested in the Newfoundland-Labrador area between 1904-1972 and 109 male and no female 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 1994-1998 was zero sperm whales. Although, in 1995 one sperm whale was entangled in a pelagic drift gillnet and was 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 1998. 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 nmi northwest of Bermuda. No information on the status of the animal was provided.

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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.

Bycatch 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 sink gillnet, or North Atlantic bottom trawl observed fisheries.

## Pelagic Drift Gillnet

Only two records exist in the present NEFSC bycatch 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, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997,NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine vessels participated in this fishery between 1989 and 1993. Since 1994, between 10 and 13 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 $1995,64 \%$ in 1996 , and $99 \%$ in 1998 . 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 bycatch, 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, 0 in 1996, NA in 1997, and 0 in 1998. Estimated average annual mortality and serious injury related to this fishery during 1994-1998 was zero, assuming the 1995 injured sperm whale was not a serious injury.

## Other Mortality

Thirteen sperm whale strandings have been documented along the USA Atlantic coast between Maine and Miami, Florida, during 1994- 1998 (NMFS unpublished data). One 1998 stranding off Florida showed signs of human interactions. The animal's head was severed, but it is unknown if it occurred pre or post-mortem.

In eastern Canada, five dead strandings were reported in Newfoundland/Labrador from 1987-1995; thirteen dead strandings along Nova Scotia from 1988-1996; seven dead strandings on Prince Edward Island from 1988-1991; two dead strandings in Quebec in 1992; and five dead strandings on Sable Island, Nova Scotia from 1990-1996 (Reeves and Whitehead 1997; Hooker et al. 1997; Lucas and Hooker 1997).

Ship strikes are another source of human induced mortality. In May 1994 a ship-struck sperm whale was observed south of Nova Scotia (Reeves and Whitehead 1997).

## STATUS OF STOCK

The status of this stock relative to OSP in USA 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, and therefore can be considered to be insignificant and approaching a zero mortality and serious injury rate. 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 5 pp.
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. 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.
Best, P. B. 1974. Biology of the sperm whale. Pages 53-81. In: W. E. Schevill (ed), 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.

Best, P. B., P. A. S. Canham and N. Macleod. 1984. Patterns of reproduction in sperm whales, Physeter macrocephlus. Rep. int Whal. Commn. (Special Issue 8):51-79.
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 .
Dufault, S., H. Whitehead, and M. Dillon. 1999. An examination of the current knowledge on the stock structure of sperm whales (Physeter macrocephalus) Worldwide. J. Cetacean Res. Manage. 1(1):1-10.

Hooker, S. K., R. W. Baird, and M. A. Showell. 1997. Cetacean Strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Paper SC/49/05 presented to the IWC Scientific Committee, September 1997. 11 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.
Lucas, A. N. and S. K. Hooker. 1997. Cetacean strandings on Sable Island, Nova Scotia, 1990-1996. Paper SC/49/06 presented to the IWC Scientific Committee, September 1997. 10 pp.
Mitchell, E. 1975. Progress report on whale research, Canada. Rep. int Whal. Commn. 25:270-272.
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.
Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

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 NMFS, Northeast Fisheries Science Center, Contract No.40ENNF500160.
Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Rep. int Whal. Commn. (Special Issue 16):27-50.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.
Palka, D., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
Reeves, R. R. and H. Whitehead. 1997. Status of sperm whale, Physeter macrocephalus, in Canada. Can. Field Nat. 111:293-307.
Rice, D. W. 1989. Sperm whale. Physeter macrocephalus Linnaeus, 1758. Pp. 177-233 in: Handbook of marine animals. Vol. 4. Ed. S. H. Ridgway and R Harrison. Academic Press, London.
Scott, T. M. and S. S. Sadove. 1997. Sperm whale, Physeter macrocephalus, sightings in the shallow shelf waters off Long Island, New York. Mar. Mammal Sci. 13:317-321.
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, 21 pp. 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.
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. 2:101-105
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. Mammal Sci. 9:55-67.
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.

## 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 USA 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 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 USA coast (CETAP 1982; Waring et al. 1992; NMFS unpublished data). Most sightings were in late spring or summer. Based on sighting data, this species is a rare inhabitant of waters off the northeast USA coast (CETAP 1982).

## POPULATION SIZE

The total number of Cuvier's beaked whales off the eastern USA Canadian Atlantic coast is unknown.

However, eight estimates of the undifferentiated complex of beaked whales (Ziphius and Mesoplodon spp.) from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 120 undifferentiated beaked whales $(\mathrm{CV}=0.71)$ 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 (CETAP 1982). An abundance of 442 ( $\mathrm{CV}=0.51$ ) undifferentiated beaked whales was estimated from an August 1990 shipboard line transect sighting survey, conducted principally along the Gulf


Figure 1. Distribution of beaked whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$. Stream north wall between Cape Hatteras and Georges Bank (Anon. 1990; Waring et al. 1992). An abundance of $262(\mathrm{CV}=0.99)$ undifferentiated beaked whales was estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and $2,000 \mathrm{~m}$ isobaths from Cape Hatteras to Georges Bank (Waring et al. 1992; Waring 1998). An abundance of $370(\mathrm{CV}=0.65)$ and $612(\mathrm{CV}=0.73)$ undifferentiated beaked whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of $330(\mathrm{CV}=0.66)$ undifferentiated beaked whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and $2,000 \mathrm{~m}$ 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 $25 \times 150$ 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 $\mathrm{g}(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of $99(\mathrm{CV}=0.64)$ 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 $25 \times 150$ 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 $\mathrm{g}(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of $1,519(\mathrm{CV}=0.69)$ 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; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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. Data collection and analysis methods used were described in Palka (1996).

An abundance of $2,600(\mathrm{CV}=0.40)$ for undifferentiated beaked whales was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of $596(\mathrm{CV}=0.50)$ for undifferentiated beaked whales was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 5,570 km of track line in waters south of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for undifferentiated beaked whales is the sum of the estimates from the two 1998 USA Atlantic surveys, 3,196 (CV=0.34), where the estimate from the northern USA Atlantic is 2,600 $(\mathrm{CV}=0.40)$ and from the southern USA Atlantic is $596(\mathrm{CV}=0.50)$. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

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.

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 $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| 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 |
| Jul-Sep 1998 | Maryland to Gulf of St. Lawrence | 2,600 | 0.40 |
| Jul-Aug 1998 | Florida to Maryland | 596 | 0.50 |
| Jul-Sep 1998 | Gulf of St. Lawrence to Florida (COMBINED) | 3,196 | 0.34 |

* 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 lognormally distributed best abundance estimate. This is equivalent to the 20 th percentile of the log-normal distribution
as specified by Wade and Angliss (1997). The best estimate of abundance for undifferentiated beaked whales is 3,196 $(\mathrm{CV}=0.34)$. The minimum population estimate for the undifferentiated complex of beaked whales (Ziphius and Mesoplodon spp.) is $2,419(\mathrm{CV}=0.34)$. 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 $2,419(\mathrm{CV}=0.34)$. 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 24 . It is not possible to determine the PBR for only Cuvier's beaked whales.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 1994-1998 total average estimated annual fishery-related mortality of beaked whales in the USA EEZ was $9.5(\mathrm{CV}=0.04)$.

## Fishery Information

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

Current data on incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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 fisheries 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 USA Atlantic EEZ might have been subject to the observed fishery-related mortality and serious injury.

Bycatch 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 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, 1996, and 1998 were $233,243,232,197,164,143$, and 113 respectively. In 1996 and 1997, NMFS issued management regulations with prohibited the operation of this fishery 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10 and 13 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 $1995,64 \%$ in 1996, and $99 \%$ in 1998. 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 bycatch, 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 bycatch for 1994-1998 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 fisheries information. Variances were estimated using bootstrap re-sampling techniques. Bycatch of beaked whales has only occurred from Georges Canyon to Hydrographer Canyon along the continental shelf break and continental slope during July to October. Forty-six fishery-related beaked whale mortalities were observed between 1989 and 1998. These included: 23 Sowerby's; 4 True's; 1 Cuvier's; and 18 undifferentiated beaked whales. Recent analysis of biological samples (genetics and morphological analysis) have been used to determine species identifications for some of the bycaught animals. Estimation of bycatch mortality by species is still underway, therefore the following estimates are for undifferentiated beaked whales. 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), 13 in 1996 (0.12), NA in 1997, and 11 in 1998 (0) (Table 2). During July 1996, one beaked whale was entangled and released alive with "gear in/around a single body part". Annual mortality estimates do not include any animals injured and released alive. The 1994-1998 total average estimated annual fishery-related mortality of beaked whales in the USA EEZ was $9.5(C V=0.04)(T a b l e ~ 2)$, assuming the 1996 injured beaked whale was not a serious injury.

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 <br> Mortality | Estimated Mortality ${ }^{4}$ | Estimated $\mathrm{CVs}^{4}$ | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{aligned} & 94- \\ & 98^{6} \end{aligned}$ | $\begin{aligned} & 1994=12 \\ & 1995=11 \\ & 1996=10 \\ & 1998=13 \end{aligned}$ | Obs. Data Logbook | $\begin{gathered} .87, .99 \\ .64, \text { NA } \\ .99 \end{gathered}$ | $\begin{aligned} & 4,9,8, \\ & \mathrm{NA}, 11 \end{aligned}$ | $\begin{gathered} 4.8,9.1^{5} \\ 13, \text { NA, } 11 \end{gathered}$ | $\begin{gathered} .08,0, .12 \\ \text { NA, } 0 \end{gathered}$ | $\begin{aligned} & 9.5^{6} \\ & (.04) \end{aligned}$ |
| TOTAL |  |  |  |  |  |  |  | $\begin{gathered} 9.5 \\ (.04) \end{gathered}$ |

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.
$6 \quad$ The fishery did not operate in 1997; the average annual mortality is based on the number of years (4; 19941998) that the fishery operated.

## Other Mortality

From 1992- to 1998, a total of 49 beaked whales stranded along the USA Atlantic coast between Florida and Massachusetts (NMFS unpublished data). This includes: 28 (includes one tentative identification) Gervais' beaked whales (one 1997 animal had plastics in esophagus and stomach, and Sargassum in esophagus; two 1998 animals that stranded in September in South Carolina showed signs of fishery interactions); 2 True's beaked whales; 5 Blainville's beaked whales; 11 Cuvier's beaked whales (one 1996 animal showed signs of human interactions propeller marks ) and 4 unidentified animals.

## STATUS OF STOCK

The status of Cuvier's beaked whale relative to OSP in USA 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 950 in order for an annual mortality of 9.5 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 950 would be necessary for an annual mortality of 9.5 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 $3,196(\mathrm{CV}=0.34)$ which would result in a minimum population estimate of 2,419 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. 1990. Cruise results, NOAA Ship CHAPMAN, Cruise No. 90-05. Marine Mammal Sighting Survey. NOAA, NMFS, NEFSC, Woods Hole Laboratory, Woods Hole, MA. 5 pp.
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. 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 .
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. 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.
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. Ridgeway and R. Harrison (eds.), Handbook of Marine Mammals, Vol. 4: River Dolphins and Toothed Whales. Academic Press, San Diego, CA, 442 pp.
Mitchell, E. D. (ed). 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.
Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

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. Rep. int Whal. Commn. (Special Issue 16):27-50.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.
Palka, D., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish Bull.
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, 21 pp. 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 (Mead 1989). 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; Nawojchik 1994). Off the northeast USA coast, beaked whale (Mesoplodon spp.) sightings have occurred principally along the southern edge of Georges Bank (CETAP, 1982; Waring et al. 1992; NMFS unpublished 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 unpublished data).

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 Cape Cod Bay to Florida, into the Caribbean and the Gulf of Mexico (Leatherwood et al. 1976; Mead 1989; NMFS unpublished data). This is the commonest species of Mesoplodon stranded along the USA Atlantic coast. The northernmost stranding was on Cape Cod.


Figure 1. Distribution of beaked whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and 1,000 m.

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, Nicolas et al. 1993). 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 USA and Canadian Atlantic coast is unknown.

However, eight estimates of the undifferentiated complex of beaked whales (Ziphius and Mesoplodon spp.) from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental
shelf edge and continental slope areas (Figure 1). An abundance of $120(\mathrm{CV}=0.71)$ undifferentiated beaked whales 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 (CETAP 1982). An abundance 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 (Anon. 1990; Waring et al. 1992). An abundance of $262(\mathrm{CV}=0.99)$ 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 (Waring et al. 1992; Waring 1998). An abundance of 370 ( $\mathrm{CV}=0.65$ ) 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 (Anon. 1991). As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of $330(\mathrm{CV}=0.66)$ undifferentiated beaked whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and $2,000 \mathrm{~m}$ 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 $25 \times 150$ 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 $\mathrm{g}(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of $99(C V=0.64)$ 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 $25 \times 150$ 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 $\mathrm{g}(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of $1,519(\mathrm{CV}=0.69)$ 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; Palka et al. in review). Total track line length was 32,600 km. 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. Data collection and analysis methods used were described in Palka (1996).

An abundance of $2,600(\mathrm{CV}=0.40)$ for undifferentiated beaked whales was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of $596(\mathrm{CV}=0.50)$ for undifferentiated beaked whales was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed $5,570 \mathrm{~km}$ of track line in waters south of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for undifferentiated beaked whales is the sum of the estimates from the two 1998 USA Atlantic surveys, 3,196 (CV=0.34), where the estimate from the northern USA Atlantic is 2,600 $(\mathrm{CV}=0.40)$ and from the southern USA Atlantic is $596(\mathrm{CV}=0.50)$. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Although the 1990-1998 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 USA coast. The collective 1990-98 data suggest that, seasonally, at least several thousand beaked whales are occupying these waters, highest levels of abundance in the Georges Bank region. 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.

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 $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| 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 |
| Jul-Sep 1998 | Maryland to Gulf of St. Lawrence | 2,600 | 0.40 |
| Jul-Aug 1998 | Florida to Maryland | 596 | 0.50 |
| Jul-Sep 1998 | Gulf of St. Lawrence to Florida (COMBINED) | 3,196 | 0.34 |

* 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 lognormally 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 3,196 $(\mathrm{CV}=0.34)$. The minimum population estimate for the undifferentiated complex of beaked whales (Ziphius and Mesoplodon spp.) is $2,419(\mathrm{CV}=0.34)$. It is not possible to determine the minimum population estimate of only Mesoplodon beaked whales.

## Current Population Trend

There are insufficient data to determine the population trends for these 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 $2,419(\mathrm{CV}=0.34)$. 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 24 . It is not possible to determine the PBR for only Mesoplodon beaked whales.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 1994-1998 total average estimated annual fishery-related mortality of beaked whales in the USA EEZ was $9.5(\mathrm{CV}=0.04)$.

## Fishery Information

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

Current data on incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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 USA Atlantic EEZ might have been subject to the observed fishery-related mortality and serious injury.

Bycatch 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, Northeast multispecies sink gillnet, midAtlantic 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, 1996, and 1998 were 233, 243, 232, 197, 164, 143, and 113 respectively. In 1996 and 1997, NMFS issued management regulations with prohibited the operation of this fishery 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10 and 13 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 $1995,64 \%$ in 1996, and $99 \%$ in 1998. 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 bycatch, 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 bycatch for 1994-1998 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 fisheries information. Variances were estimated using bootstrap re-sampling techniques. Bycatch of beaked whales has only occurred from Georges Canyon to Hydrographer Canyon along the continental shelf break and continental slope during July to October. Forty-six fishery-related beaked whale mortalities were observed between 1989 and 1998. These included: 23 Sowerby's; 4 True's; 1 Cuvier's; and 18 undifferentiated beaked whales. Recent analysis of biological samples (genetics and morphological analysis) have been used to determine species identifications for some of the bycaught animals. Estimation of bycatch mortality by species is still underway, therefore the following estimates are for undifferentiated beaked whales. 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), 13 in 1996 ( 0.12 ), NA in 1997, and 11 in 1998 (0) (Table 2). During July 1996, one beaked whale was entangled and released alive with "gear in/around a single body part". Annual mortality estimates do not include any animals injured and released alive. The 1994-1998 total average estimated annual fishery-related mortality of beaked whales in the USA EEZ was $9.5(C V=0.04)(T a b l e ~ 2)$, assuming the 1996 injured beaked whale was not a serious injury.

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 <br> Mortality | Estimated Mortality ${ }^{4}$ | Estimated $\mathrm{CVs}^{4}$ | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 94-98 ${ }^{6}$ | $\begin{aligned} & 1994=12 \\ & 1995=11 \\ & 1996=10 \\ & 1998=13 \end{aligned}$ | Obs. Data Logbook | $\begin{gathered} .87, .99 \\ .64, \text { NA } \\ .99 \end{gathered}$ | $\begin{aligned} & 4,9,8, \\ & \mathrm{NA}, 11 \end{aligned}$ | $\begin{gathered} 4.8,9.1^{5} \\ 13, \text { NA, } 11 \end{gathered}$ | $\begin{gathered} .08,0, .12 \\ \text { NA, } 0 \end{gathered}$ | $\begin{aligned} & 9.5^{6} \\ & (.04) \end{aligned}$ |
| TOTAL |  |  |  |  |  |  |  | $\begin{gathered} 9.5 \\ (.04) \end{gathered}$ |

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.
$6 \quad$ The fishery did not operate in 1997; the average mortality is based on the number of years (4; 1994-1998) that the fishery operated.

## Other Mortality

From 1992-1998, a total of 49 beaked whales stranded along the USA Atlantic coast between Florida and Massachusetts (NMFS unpublished data). This includes: 28 (includes one tentative identification) Gervais' beaked whales (one 1997 animal had plastics in esophagus and stomach, and Sargassum in esophagus; two 1998 animals that stranded in September in South Carolina showed signs of fishery interactions); 2 True's beaked whales; 5 Blainville's beaked whales; 11 Cuvier's beaked whales (one 1996 animal showed signs of human interactions propeller marks ) and 4 unidentified animals.

## STATUS OF STOCK

The status of Mesoplodon beaked whales relative to OSP in USA 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 950 in order for an annual mortality of 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 950 in order for an annual mortality of 9.5 animals not to exceed the PBR of any one of these species. The largest recent abundance estimate available for beaked whales in the western North Atlantic was $3,196(\mathrm{CV}=0.34)$ which would result in a minimum population estimate of 2,419 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. 1990. Cruise results, NOAA Ship CHAPMAN, Cruise No. 90-05. Marine Mammal Sighting Survey. NOAA, NMFS, NEFSC, Woods Hole Laboratory, Woods Hole, MA. 5 pp.
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.
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. Field 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. Field 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.
Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

Nawojchik, R. 1994. First record of Mesoplodon densirostris (Cetacea: Ziphiidae) from Rhode Island. Mar. Mammal. Sci. 10: 477-480.
Nicolas, J., A. Williams and 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. 1115, 1993, Galveston, TX (Abstract).
Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Rep. int Whal. Commn. (Special Issue 16):27-50.

Palka, D., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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.
Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the Northwest Atlantic. Rep. int Whal. Commn. (Special Issue 1): 133-147.
Trove, M. 1995. Live sighting of Mesoplodon CF. M. Mirus, True's Beaked Whale. Mar. Mammal 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, 21 pp. 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 USA coast, Risso's dolphins are 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

Total numbers of Risso's dolphins off the USA or Canadian Atlantic coast are unknown, although eight estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 4,980 Risso's dolphins ( $\mathrm{CV}=0.34$ ) 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 (CETAP 1982). An abundance of $11,017(\mathrm{CV}=0.58)$ 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 (Waring et al. 1992; Waring 1998). An abundance 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 (Anon. 1991). As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance 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 $2,000 \mathrm{~m}$ 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 $25 \times 150$ binoculars and were analyzed using DISTANCE (Buckland et al. 1993; Laake et al. 1993).


Figure 1. Distribution of Risso's dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$.

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.

An abundance 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; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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. Data collection and analysis methods used were described in Palka (1996).

An abundance of $18,631(\mathrm{CV}=0.35)$ for Risso's dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of 10,479 ( $\mathrm{CV}=0.51$ ) for Risso's dolphins was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed $5,570 \mathrm{~km}$ of track line in waters south of Maryland $\left(38^{\circ} \mathrm{N}\right)$ (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for Risso's dolphins is the sum of the estimates from the two 1998 USA Atlantic surveys, 29,110 (CV=0.29), where the estimate from the northern USA Atlantic is 18,631 (CV=0.35) and from the southern USA Atlantic is $10,479(\mathrm{CV}=0.51)$. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' 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 $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| 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 |
| Jul-Sep 1998 | Maryland to Gulf of St. Lawrence | 18,631 | 0.35 |
| Jul-Aug 1998 | Florida to Maryland | 10,479 | 0.51 |
| Jul-Sep 1998 | Gulf of St. Lawrence to Florida (COMBINED) | 29,110 | 0.29 |

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally 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 29,110 (CV=0.29). The minimum population estimate for the western North Atlantic Risso's dolphin is 22,916 ( $\mathrm{CV}=0.29$ ).

## 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 $22,916(\mathrm{CV}=0.29)$. 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 0.48 because the CV of the average mortality estimate is between 0.3-0.6; Wade and Angliss 1997). PBR for the western North Atlantic Risso's dolphin is 220.

## ANNUAL HUMAN-CAUSED MORTALITY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 was 52 Risso's dolphins ( $\mathrm{CV}=0.33$; Table 2).

## Fishery Information

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA 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 bycatch of marine mammals. DWF effort in the USA 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 USA Atlantic EEZ. In 1982, there were 112 different foreign vessels; $16 \%$, or 18 , were Japanese tuna longline vessels operating along the USA 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 USA 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 197782 , 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 USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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.

Bycatch 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 Northeast 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, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10 and 13 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, $64 \%$ in 1996, and $99 \%$ in 1998. 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 bycatch, 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 bycatch 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 fisheries information. Variances were estimated using bootstrap resampling techniques. Fifty one Risso's dolphin mortalities were observed between 1989 and 1998. One animal was entangled and released alive. Bycatch 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), 0 in 1996, NA in 1997, 9 in 1998 (0). The 1994-1998 average mortality for this fishery was $4.1(\mathrm{CV}=0.01)$ (Table 2).

## 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 JuneNovember 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 $1995,52 \%$ and $55 \%$, respectively, of the sets were observed. Nineteen vessels have operated in this fishery. The fishery extends from $35^{\circ} \mathrm{N}$ to $41^{\circ} \mathrm{N}$, and from $69^{\circ} \mathrm{W}$ to $72^{\circ} \mathrm{W}$. Approximately $50 \%$ of the total effort was within a one degree square at $39^{\circ} \mathrm{N}, 72^{\circ} \mathrm{W}$, around Hudson Canyon. Examination of the locations and species composition of the bycatch, 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 ). Since this fishery is no longer exists, it has been excluded from Tables 2 and 3.

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

Total effort, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, 9,869 sets in 1992, 9,862 sets in 1993, 9,481 sets in 1994, 10,129 sets in 1995, 9,885 sets in 1996, 8,023 sets in 1997, and 6,675 sets in 1998 (Cramer 1994; Scott and Brown 1997; Johnson et al. 1999; Yeung 1999a). 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. The 1993-1997, estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 1990-1993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson et al. 1999). Further, Yeung (1999b), revised the 1992-1997 fishery mortality estimates in Johnson et al. (1999) to include seriously injured animals. The 1998 bycatch estimates were from Yeung (1999a). Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod. Excluding the Gulf of Mexico, from 1992-1998 one mortality was observed in 1994 and 1998 (Cramer 1994; Scott and Brown 1997; Johnson et al. 1999; Yeung (1999a) (Table 2). Estimated annual fishery-related mortality (CV in parentheses) was 74 in 1992 ( 0.71 ), 0 in 1993 (0), 87 in 1994 (0.38), 65 in 1995 (0.59), 52 in 1996 (1.00), 0 in 1997 (0), and 35 in 1998 (1.00). The 1994-1998 estimated mean annual Risso's dolphin mortality attributable to this fishery is $48(C V=0.35)$ (Table 2). Seriously injured and released alive animals are included in the Table 2 mortality estimates.

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 Serious Injury | Observed Mortality | Estimated ${ }^{5}$ Mortality | $\begin{gathered} \text { Estimated } \\ \text { CVs } \end{gathered}$ | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{array}{\|l\|} \hline \text { Pelagic } \\ \text { Drift } \\ \text { Gillnet } \end{array}$ | 94-98 | $\begin{gathered} 1994=12^{3} \\ 1995=11 \\ 1996=10 \\ 1998=13 \end{gathered}$ | Obs. Data Logbook | $\begin{gathered} \hline .87, .99, \\ .64, \text { NA, } .99 \end{gathered}$ | $\begin{gathered} 0,0,0,0, \\ 0 \end{gathered}$ | $\begin{gathered} 1,6,0, \mathrm{NA}, \\ 9 \end{gathered}$ | $\begin{aligned} & 1.56^{4}, 0, \\ & \text { NA, } 9 \end{aligned}$ | $\begin{aligned} & .16,0,0, \\ & \text { NA, } 0 \end{aligned}$ | $\begin{gathered} 4.1^{6} \\ (0.01) \end{gathered}$ |
| Pelagic Longline $^{7}$ | 94-98 |  | Obs. Data Logbook | $\begin{gathered} .05, .06, \\ .03, .04, .05 \end{gathered}$ | $\begin{gathered} 6,3,1,0, \\ 1 \end{gathered}$ | $\begin{gathered} 0,0,0,0, \\ 1 \end{gathered}$ | $\begin{array}{r} 87,65, \\ 52,0,35 \end{array}$ |  | $\begin{gathered} \hline 48 \\ (0.35) \end{gathered}$ |
| TOTAL |  |  |  |  |  |  |  |  | $\begin{gathered} 52 \\ (0.33) \\ \hline \end{gathered}$ |

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 Seriously injured and released alive animals are included in the Table 2 mortality estimates.
${ }^{6} \quad$ The average is based on the number of years $(4 ; 1994,1995,1996$, and 1998) that the fishery operated.
7 1992-1997 Mortality estimates were taken from Table 12 in Yeung (1999b), and exclude the Gulf of Mexico, and Northeast Distant.

## Other mortality

From 1995-1998, twelve Risso's dolphins stranding were recorded along the USA Atlantic coast (NMFS unpublished data).

## STATUS OF STOCK

The status of Risso's dolphins relative to OSP in the USA 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, can not be considered to be insignificant and approaching a zero mortality and serious injury rate. The 1994-1998 average annual fishery-related mortality does 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. Field Nat. 105:233242.

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.
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. U.S. Mar. Fish. Rev. 56(3): 24-27.
Goudey, C. A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic. Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 10 pp.
Goudey, C. A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic. Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 13 pp.
Johnson, D. R., C. A. Brown and C. Yeung. 1999. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1992-1997. NOAA Technical Memorandum NMFS-SEFSC-418, 70 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. 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.
Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

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. Biology of the Phocoenids. Rep. int Whal. Commn. (Special Issue 16):27-50.
Palka, D., G. Waring, and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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.
Scott, G. P. and C. A. Brown. 1997. Estimates of marine mammal and marine turtle catch by the U.S. 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, 21 pp. 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.

Yeung, C. 1999a. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Technical Memorandum NMFS-SEFSC-430, 26 pp.

Yeung, C. 1999b. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. NOAA Technical Memorandum NMFS-SEFSC-429, 23 pp.

## 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 USA 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 unpublished 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 USA and Canadian Atlantic coast is unknown, although ten estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). Two estimates were derived from catch data and population models that estimated the abundance of the entire stock. Seven seasonal estimates are available from selected regions in USA waters during spring, summer and autumn 1978-82, August 1990, JuneJuly 1991, August-September 1991, June-July 1993, July-September 1995, and July-August 1998. 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. One estimate is available from the Gulf of St. Lawrence.

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.

An abundance of $11,120 \quad(\mathrm{CV}=0.29)$ 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 (CETAP 1982). An abundance of 3,636 (CV=0.36) Globicephala sp. was


[^1]estimated from a June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and $2,000 \mathrm{~m}$ isobaths from Cape Hatteras to Georges Bank (Waring et al. 1992; Waring 1998). An abundance of 3,368 $(\mathrm{CV}=0.28)$ and $5,377(\mathrm{CV}=0.53)$ Globicephala sp. was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Anon. 1991). As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of $668(\mathrm{CV}=0.55)$ Globicephala sp. was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m 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 $25 \times 150$ 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 $\mathrm{g}(0)$ or dive-time. Variability was estimated using bootstrap resampling techniques.

An abundance of $8,176(\mathrm{CV}=0.65)$ 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; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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. Data collection and analysis methods used were described in Palka (1996).

Kingsley and Reeves (1998), obtained an abundance estimate of 1,600 long-finned pilot whales ( $\mathrm{CV}=0.65$ ) from a late August and early September 1995 aerial survey of cetaceans in the Gulf of St. Lawrence in 1995 and 1998 (Table 1). Based on an examination of long-finned pilot whale summer distribution patterns, and information on stock structure it was deemed appropriate to combine the these estimates with NMFS 1995 summer survey data. The best 1995 abundance estimate for Globicephala sp. is the sum of the estimates from the USA and Canadian surveys, 9,776 $(\mathrm{CV}=0.55)$, where the estimate from the USA survey is $8,176(\mathrm{CV}=0.65)$ and from the Canadian $1,600(\mathrm{CV}=0.65)$.

An abundance of $9,800(\mathrm{CV}=0.34)$ for Globicephala sp . was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of $4,724(\mathrm{CV}=0.61)$ for Globicephala sp . was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 5,570 km of track line in waters south of Maryland $\left(38^{\circ} \mathrm{N}\right)$ (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for Globicephala sp. is the sum of the estimates from the two 1998 USA Atlantic surveys, $14,524(\mathrm{CV}=0.30)$, where the estimate from the northern USA Atlantic is $9,800(\mathrm{CV}=0.34)$ and from the southern USA Atlantic is $4,724(\mathrm{CV}=0.61)$. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' 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 $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| 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 |
| Aug-Sep 1995 | Gulf of St. Lawrence | 1,600 | 0.65 |
| Jul-Sep 1995 | Virginia to Gulf of St. Lawrence | 9,776 | 0.55 |
| Jul-Sep 1998 | Maryland to Gulf of St. Lawrence | 9,800 | 0.34 |
| Jul-Aug 1998 | Florida to Maryland | 4,724 | 0.61 |
| Jul-Sep 1998 | Gulf of St. Lawrence to Florida (COMBINED) | 14,524 | 0.30 |

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally 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 14,524 ( $\mathrm{CV}=0.30$ ). The minimum population estimate for Globicephala sp . is $11,343(\mathrm{CV}=0.30)$.

## 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 $11,343(\mathrm{CV}=0.30)$. 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 the CV of the average mortality estimate is less than 0.3 (Wade and Angliss 1997), and because this stock is of unknown status. PBR for the western North Atlantic Globicephala sp. is 113.

## ANNUAL HUMAN-CAUSED MORTALITY

Total fishery-related mortality and serious injury cannot be estimated separately for the two species of pilot whales in the USA 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 annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 in the USA fisheries listed below was 137 (CV=0.22) pilot whales (Table 2). The Canadian average annual mortality estimate for 1994 to 1996 from the Nova Scotia trawl fisheries is 9 long-finned pilot whales. It is not possible to estimate variance of the Canadian estimate. The total average annual mortality estimate for 1994 to 1998 from the USA and Nova Scotia trawl fisheries is 146 (Table 2).

## Fishery Information

USA
Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA A fishery observer program, which has collected fishery data and information on incidental bycatch 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 USA 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 USA 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 USA vessels involved in joint venture fishing operations in which USA captains transfer their catches to foreign processing vessels. Due to temporal fishing restrictions, the bycatch 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 $35^{\circ} 30^{\prime} \mathrm{N}$ to $38^{\circ} 00^{\prime} \mathrm{N}$ (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 bycatch 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 USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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.

Bycatch 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 Northeast 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, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999

NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10- and 13 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 $1995,64 \%$ in 1996, 1997 (NA), and $99 \%$ in 1998. 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 bycatch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch 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 fisheries information. Variances were estimated using bootstrap resampling techniques. Between 1989 and 1998, eighty-seven 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), 11 in 1996 (.17), 1997 (NA), and 12 in $1998(0)$; average annual mortality between 1994-1998 was 13 pilot whales ( 0.04 ) (Table 2). 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 $35^{\circ} \mathrm{N}$ to $41^{\circ} \mathrm{N}$, and from $69^{\circ} \mathrm{W}$ to $72^{\circ} \mathrm{W}$. Approximately $50 \%$ of the total effort was within a one degree square at $39^{\circ} \mathrm{N}, 72^{\circ} \mathrm{W}$, around Hudson Canyon. Examination of the locations and species composition of the bycatch, 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 fisheries information in 1993. In 1994 and 1995 observers reported one and twelve mortalities, respectively. The estimated fishery-related mortality to pilot whales in the USA Atlantic attributable to this fishery in 1994 was $2.0(\mathrm{CV}=0.49)$ and $22(\mathrm{CV}=0.33)$ in 1995. Since this fishery is no longer exists, it has been excluded from Table 2.

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 USA 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. Total effort, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, 9,869 sets in 1992, 9,862 sets in 1993, 9,481 sets in 1994, 10,129 sets in 1995, 9,885 sets in 1996, 8,023 sets in 1997, and 6,675 sets in 1998 (Cramer 1994; Scott and Brown 1997; Johnson et al.1999; Yeung 1999a). Since 1992, this fishery has been monitored with about 5\% observer coverage, in terms of trips observed, within every statistical reporting area within the EEZ and beyond. Off the USA Atlantic coast, 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. The 1992-1997, estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 1992-1993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson et al. 1999). Further, Yeung
(1999b), revised the 1992-1997 fishery mortality estimates in Johnson et al. (1999) to include seriously injured animals. The 1998 bycatch estimates were from Yeung (1999a). Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod (Johnson et al. 1999). Pilot whales are frequently observed to feed on hooked fish, particularly big-eye tuna (NMFS unpublished data). Between 1990-1997 fifty- eight pilot whales (including two identified as a short-finned pilot whales) were released alive, and one mortality was observed. The condition codes that the observers assigned to the disentangled animals were: alive (41 animals); unknown (10 animals); and dead (5 animals). January-March bycatch was concentrated on the continental shelf edge northeast of Cape Hatteras. Bycatch 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 bycatch occurred along the 20 to 50 fathom contour lines between Barnegatt Bay and Cape Hatteras. The estimated fishery-related mortality to pilot whales in the USA Atlantic (excluding the Gulf of Mexico) attributable to this fishery was: 105 in $1992(\mathrm{CV}=1.00), \quad 15$ in $1993(\mathrm{CV}=1.0), 137$ in 1994 ( $\mathrm{CV}=0.44$ ), 258 (includes 58 estimated short-finned pilot whales) in 1995 (CV=0.29), and 0 in 1996-1998; average annual mortality between 1994 and 1998 was 79 pilot whales (CV=0.24) (Table 2). Seriously injured and released alive animals are included in the Table 2 mortality estimates.

## 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. This fishery was not observed in 1997 and 1998.

## 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. The estimated fishery-related mortality to pilot whales in the USA Atlantic attributable to this fishery was: 0 in 1994-1998; average annual mortality between 1994 and 1998 was 0 pilot whales (Table 2). However, these estimates should be viewed with caution due to the extremely low ( $<1 \%$ ) observer coverage.

## 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 USA 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 selfreported fisheries information from the mackerel trawl fishery between 1990-1992. One mortality was observed in the 1996 and 1998, and both occurred in the Illex squid fishery. The estimated fishery-related mortality to pilot whales in the USA Atlantic attributable to this fishery was: 45 in 1996, 0 in 1997, and 85 in 1998; average annual mortality between 1996 and 1998 was 43 pilot whales (CV=0.61) (Table 2). However, these estimates should be viewed with caution due to the extremely low ( $<1 \%$ ) observer coverage.

## Mid-Atlantic Coastal Gillnet

Observer coverage of the USA 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 1995221 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\% 4\%, 3\%, and $5 \%$ for 1995, 1996, 1997, and 1998 (Table 2).

No pilot whales were taken in observed trips during 1993-1997. One pilot whale was observed taken in 1998 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 7 in 1998 (1.1). Average annual estimated fishery-related mortality attributable to this fishery during 1995-1998 was 2 pilot whales (CV=1.1)

## 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 14,211 sets), 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.

In Canada, the fisheries observer program places observers on all foreign fishing vessels, on between 25-40\% of large Canadian vessels (greater than 100 ft ), and on approximately $5 \%$ of small vessels (Hooker et al. 1997). Fishery observer effort off the coast of Nova Scotia during 1991-1996 varied on a seasonal and annual basis, reflecting changes in fishing effort (see Figure 3, Hooker et al. 1997). During the 1991-96 period, long-finned pilot whales were bycaught (number of animals in parentheses) in bottom trawl (65); midwater trawl (6); and longline (1) gear. Recorded bycatches by year were: 16 in 1991, 21 in 1992, 13 in 1994, 9 in 1995, and 6 in 1996. Pilot whale bycatches occurred in all months except January-March and September (Hooker et al. 1997)

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 | $\begin{aligned} & \text { Data } \\ & \text { Type }^{1} \end{aligned}$ | Observed Serious Injury | Observer Coverage ${ }^{2}$ | Observed Mortality | Estimated Mortality ${ }^{5}$ | Estimated CVs | Mean <br> Annual Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pelagic ${ }^{6}$ <br> Drift <br> Gillnet | 94-98 | $\begin{aligned} & 1994=12^{3} \\ & 1995=11 \\ & 1996=10 \\ & 1998=13 \end{aligned}$ | Obs. Data Logbook | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} .87, .99 \\ .64, \text { NA, } .99 \end{gathered}$ | $\begin{aligned} & 17,9,7 \\ & \mathrm{NA}, 12 \end{aligned}$ | $\begin{gathered} 20,9.1^{4} \\ 11, \mathrm{NA}, 12 \end{gathered}$ | $\begin{gathered} .06,0, \\ .17, \text { NA, } 0 \end{gathered}$ | $\begin{gathered} 13^{6} \\ (0.04) \end{gathered}$ |
| Atlantic ${ }^{8}$ squid, mackerel, butterfish trawl | 96-98 | NA | Obs. Data Weighouts | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} .007, .008, \\ .003 \end{gathered}$ | 6, 0, 1 | 45, 0, 85 | $\begin{gathered} 1.27,0 \\ .65 \end{gathered}$ | 43 (0.61) |
| N. Atl. Otter Trawl | 94-98 | NA | Obs. Data <br> Weighouts | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} .004, \\ .011^{7}, .002, \\ .002, .001 \end{gathered}$ | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $0,0,0,0,0$ | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | 0 (0) |
| Pelagic ${ }^{9}$ <br> Longline | 94-98 |  | Obs. Data Logbook | $\begin{gathered} 12,11,0 \\ 0,0 \end{gathered}$ | $\begin{gathered} .05, .06 \\ .03, .04, .03 \end{gathered}$ | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} 137,258,0 \\ 0,0 \end{gathered}$ | $\begin{gathered} 0.44,0.29 \\ 0,0,0 \end{gathered}$ | $\begin{gathered} 79 \\ (0.24) \end{gathered}$ |
| Mid- <br> Atlantic <br> Coastal <br> Sink <br> Gillnet | 94-98 | NA | Obs. Data Weighouts | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{aligned} & .05, .04, \\ & .03, .05 \end{aligned}$ | $0,0,0,1$ | 0, 0, 0, 7 | 0, 0, 0, 1.1 | $\begin{gathered} 2 \\ (1.1) \end{gathered}$ |
| Nova Scotia trawl fisheries | 94-96 | NA | Obs. Data | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | NA, NA, NA | 13, 9, 6 | 13, 9, 6 | $\begin{gathered} \text { NA, NA, } \\ \text { NA } \end{gathered}$ | $\begin{gathered} 9 \\ (\mathrm{NA}) \end{gathered}$ |
| TOTAL |  |  |  |  |  |  |  |  | $\begin{gathered} 146 \\ (0.22) \end{gathered}$ |

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 of the mid-Atlantic coastal sink gillnet fishery is measured in tons of fish landed.
Observer coverage for the pelagic drift gillnet, pair trawl and longline fishery are in terms of sets. The trawl fisheries are measured in trips.
3 1994, 1995 and 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 0.84 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.
5 Annual mortality estimates include seriously injured and released alive animals.
${ }^{6}$ The fishery did not operate in 1997; the average annual mortality is based on the number of years (4; 1994, 1995, 1996, and 1998) that the fishery operated.
7 Observer coverage for the Atlantic bottom trawl fishery in 1995 is based on only January to May data.
8 In 1997 and 1998 the observed pilot whales were taken from the Illex squid otter trawl subfishery.
Mortality estimates were taken from Yeung (1999a,b) and exclude the Gulf of Mexico.

## 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 NMFS Northeast Region (Anon. 1993b) since 1980. From 1992-1998, 71 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).

In eastern Canada, six dead strandings were reported on Sable Island, Nova Scotia from 1990-1996; and fourteen strandings along Nova Scotia from 1991-1996 (Hooker et al. 1997; Lucas and Hooker 1997).

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 USA 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 a strategic stock because the 19941998 estimated average annual fishery-related mortality, excluding Nova Scotia bycatches to pilot whales, Globicephala sp., exceeds PBR.

## REFERENCES

Abend, A. 1993. Long-finned pilot whale distribution and diet as determined from stable carbon and nitrogen ratio isotope tracers. MS 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. Report of the study group on long-finned pilot whales. ICES C.M. 1993/N:5 29 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. 1993c. Status of fishery resources off the northeastern United States for 1993. NOAA Tech. Mem. NMFS-F/NEC-101, 140 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 14:117135.

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): 107116.

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.
Goudey, C. A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic, Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 10 pp.

Goudey, C. A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic, Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 13 pp.
Hooker, S. K., R. W. Baird and M. A. Showell. 1997. Cetacean Strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Paper SC/49/05 presented to the IWC Scientific Committee, September 1997. 11 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.
Johnson, D. R., C. A. Brown and C. Yeung. 1999. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1992-1997. NOAA Technical Memorandum NMFS-SEFSC-418. 70 pp.
Kingsley, M.C.S. and R.R. Reeves. 1998. Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. Can. J. Zool. 76: 1529-1550.
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.
Lucas, A. N. and S. K. Hooker. 1997. Cetacean strandings on Sable Island, Nova Scotia, 1990-1996. Paper SC/49/06 presented to the IWC Scientific Committee, September 1997. 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: 613629.

Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

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. Rep. int Whal. Commn. (Special Issue 16):27-50.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.
Palka, D., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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 U.S. 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, 21 pp. 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.
Yeung, C. 1999a. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Technical Memorandum NMFS-SEFSC-430, 26 pp.

Yeung, C. 1999b. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. NOAA Technical Memorandum NMFS-SEFSC-429, 23 pp.

## 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 USA Atlantic Exclusive Economic Zone (EEZ) is generally thought to be Cape Hatteras, North Carolina (Leatherwood and Reeves 1983). Sightings of these animals in USA 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.

## POPULATION SIZE

An abundance of 9,800 (CV=0.34) for Globicephala sp . was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of 4,724 (CV=0.61) for Globicephala sp. was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed $5,570 \mathrm{~km}$ of track line in waters


Figure 1. Distribution of pilot whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 $m$ and $1,000 \mathrm{~m}$. south of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for Globicephala sp. is the sum of the estimates from the two 1998 USA Atlantic surveys, $14,524(\mathrm{CV}=0.30)$, where the estimate from the northern USA Atlantic is $9,800(\mathrm{CV}=0.34)$ and from the southern USA Atlantic is $4,724(\mathrm{CV}=0.61)$. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally distributed best abundance estimate. This is equivalent to the 20 th percentile of the log-normal distribution
as specified by Wade and Angliss (1997). The best estimate of abundance for Globicephala sp. is 14,524 ( $\mathrm{CV}=0.30$ ). The minimum population estimate for Globicephala sp. is 11,343.

## 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 Globicephala sp . is $11,343(\mathrm{CV}=0.30)$. 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 the CV of the average mortality estimate is less than 0.3 (Wade and Angliss 1997), and because this stock is of unknown status. PBR for the western North Atlantic Globicephala sp. is 113 .

## ANNUAL HUMAN-CAUSED MORTALITY

Total fishery-related mortality and serious injury cannot be estimated separately for the two species of pilot whales in the USA 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 annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 in the USA fisheries listed below was 137 (CV=0.22) pilot whales (Table 2). The Canadian average annual mortality estimate for 1994 to 1996 from the Nova Scotia trawl fisheries is 9 long-finned pilot whales. It is not possible to estimate variance of the Canadian estimate. The total average annual mortality estimate for 1994 to 1998 from the USA and Nova Scotia trawl fisheries is 146 (Table 2).

## Fishery Information <br> USA

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

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA A fishery observer program, which has collected fishery data and information on incidental bycatch 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 USA 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 USA 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 USA vessels involved in
joint venture fishing operations in which USA captains transfer their catches to foreign processing vessels. Due to temporal fishing restrictions, the bycatch 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 $35^{\circ} 30^{\prime} \mathrm{N}$ to $38^{\circ} 00^{\prime} \mathrm{N}$ (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 bycatch 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 USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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.

Bycatch 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 Northeast 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, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-13 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 , $64 \%$ in 1996, 1997 (NA), and $99 \%$ in 1998. 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 bycatch, from 1989 to 1993, were obtained using the aggregated (pooled 19891993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch 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 fisheries information. Variances were estimated using bootstrap re-sampling techniques. Between 1989 and 1998, eighty-seven 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 ), 11 in 1996 (.17), 1997 (NA), and 12 in 1998 (0); average annual mortality between 1994-1998 was 13 pilot whales ( 0.04 ) (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. 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, $52 \%$ and $54 \%$, respectively, of the sets were observed. Twelve vessels have operated in this fishery. The fishery extends from $35^{\circ} \mathrm{N}$ to $41^{\circ} \mathrm{N}$, and from $69^{\circ} \mathrm{W}$ to $72^{\circ} \mathrm{W}$. Approximately $50 \%$ of the total effort was within a one degree square at $39^{\circ} \mathrm{N}, 72^{\circ} \mathrm{W}$, around Hudson Canyon. Examination of the locations and species composition of the bycatch, 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 fisheries information in 1993. In 1994 and 1995 observers reported one and twelve mortalities, respectively. Since this fishery no longer exists, it has been excluded from Tables 2 and 3.

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 USA 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. Total effort, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, 9,869 sets in 1992, 9,862 sets in 1993, 9,481 sets in 1994, 10,129 sets in 1995, 9,885 sets in 1996, 8,023 sets in 1997, and 6,675 sets in 1998 (Cramer 1994; Scott and Brown 1997; Johnson et al.1999; Yeung 1999a). Since 1992, this fishery has been monitored with about 5\% observer coverage, in terms of trips observed, within every statistical reporting area within the EEZ and beyond. Off the USA Atlantic coast, 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. The 1992-1997, estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 1992-1993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson et al. 1999). Further, Yeung (1999b), revised the 1992-1997 fishery mortality estimates in Johnson et al. (1999) to include seriously injured animals. The 1998 bycatch estimates were from Yeung (1999a). Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod (Johnson et al. 1999). Pilot whales are frequently observed to feed on hooked fish, particularly big-eye tuna (NMFS unpublished data). Between 1990-1997 fifty-eight pilot whales (including two identified as a short-finned pilot whales) were released alive, and one mortality was observed. The condition codes that the observers assigned to the disentangled animals were: alive (41 animals); unknown (10 animals); and dead (5 animals). January-March bycatch was concentrated on the continental shelf edge northeast of Cape Hatteras. Bycatch 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 bycatch occurred along the 20 to 50 fathom contour lines between Barnegatt Bay and Cape Hatteras. The estimated fishery-related mortality to pilot whales in the USA Atlantic (excluding the Gulf of Mexico) attributable to this fishery was: 105 in 1992 ( $\mathrm{CV}=1.00$ ), 15 in $1993(\mathrm{CV}=1.0), 137$ in 1994 ( $\mathrm{CV}=0.44$ ), 258 (includes 58 estimated short-finned pilot whales) in 1995 (CV=0.29), and 0 in 1996-1998; average annual mortality between 1994 and 1998 was 79 pilot whales (CV=0.24) (Table 2). Seriously injured and released alive animals are included in the Table 2 mortality estimates. Table 3 summarizes the number of animals released alive and classified as injured or noninjured. It also includes the ratio of observed to estimated mortalities for this fishery.

## 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. The estimated fishery-related mortality to pilot whales in the USA Atlantic attributable to this fishery was: 0 in 1994-1998; average annual mortality between 1994-1998 was 0 pilot whales (Table 2). However, these estimates should be viewed with caution due to the extremely low ( $<1 \%$ ) observer coverage.

## 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 USA 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 selfreported fisheries information from the mackerel trawl fishery between 1990-1992. One mortality was observed in the 1996 and 1998, and both occurred in the Illex squid fishery. The estimated fishery-related mortality to pilot whales in the USA Atlantic attributable to this fishery was: 45 in 1996, 0 in 1997, and 85 in 1998; average annual mortality between 1996-1998 was 43 pilot whales (CV=0.61) (Table 2). However, these estimates should be viewed with caution due to the extremely low ( $<1 \%$ ) observer coverage.

## Mid-Atlantic Coastal Gillnet

Observer coverage of the USA 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 1995221 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 $5 \% 4 \%, 3 \%$, and $5 \%$ for $1995,1996,1997$, and 1998 (Table 2).

No pilot whales were taken in observed trips during 1993-1997. One pilot whale was observed taken in 1998 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 7 in 1998 (1.1). Average annual estimated fishery-related mortality attributable to this fishery during 1995-1998 was 2 pilot whales (CV=1.1)

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 ${ }^{1}$ | Observed Serious Injury | Observer Coverage ${ }^{2}$ | Observed Mortality | Estimated Mortality ${ }^{5}$ | Estimate d CVs |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 94-98 | $\begin{aligned} & 1994=12^{3} \\ & 1995=11 \\ & 1996=10 \\ & 1998=13 \end{aligned}$ | Obs. Data <br> Logbook | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | .87, .99, .64, NA, . 99 | $\begin{aligned} & 17,9,7, \\ & \text { NA, } 12 \end{aligned}$ | $\begin{gathered} 20,9.1^{4} \\ 11, \mathrm{NA}, 12 \end{gathered}$ | $\begin{gathered} .06,0 \\ .17, \text { NA, } \\ 0 \end{gathered}$ | $\begin{gathered} 13^{6} \\ (0.04) \end{gathered}$ |
| Atlantic ${ }^{8}$ squid, mackerel, butterfish trawl | 96-98 | NA | Obs. Data Weighouts | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} .007, .008, \\ .003 \end{gathered}$ | 6, 0, 1 | 45, 0, 85 | $\begin{gathered} 1.27,0 \\ .65 \end{gathered}$ | 43 (0.61) |
| N. Atl. Otter Trawl | 94-98 | NA | Obs. Data Weighouts | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} .004, \\ .011^{7}, .002, \\ .002, .001 \end{gathered}$ | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} 0,0,0,0, \\ 0 \end{gathered}$ | $\begin{gathered} 0,0,0, \\ 0,0 \end{gathered}$ | 0 (0) |
| Pelagic ${ }^{9}$ Longline | 94-98 |  | Obs. Data Logbook | $\begin{gathered} 12,11,0 \\ 0,0 \end{gathered}$ | $\begin{gathered} .05, .06 \\ .03, .04 \\ .03 \end{gathered}$ | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} 137,258, \\ 0,0,0 \end{gathered}$ | $\begin{gathered} 0.44, \\ 0.32,0, \\ 0,0 \end{gathered}$ | $\begin{gathered} 79 \\ (0.24) \end{gathered}$ |
| Mid- <br> Atlantic <br> Coastal <br> Sink <br> Gillnet | 94-98 | NA | Obs. Data Weighout | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{aligned} & .05, .04, \\ & .03, .05 \end{aligned}$ | 0, 0, 0, 1 | $0,0,0,7$ | $\begin{gathered} 0,0,0, \\ 1.1 \end{gathered}$ | $\begin{gathered} 2 \\ (1.1) \end{gathered}$ |
| Nova Scotia trawl fisheries | 94-96 | NA | Obs. Data | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} \text { NA, NA, } \\ \text { NA } \end{gathered}$ | 13, 9, 6 | 13, 9, 6 | $\begin{gathered} \text { NA, NA, } \\ \text { NA } \end{gathered}$ | $\begin{gathered} 9 \\ \text { (NA) } \end{gathered}$ |
| TOTAL |  |  |  |  |  |  |  |  | $\begin{array}{r} 146 \\ (0.22) \end{array}$ |

[^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, 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.

In Canada, the fisheries observer program places observers on all foreign fishing vessels, on between 25-40\% of large Canadian vessels (greater than 100 ft ), and on approximately $5 \%$ of small vessels (Hooker et al. 1997). Fishery observer effort off the coast of Nova Scotia during 1991-1996 varied on a seasonal and annual basis, reflecting changes in fishing effort (see Figure 3, Hooker et al. 1997). During the 1991-96 period, long-finned pilot whales were bycaught (number of animals in parentheses) in bottom trawl (65); midwater trawl (6); and longline (1) gear. Recorded bycatches by year were: 16 in 1991, 21 in 1992, 13 in 1994, 9 in 1995, and 6 in 1996. Pilot whale bycatches occurred in all months except January-March and September (Hooker et al. 1997).

## Other Mortality

There were 220 short-finned pilot whale strandings documented during 1987-1998 along the USA Atlantic coast between Cape Hatteras, North Carolina, and Miami, Florida; five 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 USA 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 1994-1998 estimated average annual fishery-related mortality to pilot whales, excluding Nova Scotia bycatches 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.
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): 107116.

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.
Goudey, C.A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic, Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 10 pp.
Goudey, C.A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic, Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 13 pp.
Hooker, S. K., R. W. Baird and M. A. Showell. 1997. Cetacean Strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Paper SC/49/05 presented to the IWC Scientific Committee, September 1997. 11 pp.
Johnson, D. R., C. Yeung and C. A. Brown,. 1999. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1992-1997. NOAA Tech. Mem. NMFS-SEFSC-418. 70 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.

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.
Lens, S. 1997. Interactions between marine mammals and deep water trawlers in the NAFO regulatory area. ICES CM 1997/Q:8. 10 pp.
Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull.

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. 40ENNF500160.
Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Rep. int Whal. Commn. (Special Issue 16):27-50.

Palka, D., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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 U.S. 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., 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.
Yeung, C. 1999a. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Technical Memorandum NMFS-SEFSC-430, 26 pp.

Yeung, C. 1999b. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. NOAA Technical Memorandum NMFS-SEFSC-429, 23 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 $35^{\circ} \mathrm{N}$ ) and perhaps as far east as $43^{\circ} \mathrm{W}$ (Evans 1987). Distribution of sightings, strandings and incidental takes suggests the possible 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. 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 $39^{\circ} \mathrm{N}$ ) north through Georges Bank, and in the Gulf of Maine to the lower Bay of Fundy . Sightings data indicate seasonal shifts in distribution (Northridge et al. 1997). 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, in particular, around Hudson Canyon have been seen at all times of the year but at 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 USA 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).

## POPULATION SIZE

The total number of white-sided dolphins along the eastern USA and Canadian Atlantic coast is unknown, although four estimates from select regions are available: i) from spring, summer and autumn 197882, ii) July-September 1991-92, iii) June-July 1993 and iv) July-September 1995 (Table 1; Figure 1).

An abundance of 28,600 white-sided dolphins $(\mathrm{CV}=0.21)$ 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).


Figure 1. Distribution of white-sided dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$.

An abundance of 20,400 ( $\mathrm{CV}=0.63$ ) 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

An abundance of $729(\mathrm{CV}=0.47)$ white-sided dolphins was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and $2,000 \mathrm{~m}$ isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (Table 1; Anon. 1993).

An abundance 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; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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. Data collection and analysis methods used were described in Palka (1996).

Kingsley and Reeves (1998) estimated there were $11,740(\mathrm{CV}=0.47)$ white-sided dolphins in the Gulf of St. Lawrence during 1995 and $560(C V=0.89)$ white-sided dolphins in the northern Gulf of St. Lawrence during 1996. It is assumed these estimates apply to the Gulf of St. Lawrence stock. During the 1995 survey, 8427 km of track lines were flown in an area of $221,949 \mathrm{~km}^{2}$ during August and September. During the 1996 survey, $3,993 \mathrm{~km}$ of track lines were flown in an area of $94,665 \mathrm{~km}^{2}$ during July and August. Data were analyzed using Quenouille's jackknife bias reduction procedure on line transect methods that model the left truncated sighting curve. These estimates were uncorrected for visibility biases, such as $g(0)$.

The best available current abundance estimate for white-sided dolphins in the Gulf of Maine stock is 27,200 $(\mathrm{CV}=0.43)$ 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 $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $N_{\text {best }}$ | CV |  |  |  |
| :--- | :--- | ---: | ---: | :---: | :---: | :---: |
| Gulf of Maine stock |  |  |  |  |  |  |
| 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 |  |  |  |
| Gulf of St. Lawrence stock |  |  |  |  |  |  |
| Aug-Sep 1995 | entire Gulf of St. Lawrence | 11,740 | 0.47 |  |  |  |
| July-Aug 1996 | northern Gulf of St. Lawrence | 560 | 0.89 |  |  |  |

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally 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 Gulf of Maine stock of white-sided dolphins is $27,200(\mathrm{CV}=0.43)$. The minimum population estimate for these white-sided dolphins is $19,196(\mathrm{CV}=0.43)$.

## 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 $230-240 \mathrm{~cm}$ for males, and $201-222 \mathrm{~cm}$ 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 $19,196(\mathrm{CV}=0.43)$. 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 0.48 because this stock is of unknown status and the CV of the mortality estimate is between 0.3 and 0.6. PBR for the Gulf of Maine stock of the western North Atlantic white-sided dolphin is 184.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY Fishery Information

Recently, within USA waters, white-sided dolphins have been caught in the Northeast multispecies sink gillnet, mid-Atlantic coastal gillnet, pelagic drift gillnet, North Atlantic bottom trawl, and Atlantic squid, mackerel, butterfish trawl fisheries (Table 2). Estimated average annual fishery-related mortality and serious injury to the Gulf of Maine stock of the western North Atlantic white-sided dolphin from these USA fisheries during 1994-1998 was 223 dolphins per year (CV=0.44).

## Earlier Interactions

In the past, incidental takes of white-sided dolphins have been recorded in the Northeast 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 have 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 USA vessels involved in joint-venture fishing operations in which USA captains transfer their catches to foreign processing vessels. Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA. With implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) in that year, an observer program was established which recorded fishery data and information of incidental bycatch of marine mammals. DWF effort in the USA Atlantic Exclusive Economic Zone (EEZ) under MFCMA had 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 USA 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.

## USA <br> Northeast Multispecies Sink Gillnet

Between 1990 and 1998 there were 40 mortalities observed in the Northeast multispecies sink gillnet 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. In 1993 there were approximately 349 vessels (full and part time) in the Northeast multispecies sink gillnet fishery (Walden 1996). During 1998 it was estimated there were 301 full and part-time vessels participating in this fishery. This is the number of unique vessels in the commercial landings database (Weighout) that reported catch from this fishery during 1998 from the states of Rhode Island and north. This does not include a small percentage of records where the vessel number was missing. Observer coverage, expressed as a percentage of the number of trips, has been $1 \%, 6 \%, 7 \%, 5 \%, 7 \%, 5 \%, 4 \%, 6 \%$, and $5 \%$ for years 1990 to 1998, respectively. Most white-sided dolphins have been taken in waters south of Cape Ann during April to December. In recent years, the majority of the takes have been east and south of Cape Cod. Estimated annual fishery-related mortalities (CV in parentheses) were $49(0.46)$ in 1991, $154(0.35)$ in 1992, $205(0.31)$ in 1993, $240(0.51)$ in 1994, $80(1.16)$ in 1995, 114 ( 0.61 ) in 1996 (Bisack 1997a), 140 ( 0.61 ) in 1997, and 34 ( 0.92 ) in 1998. Average annual estimated fisheryrelated mortality during 1994-1998 was 122 white-sided dolphins per year (0.31) (Table 2).

## Mid-Atlantic Coastal Gillnet

One white-sided dolphin was observed taken in this fishery during 1997 (Table 2). None were taken in observed trips during 1993 to 1996, and none in 1998. In July 1993, an observer program was initiated in the USA mid-Atlantic coastal gillnet fishery by the NEFSC Sea Sampling program. Twenty trips were observed during 1993. During 1994 and 1995221 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 the vessels operate right off the beach. During 1998, it was estimated there were 302 full and part-time vessels participating in this fishery. This is the number of unique vessels in the commercial landings database (Weighout) that reported catch from this fishery during 1998 from the states of Connecticut to North Carolina. This does not include a small percentage of records where the vessel number was missing. Observer coverage, expressed as percent of tons of fish landed, was $5 \%, 4 \%, 3 \%$, and $5 \%$ for 1995 to 1998 , respectively (Table 2). Observed fishing effort was concentrated off NJ and scattered between DE and NC from the beach to 50 miles off the beach. Bycatch estimates were determined using methods similar to that used for bycatch estimates in the Northeast multispecies gillnet fishery (Bravington and Bisack 1996; Bisack 1997a). Using the observed takes of white-sided dolphins, the estimated annual mortality (CV in parentheses) attributed to this fishery was 0 for 1993 to 1996 and 1998 , and 45 ( 0.82 ) for 1997. 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 these figures are under-estimates. Average estimated white-sided dolphin mortality and serious injury from the mid-Atlantic coastal gillnet fishery during 1995 to 1998 was 11 (CV=0.82) (Table 2).

## Pelagic Drift Gillnet

Because there have been no observed takes of white-sided dolphins in this fishery recently, 1994 to 1998, next time this section will be moved to the "Earlier Interactions" section above. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery operated during 1998. Then, in January 1999 NMFS issued a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery (50 CFR Part 630). During 1991 to 1998, two white-sided dolphins were observed taken in the Atlantic pelagic drift gillnet fishery, both in 1993. In 1986, NMFS established a mandatory self-reported fisheries 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 1991to 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 to 1998, there were $11,12,10,0$, and 11 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 $1995,64 \%$ in 1996, no fishery in 1997 , and $99 \%$ coverage during 1998. Observer coverage dropped during 1996 because some vessels were deemed too small or unsafe by the contractor that provided observer coverage to NMFS. 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 is stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Total annual bycatch after 1993 were estimated for each year separately by summing the observed caught with the product of the average bycatch per haul and the number of unobserved hauls as recorded in logbooks. Variances were estimated using bootstrap re-sampling techniques (Bisack 1997b). Estimated
annual fishery-related mortality and serious injury (CV in parentheses) was 4.4 (.71) in 1989, 6.8 (.71) in 1990, 0.9 (.71) in 1991, $0.8(.71)$ in 1992, 2.7 ( 0.17 ) in 1993, and 0 in 1994 to 1998. There was no fishery during 1997. Estimated average annual mortality and serious injury related to this fishery during 1994-1996, and 1998 was 0.0 white-sided dolphins (Table 2).

## North Atlantic Bottom Trawl

Three mortalities were documented between 1991 and 1998 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, though at a low level. The observer coverage was $0.4 \%$ in 1994, $1.1 \%$ in 1995, $0.2 \%$ in $1996,0.2 \%$ in 1997, and $0.1 \%$ in 1998. 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 $970(C V=0.04)$ 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 taken 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 in 1992 was 110 $(C V=0.97)$, in 1994 it was $182(C V=0.71)$, and it was 0 in other years (Bisack 1997b). The average annual estimate fishery-related mortality during 1994-1998 was 36.4 white-sided dolphins (CV=0.71) (Table 2).

## Squid, Mackerel, Butterfish Trawl

One white-sided dolphin was observed taken in the mackerel sub-fishery during 1997 (Table 2). The squid, mackerel, butterfish trawl fishery, though managed under one fishery management plan by the mid-Atlantic Fisheries Management Council, is actually three independent fisheries operating in different areas during different times of the year (NMFS 1998). The Loligo squid sub-fishery is mostly in southern New England, New York and mid-Atlantic waters, where fishing patterns reflect the seasonal migration of the Loligo (offshore during October to March and inshore during April to September). The Illex squid sub-fishery is primarily on the continental slope during June to September. The mackerel sub-fishery during January to May is primarily in the southern New England and mid-Atlantic waters, while during May to December, it is primarily in the Gulf of Maine. Butterfish is primarily a bycatch of the squid and mackerel sub-fisheries. Butterfish migrate north and inshore during the summer, and south and offshore during the winter. In 1995, the squid, mackerel, butterfish trawl fishery was classified as a Category II fishery. Observer coverage was very low; as expressed as percentage of trips observed, it was $0.7 \%$ in $1996,0.8 \%$ in 1997, and $0.3 \%$ in 1998. The bycatch, stratified by sub-fishery, season and geographical area, was estimated using the ratio estimator method, as was documented in Bisack (1997b). The estimated fishery-related mortality was 0 in 1996, 161 ( $\mathrm{CV}=1.58$ ) in 1997, and 0 in 1998. The average annual estimated fishery-related mortality during 1996 to 1998 was 54 (CV=1.58) (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 reported 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 nonoperational 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). Hooker et al. (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on between $25-40 \%$ of large Canadian fishing vessels (greater than 100 feet long), and on approximately $5 \%$ of smaller Canadian fishing vessels. By-caught marine mammals were noted as weight in kilos rather than by the numbers of animals caught. Thus the number of individuals was estimated by dividing the total weight per species per trip by the maximum recorded weight of each species. During 1991 through 1996, it was estimated six whitesided dolphins were observed taken. One from a long line trip south of the Grand Banks $\left(43^{\circ} 10^{\prime} \mathrm{N} 53^{\circ} 08^{\prime} \mathrm{W}\right)$ in November 1996. The other five were taken in the bottom trawl fishery off Nova Scotia in the Atlantic Ocean: 1 in July 1991, 1 in April 1992, 1 in May 1992,1 in April 1993, 1 in June 1993 and 0 in 1994 to 1996.

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 <br> Mortality | Estimated Mortality | $\begin{aligned} & \text { Estimated } \\ & \text { CVs } \end{aligned}$ | Mean Annual Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Northeast <br> Multispecies Sink Gillnet | 94-98 | $\begin{aligned} & 1993=349 \\ & 1998=301 \end{aligned}$ | Obs. Data Weighout Trip Logbook | $\begin{gathered} .07, .05, .04 \\ .06, .05 \end{gathered}$ | $\begin{gathered} 10^{3}, \\ 2^{3}, 2^{3}, \\ 4^{3}, 1 \end{gathered}$ |  | $\begin{gathered} .51, \\ \text { 1.16,.61, } \\ .61, .92 \end{gathered}$ | $\begin{gathered} 122 \\ (0.31) \end{gathered}$ |
| Mid-Atlantic Coastal Sink Gillnet | 95-98 | 1998=302 | Obs. Data Weighout | $\begin{gathered} .05, .04, .03, \\ .05 \end{gathered}$ | $\begin{gathered} 0,0, \\ 1,0 \end{gathered}$ | $\begin{aligned} & 0,0, \\ & 45,0 \end{aligned}$ | $\begin{aligned} & 0,0, \\ & .82,0 \end{aligned}$ | $\begin{gathered} 11 \\ (0.82) \end{gathered}$ |
| Pelagic Drift Gillnet | 94-98 ${ }^{5}$ | $\begin{aligned} 1994 & =11 \\ 1995 & =12 \\ 1996 & =10 \\ 1997 & =\text { NA }^{5} \\ 1998 & =13 \end{aligned}$ | Obs. Data Logbook | $\begin{gathered} .87, .99, .64, \\ \mathrm{NA}^{5}, .99 \end{gathered}$ | $\begin{gathered} 0, \\ 0,0, \\ \mathrm{NA}^{5}, 0 \end{gathered}$ | $\begin{gathered} 0, \\ 0,0, \\ \mathrm{NA}^{5}, 0 \end{gathered}$ | $\begin{gathered} 0, \\ 0,0, \\ \mathrm{NA}^{5}, 0 \end{gathered}$ | $\begin{aligned} & 0.0^{5} \\ & (0.0) \end{aligned}$ |
| North Atlantic Bottom Trawl | 94-98 | 1993=970 | Obs. Data Weighout | $\begin{gathered} .004, \\ .011^{4}, .002, \\ .002, .001 \end{gathered}$ | $\begin{array}{r} 2, \\ 0,0, \\ 0,0 \end{array}$ | $\begin{array}{r} 182, \\ 0,0, \\ 0,0 \end{array}$ | $\begin{array}{r} .71, \\ 0,0, \\ 0,0 \end{array}$ | $\begin{gathered} 36.4 \\ (0.71) \end{gathered}$ |
| Squid, Mackerel, Butterfish Trawl | 96-98 | Unk ${ }^{7}$ | Obs. Data Weighout | $\begin{gathered} .007, .008 \\ .003 \end{gathered}$ | $\begin{gathered} 0,1^{6}, \\ 0 \end{gathered}$ | $\begin{gathered} 0,161^{6} \\ 0 \end{gathered}$ | $\begin{gathered} 0,1.58^{6} \\ 0 \end{gathered}$ | $\begin{gathered} 54 \\ (1.58) \end{gathered}$ |
| Total |  |  |  |  |  |  |  | $\begin{gathered} 223 \\ (0.44) \end{gathered}$ |

Observer data (Obs. Data), used to measure bycatch rates, are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. NEFSC collects Weighout (Weighout) landings data which is used as a measure of total effort. 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, used to measure total effort for the pelagic drift gillnet fishery, are collected at the Southeast Fisheries Science Center (SEFSC).
2 Observer coverage for the Northeast sink gillnet and both trawl fisheries are measured in trips, the pelagic drift gillnet fishery is measured in sets, and the mid-Atlantic coastal sink gillnet fishery is measured in tons of fish landed.
3 White-sided dolphins taken on observed pinger trips were added directly to the estimated total bycatch for that year when there was no closure in effect. There was one observed white-sided dolphin take on a pinger trip in 1994, and two takes on pinger trips during 1997; these three takes were not included in the observed mortality count. No takes were observed on pinger trips during 1995, 1996, and 1998.
Observer coverage for the Atlantic bottom trawl fishery in 1995 is based on only January to May data (the only time takes were observed).
Fishery closed during 1997. So average bycatch is from 1994, 1995, 1996, and 1998.
The observed take was in the mackerel sub-fishery.
Number of vessels is unknown.

## Other Mortality <br> USA

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.

During 1997, there were 17 recorded stranded white-sided dolphins, of which 16 died and one was released alive (from Rhode Island during February), according to the NE Regional Office/NMFS strandings and entanglement database. One stranding was in Virginia during March, the rest were from Maryland to Maine during January to August, where 10 were from Massachusetts. The cause of death of these strandings were not determined.

During 1998, there were 88 stranded white-sided dolphins documented in the NE Regional Office/NMFS strandings and entanglement database. One stranding, from Delaware during May, was probably a fishery interaction. The rest of the recorded strandings were from Massachusetts, where 65, 16, 2 and 4 were recorded during January, February, April, May, and November, respectively. There were 70 animals found in a mass stranding, near Wellfleet, Massachusetts, during the week of January 29 to February 3. Of these, two were released alive. Of the four found during the November group stranding, one was released alive.

## CANADA

Whales and dolphins stranded during 1991 and 1996 on the coast of Nova Scotia were documented by the Nova Scotia Stranding Network (Hooker et al. 1997). Strandings on the beaches of Sable Island were documented by researchers with Fisheries and Oceans, Canada (Lucas and Hooker 1997). Sable Island is approximately 170 km southeast of mainland Nova Scotia. The white-sided dolphins stranded at all times of the year on the mainland and on Sable Island. On the mainland of Nova Scotia, a total of 34 stranded white-sided dolphins were recorded between 1991 and 1996 (Table 3). During July 1992, 26 white-sided dolphins stranded on the Atlantic side of Cape Breton. Of these 26, 11 were released alive and the rest were found dead. Among the rest of the Nova Scotia strandings, one was found in Minas Basin, two near Yarmouth and the rest near Halifax. On Sable Island, 8 stranded white-sided dolphins were documented (Table 3).

Table 3. Documented number of stranded white-sided dolphins, by month and year, along the coast of Nova Scotia (Hooker et al. 1997), and on Sable Island (Lucas and Hooker 1996).

| Year | Month | Number of strandings |  |
| :---: | :---: | :---: | :---: |
|  |  | Nova Scotia | Sable <br> Island |
| 1991 | Aug | 1 | 0 |
|  | Oct | 1 | 0 |
| 1992 | Jul | 26 | 0 |
| 1993 | Jan | 0 | 1 |
|  | Mar | 0 | 5 |
|  | Nov | 1 | 0 |
| 1994 | Feb | 1 | 0 |
|  | Nov | 1 | 0 |
| 1995 | Apr | 1 | 0 |
|  | Aug | 1 | 1 |
| 1996 | Oct | 1 | 0 |
|  | Dec | 0 | 1 |
| TOTAL |  | 34 | 8 |

## STATUS OF STOCK

The status of white-sided dolphins, relative to OSP, in the USA 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. 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. NOAA, NMFS, NEFSC. Woods Hole, MA. 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 bycatch in the Gulf of Maine sink gillnet fishery, 1990-1993. Rep. int Whal. Comm 46: 567-74.

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, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts, 12 pp.
Hain, J. H. W. and G. T. Waring. 1994. Status 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.
Hooker, S. K., R. W. Baird and M. A. Showell. 1997. Cetacean strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Meeting document SC/49/O5 submitted to the 1997 International Whaling Commission meeting in Bournemouth, UK.
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., P. M. Payne, D. W. Heinemann 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.
Kingsley, M. C. S. and R. R. Reeves. 1998. Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. Can. J. Zool. 76:1529-1550.
Lucas, Z. N. and S. K. Hooker. 1997. Cetacean strandings on Sable Island, Nova Scotia, 1990-1996. Meeting document SC/49/O6 submitted to the 1997 International Whaling Commission meeting in Bournemouth, UK.
NMFS (National Marine Fisheries Service). 1998. Status of the fishery resources off northeastern United States for 1998. NOAA Technical Memorandum NMFS-NE-115.

Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna driftnet and pair trawl fisheries. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500160.
Northridge, S., M. Tasker, A. Webb, K. Camphuysen and M. Leopold. 1997. White-beaked Lagenorhynchus albirostris and Atlantic white-sided dolphin L. acutus distributions in northwest European and U.S. North Atlantic waters. Rep. int.Whal. Commn 47:797-805.
Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA, NMFS, NEFSC Ref. Doc. 96-04; 37 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.
Palka, D., A. Read and C. Potter. 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., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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 whitesided 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, 38 pp. 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 $200-300 \mathrm{~m}$ isobaths or over prominent underwater topography from $50^{\circ} \mathrm{N}$ to $40^{\circ} \mathrm{S}$ 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 along the continental slope ( 100 to 2,000 meters), and are associated with Gulf Stream features in waters off the northeastern USA coast (CETAP 1982; Selzer and Payne 1988; Waring et al. 1992). They are widespread from Cape Hatteras northeast to Georges Bank ( $35^{\circ}$ to $42^{\circ}$ 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 (Palka et al. in review). 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 $11^{\circ} \mathrm{C}$ (Sergeant et al. 1970; Gowans and Whitehead 1995).

## POPULATION SIZE

Total numbers of common dolphins off the USA or Canadian Atlantic coast are unknown, although five estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas (Figure 1). An abundance of 29,610 common dolphins ( $\mathrm{CV}=0.39$ ) 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 (CETAP 1982). An abundance of 22,215 ( $\mathrm{CV}=0.40$ ) common dolphins was estimated from a


Figure 1. Distribution of common dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$. June and July 1991 shipboard line transect sighting survey conducted primarily between the 200 and $2,000 \mathrm{~m}$ isobaths from Cape Hatteras to Georges Bank (Waring et al. 1992; Waring 1998). As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance 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 $2,000 \mathrm{~m}$ 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 $25 \times 150$ 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.

An abundance of $6,741(C V=0.69)$ 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; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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. Data collection and analysis methods used were described in Palka (1996).

An abundance of $30,768(\mathrm{CV}=0.32)$ for common dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

No common dolphins were encountered during the SEFSC component of the joint surveys. That shipboard line transect sighting survey was conducted between 8 July and 17 August 1998 and surveyed $5,570 \mathrm{~km}$ of track line in waters south of Maryland ( $38^{\circ} \mathrm{N}$ ) (Mullin in review).

Although the 1991, 1993, 1995, and 1998 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 USA coast. The 1993, 1995, and 1998 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.

The best available abundance estimate for common dolphins is $30,768(\mathrm{CV}=0.32)$ as estimated from the July 6 to September 6, 1998 USA Atlantic surveys. This estimate is considered best because these surveys have the most complete coverage of the species' habitat. The previous best estimate of $22,215(\mathrm{CV}=0.40)$ is nearly eight years old.

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 $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| 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 |
| Jul-Sep 1998 | Maryland to Gulf of St. Lawrence | 30,768 | 0.32 |

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally 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 30,768 ( $\mathrm{CV}=0.32$ ). The minimum population estimate for the western North Atlantic common dolphin is 23,655 ( $\mathrm{CV}=0.32$ ).

## 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 $23,655(\mathrm{CV}=0.32)$. 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 0.48 because the CV of the average mortality estimate is between 0.3-0.6; Wade and Angliss 1997), and because this stock is of unknown status. PBR for the western North Atlantic common dolphin is 227 .

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 was 612 common dolphins $\mathrm{CV}=0.40$; Table 2 ).

## Fishery Information <br> USA

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the USA 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 bycatch 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 USA 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 $89 \%$ $(\mathrm{n}=110)$ 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 bycatch 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 USA vessel involved in joint-venture fishing operations in which USA captains transfer their catches to foreign processing vessels. The bycatch occurred during winter/spring (December to May).

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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.

Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet, pelagic pair trawl, pelagic longline fishery, mid-Atlantic coastal sink gillnet, North Atlantic bottom trawl, Northeast multispecies sink gillnet, and Atlantic squid, mackerel, butterfish trawl 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, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997,

NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10- and 13 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, $64 \%$ in 1996, and $99 \%$ in 1998. 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 bycatch, from 1989 to 1993, were obtained using the aggregated (pooled 19891993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch 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 fisheries information. Variances were estimated using bootstrap re-sampling techniques. Eight hundred and sixty-one common dolphin mortalities were observed between 1989 and 1998 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), 106 in 1996 (0.07), and 255 in 1998 (0); average annual estimated fishery-related mortality during 1994-1998 attributable to this fishery was was 152 common dolphins ( $\mathrm{CV}=0.01$ ) (Table 2).

## 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 $35^{\circ} \mathrm{N}$ to $41^{\circ} \mathrm{N}$ and $69^{\circ} \mathrm{W}$ to $72^{\circ} \mathrm{W}$. Approximately $50 \%$ of the total effort was within a one degree square at $39^{\circ} \mathrm{N}, 72^{\circ} \mathrm{W}$, around Hudson Canyon from 1991 to 1993. Examination of the (1991-1993) locations and species composition of the bycatch, 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). Since this fishery is no longer in operation it has been deleted from 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.

## Pelagic Longline

The pelagic longline fishery operates in the USA 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, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, 9,869 sets in 1992, 9,862 sets in 1993, 9,481 sets in 1994, 10, 129 sets in 1995, 9,885 sets in 1996, 8,023 sets in 1997, and 6,675 sets in 1998 (Cramer 1994; Scott and Brown 1997; Johnson et al.1999; Yeung 1999a). Since 1992, this fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, within every statistical reporting area within the EEZ and beyond. Off the USA Atlantic coast, 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. The 1994-1998, estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 1992-1993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson et al. 1999). Further, Yeung (1999b), revised the 1992-1997
fishery mortality estimates in Johnson et al. (1999) to include seriously injured animals. The 1998 bycatch estimates were from Yeung (1999a). Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod (Johnson et al. 1999). Between 1990-1998 one common dolphin was hooked and released alive.

## Northeast Multispecies Sink Gillnet

In 1993, there were approximately 349 full and part-time vessels in the Northeast 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 $1 \%, 6 \%, 7 \%, 5 \%, 7 \%, 5 \%, 4 \%, 6 \%$, and $5 \%$ for 1990 to 1998 , 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 ( $\mathrm{CV}=1.39$ ) ; estimated annual mortality (1994-1998) was 12.6 common dolphins ( $\mathrm{CV}=1.39$ ) (Table 2). Annual estimates of common dolphin bycatch in the Northeast multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort.

## Mid-Atlantic Coastal Gillnet

Observer coverage of the USA 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 1995221 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\% 4\%, 3\%, and $5 \%$ for $1995,1996,1997$, and 1998 (Table 2).

No common dolphins were taken in observed trips during 1993 and 1994. Two common dolphin were observed taken in 1995, 1996, and 1997, and no takes were observed in 1998 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All bycatches 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), 43 in 1996 ( 0.79 ), 16 in 1997 ( 0.53 ), and 0 in 1998. Average annual estimated fishery-related mortality attributable to this fishery during 1995-1998 was 16.5 common dolphins ( $\mathrm{CV}=0.53$ )

## 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. Four mortalities were observed between 1991-1998. Observer coverage, expressed as number of trips, was < $1 \%$ from 1994-1998 (Table 2). 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), 142 in 1995 (0.77), 0 in 1996 (0), 93 in 1997 (1.06), and 0 in 1998. Average annual estimated fishery-related mortality attributable to this fishery during 19941998 was 47 common dolphins (CV=0.63) (Table 2). However, these estimates should be viewed with caution due to the extremely low ( $<1 \%$ ) observer coverage.

## 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 USA 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. Observer coverage, expressed as number of trips, was < $1 \%$ from 1996-1998 (Table 2). Three common dolphin mortalities were observed in 1996, one in 1997, and zero in 1998 (Table 2). The 1996 mortalities were in the Loligo squid fishery and the 1997 mortality occurred in the Atlantic mackerel fishery. The estimated annual fishery-related mortality and serious injury attributable to this fishery (CV in parentheses) was 940 in 1996 ( 0.75 ), 161 in 1997 ( 0.49 ), and 0 in 1998. Average annual estimated fishery-related mortality attributable to this fishery during 1996-1998 was 367 common dolphins ( $\mathrm{CV}=0.64$ ) (Table 2). However, these estimates should be viewed with caution due to the extremely low ( $<1 \%$ ) observer coverage and uncertainties regarding number of vessels participating in this "fishery".

## Mackerel Joint Venture

A USA joint venture fishery was conducted in the mid-Atlantic region from February-May 1998. NMFS, maintained $100 \%$ observer coverage on the foreign joint venture vessels. One hundred and fifty-two transfers from the USA vessels were observed. Seventeen common dolphin mortalities were observed in March. The principal fish species in the transferred trawl nets and number of bycaught animals (in parentheses) were: squid (11), butterfish (4), and mackerel (2). Average annual estimated fishery-related mortality attributable to this fishery in 1998 was 17 common dolphins ( $\mathrm{CV}=0$ ) (Table 2).

## CANADA

Between January 1993 and December 1994, 36 Spanish deep water trawlers, covering 74 fishing trips (4,726 fishing days and 14,211 sets), 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 ${ }^{1}$ | Observed Serious Injury | Observer Coverage ${ }^{2}$ | Observed <br> Mortality | Estimated Mortality ${ }^{5}$ | $\begin{aligned} & \text { Estimated } \\ & \text { CVs } \end{aligned}$ | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pelagic Drift Gillnet ${ }^{6}$ | 94-98 | $\begin{aligned} & 1994=11 \\ & 1995=12 \\ & 1996=10 \\ & 1998=13 \end{aligned}$ | Obs. Data Logbook | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} .87, .99 \\ .64, \text { NA, } .99 \end{gathered}$ | $\begin{gathered} 142,82, \\ 74, \text { NA } \\ 255 \end{gathered}$ | $\begin{gathered} 238,163, \\ 83^{3}, 106, \mathrm{NA}, \\ 255 \end{gathered}$ | $\begin{aligned} & .08, .02,0, \\ & .07, \text { NA, } 0 \end{aligned}$ | $\begin{aligned} & 151.8^{6} \\ & (0.01) \end{aligned}$ |
| Northeast Multispecies Sink Gillnet | 94-98 | 349 | Obs. Data Weighout, Logbooks | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} .07, .05 \\ .04, .06, .05 \end{gathered}$ | $\begin{gathered} 0,0,1,0 \\ 0 \end{gathered}$ | $\begin{gathered} 0,0,63,0 \\ 0 \end{gathered}$ | $\begin{gathered} 0,0,1.39 \\ 0,0 \end{gathered}$ | $\begin{gathered} 12.6 \\ (1.39) \end{gathered}$ |
| Mid-Atlantic Coastal Sink Gillnet | 94-98 | NA | Obs. Data Weighout | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{aligned} & .05, .04, \\ & .03, .05 \end{aligned}$ | 2, 2, 2, 0 | $\begin{gathered} 7.4,43,16 \\ 0 \end{gathered}$ | $\begin{gathered} .69, .79, \\ .53,0 \end{gathered}$ | $\begin{gathered} 16.5 \\ (0.53) \end{gathered}$ |
| Atlantic squid, mackerel, butterfish trawl | 96-98 | NA | Obs. Data Weighout | 0, 0,0 , | $\begin{gathered} .007, .008, \\ .003 \end{gathered}$ | $3^{7}, 1^{7}, 0$ | 940, 161, 0 | .75, .49, 0 | $\begin{gathered} 367 \\ (0.64) \end{gathered}$ |
| North <br> Atlantic <br> Bottom <br> Trawl | 94-98 | 970 | Obs. Data Weighout | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} .004, .011^{4}, \\ .002, .002, \\ .001 \end{gathered}$ | $\begin{gathered} 0,3,0,1, \\ 0 \end{gathered}$ | $\begin{gathered} 0,142,0, \\ 93,0 \end{gathered}$ | $\begin{gathered} 0, .77,0 \\ 1.06,0 \end{gathered}$ | $\begin{gathered} 47 \\ (0.63) \end{gathered}$ |
| Mackerel joint venture | 98 | 4 | Obs. Data | 0 | 1.00 | 17 | 17 | 0 | $\begin{gathered} 17 \\ (0) \end{gathered}$ |
| TOTAL |  |  |  |  |  |  |  |  | $\begin{gathered} 612 \\ (0.40) \end{gathered}$ |

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 trips. Assessments for the coastal gillnet fishery have not been completed. The number of trips sampled by the NEFSC Sea Sampling Program are reported here.
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.
Observer coverage for the North Atlantic bottom trawl fishery in 1995 is based on January to May data.
Seriously injured and released alive animals areincluded in the Table 2 mortality estimates.
The fishery did not operate in 1997; the average annual mortality is based on the number of years (4; ) that the fishery operated.
In 1996 and 1997 the observed common dolphins were taken in the Loligo squid and Atlantic mackerel otter trawl subfisheries, respectively.

## Other Mortality

From 1992-1998, 94 common dolphins were stranded between North Carolina and Massachusetts, predominantly along beaches in the latter state (NMFS unpublished data). The total includes ten and nine common dolphins that, respectively mass stranded in November 1997 and January 1998 on Cape Cod.

Three common dolphin strandings were reported on Sable Island, Nova Scotia from 1990-1996 (Lucas and Hooker 1997).

## STATUS OF STOCK

The status of common dolphins, relative to OSP, in the USA 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 the 1994-1998 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.
Cramer, J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352. 19 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. Field 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.
Goudey, C. A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic, Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 10 pp.
Goudey, C. A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic, Massachusetts Institute of Technology, Sea Grant, 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.
Johnson, D. R., C. A. Brown and C. Yeung. 1999. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1992-1997. NOAA Technical Memorandum NMFS- SEFSC-418. 70 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.
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.
Lucas, A. N. and S. K. Hooker. 1997. Cetacean strandings on Sable Island, Nova Scotia, 1990-1996. Paper SC/49/06 presented to the IWC Scientific Committee, September 1997. 10 pp.

Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

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. Rep. int Whal. Commn. Special Issue 16:2750.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.
Palka, D., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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.
Scott, G.P. and C.A. Brown. 1997. Estimates of marine mammal and turtle catch by the U.S. Atlantic pelagic longline fleet in 1994-1995. Miami Laboratory Contribution MIA-96/97-28.
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. Mammal. 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, 21 pp. 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.
Yeung, C. 1999a. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Technical Memorandum NMFS-SEFSC-430, 26 pp.

Yeung, C. 1999b. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. NOAA Technical Memorandum NMFS-SEFSC-429, 23 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. 1994). The large, heavily spotted form of the Atlantic spotted dolphin along the southeastern and Gulf coasts of the United States, which may warrant designation as a distinct sub-species (Rice 1998), ( inhabits the continental shelf, usually being found inside or near the 200 m isobath (within $250-350 \mathrm{~km}$ of the coast) but sometimes coming into very shallow water adjacent to the beach (Figure 1). Off the northeast USA coast, spotted dolphins are widely distributed on the continental shelf, along the continental shelf edge, and offshore over the deep ocean south of $40^{\circ} \mathrm{N}$ (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; Mullin in review). Sightings have also been made along the north wall of the Gulf Stream and warmcore ring features (Waring et al. 1992). Stock structure in the western North Atlantic is unknown.

## POPULATION SIZE

Total numbers of Atlantic spotted dolphins off the USA or Canadian Atlantic coast are unknown, although three estimates from selected regions of the habitat do exist for select time periods. Because $S$. frontalis and S. attenuata are difficult to differentiate at sea, the reported abundance estimates, prior to 1998, are for both species of spotted dolphins combined. Sightings were almost exclusively in the continental shelf edge and continental slope areas west of Georges Bank (Figure 1). An abundance of 6,107 undifferentiated spotted dolphins $(\mathrm{CV}=0.27)$ 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 (CETAP 1982). As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 4,772 $\quad(\mathrm{CV}=1.27)$ undifferentiated 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; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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


Figure 1. Distribution of spotted dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$.

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. Data collection and analysis methods used were described in Palka (1996).

An abundance of $32,043(\mathrm{CV}=1.39)$ for offshore Atlantic spotted dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of 4,396 (CV=0.62) for offshore, and 15,840 (CV=0.60) for coastal Atlantic spotted dolphins was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed $5,570 \mathrm{~km}$ of track line in waters south of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for the Atlantic spotted dolphins is the sum of the estimates from the two 1998 USA Atlantic surveys, $52,279(\mathrm{CV}=0.87)$, where the estimate from the northern USA Atlantic is $32,043(\mathrm{CV}=1.39)$ and estimates from the southern USA Atlantic are 4,396 (CV=0.62) and 15,840 (CV=0.60). At their November 1999 meeting, the Atlantic SRG recommended that, without a genetic determination of stock structure, the abundance estimates for the coastal and offshore forms should be combined. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Table 1. Summary of abundance estimates for both undifferentiated spotted dolphins (1995), and differentiated Atlantic spotted dolphins (1998). Month, year, and area covered during each abundance survey, and resulting abundance estimate $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathbf{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| Jul-Sep 1995 | Virginia to Gulf of St. Lawrence | $4,772^{1}$ | 1.27 |
| Jul-Sep 1998 | Maryland to Gulf of St. Lawrence | $32,043^{2}$ | 1.39 |
| Jul-Aug 1998 | Florida to Maryland | $4,396^{2}$ | 0.62 |
| Jul-Sep 1998 | Gulf of St. Lawrence to Florida (COMBINED) | $36,439^{3}$ | 1.22 |
| Jul-Aug 1998 | Florida to Maryland | $15,840^{4}$ | 0.60 |

${ }^{1}$ Because of uncertain species identification in the 1995 survey, all spotted dolphins were lumped together.
${ }^{2}$ This represents the first estimate for the offshore Atlantic spotted dolphin.
${ }^{3}$ This is the combined estimate for the two survey regions
${ }^{4}$ This represents the first estimate for the coastal Atlantic spotted dolphin

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally distributed best abundance estimate. This is equivalent to the 20 th percentile of the log-normal distribution as specified by Wade and Angliss (1997). Until more definitive stock identification (i.e., genetic analysis) work is completed, the Atlantic Scientific Review Group recommends that the best estimate of abundance for Atlantic spotted dolphins is the combined estimates for the offshore $15,840(\mathrm{CV}=0.60)$ and coastal $36,439(\mathrm{CV}=1.22)$ forms of Atlantic spotted dolphins. This estimate is $52,279(\mathrm{CV}=0.87)$. The minimum population estimates based on the combined offshore and coastal abundance estimates is $27,785(\mathrm{CV}=0.87)$.

## Current Population Trend

There are insufficient data to determine the population trends for this species, given that surveys prior to 1998 did not differentiate between species of spotted dolphins.

## 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 combined offshore and coastal 'forms' of Atlantic spotted dolphins is 52,279 ( $\mathrm{CV}=0.87$ ). 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 combined offshore and coastal forms of Atlantic spotted dolphins is 278 .

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 was 7.8 undifferentiated spotted dolphins (Stenella spp.) CV=0.01; Table 2).

## Fishery Information

No spotted dolphin mortalities were observed in 1977-1991 foreign fishing activities. Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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 USA 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.

Bycatch 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, Northeast 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, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10- and 13 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 $1995,64 \%$ in 1996, and $99 \%$ in 1998. 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 bycatch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch 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 fisheries information. Variances were estimated using bootstrap re-sampling techniques. Forty-nine undifferentiated spotted dolphins mortalities were observed in the drift gillnet fishery between 1989 and 1998 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, 2 in 1996 (0.06), NA in 1997, and 0 in 1998; average annual mortality and serious injury during 1994-1998 was 7.8 (0.01) (Table 2). Pelagic Longline

The pelagic longline fishery operates in the USA Atlantic ( including Caribbean) and Gulf of Mexico EEZ (SEFSC unpublished data). 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, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, 9,869 sets in 1992, 9,862 sets in 1993, 9,481 sets in 1994, 10,129 sets in 1995, 9,885 sets in 1996, 8,023 sets in 1997, and 6,675 sets in 1998 (Cramer 1994; Scott and Brown 1997; Johnson et al.1999; Yeung 1999b). Since 1992, this fishery has been monitored with about 5\% observer coverage, in terms of trips observed, within every statistical reporting area within the EEZ and beyond. Off the USA Atlantic coast, 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. The 1994-1998, estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 19921993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson et al. 1999; Yeung 1999a). Further, Yeung (1999b), revised the 1992-1997 fishery mortality estimates in Johnson et al. (1999) to include seriously injured animals. The 1998 bycatch estimates were from Yeung (1999a). Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod (Johnson et al. 1999). Excluding the Gulf of Mexico where one animal was hooked and released alive (Appendix 1), no Atlantic spotted dolphin bycatches were observed for 1992-1998.

Table 2. Summary of the incidental mortality of undifferentiated 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 ${ }^{1}$ | Observed <br> Serious <br> Injury | Observer <br> Coverage ${ }^{2}$ | Observed <br> Mortality | Estimated <br> Mortality | Estimated <br> CVs | Mean <br> Annual <br> Mortality |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pelagic <br> Drift <br> Gillnet ${ }^{6}$ | $94-98$ | $1994=11^{3}$ <br> $1995=12$ <br> $1996=10$ <br> $1998=13$ | Obs. Data <br> Logbook | $0,0,0,0$, <br> 0 | $.87, .99$, <br> .64, NA, <br> .99 | $29,0,2$, <br> NA, 0 | $29,0,2^{4}$, <br> NA, 0 | $.01,0,0$, <br> NA, 0 | 7.75 <br> $(0.01)$ |
| TOTAL |  |  |  |  |  |  |  |  |  |

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.
31 1994, 1995, 1996, and 1998 shown, other years not available on an annual basis.
4 Estimates were based on two seasons. The two observed takes were during the winter season when observer coverage was 100\%.
5 Annual mortality estimates include animals seriously injured and released alive.
$6 \quad$ The fishery did not operate in 1997 ; the average annual mortality is based on the number of years $(4$; 1994-1998) that the fishery operated.

## Other Mortality

From 1995-1998, thirteen 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 USA 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 less than $10 \%$ of the calculated PBR and, 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

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. 1994. Large pelagic logbook newsletter-1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.
Johnson, D. R., C. A. Brown, and C. Yeung. 1999. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1992-1997. SEFSC PRD-98/99-03. 68 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.

Leatherwood, S., D. K. Caldwell and H. E. Winn. 1976. Whales, dolphins, and porpoises of the western North Atlantic. A guide to their identification. NOAA Tech. Rep. NMFS Circ. 396, U.S. Dept. Commer. Washington, DC 176 pp.
Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

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. Rep. int Whal. Commn. Special Issue 16:2750.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.
Palka, D., G. Waring, and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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. Mammal 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.
Rice, D. W. 1998. Marine mammals of the world, systematics and distribution. Spec. Publ. No 4. Society for Marine Mammalogy, Lawrence, KS. 231 pp.
Scott, G. P. and C. A. Brown. 1997. Estimates of marine mammal and marine turtle catch by the U.S. 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.
Yeung, C. 1999a. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Technical Memorandum NMFS-SEFSC-430, 26 pp.

Yeung, C. 1999b. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. NOAA Technical Memorandum NMFS-SEFSC-429, 23 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 USA 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

Total numbers of pantropical spotted dolphins off the USA or Canadian Atlantic coast are unknown, although three estimates from selected regions of the habitat do exist for select time periods. Because S. frontalis and S. attenuata are difficult to differentiate at sea, the reported abundance estimates, prior to 1998, are for both species of spotted dolphins combined. Sightings were almost exclusively in the continental shelf edge and continental slope areas west of Georges Bank (Figure 1). An abundance of 6,107 undifferentiated spotted dolphins ( $\mathrm{CV}=0.27$ ) 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 (CETAP 1982). As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

An abundance of 4,772 $\quad(\mathrm{CV}=1.27)$ undifferentiated 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; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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,


Figure 1. Distribution of spotted dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$.
and shelf waters off Nova Scotia from the coastline to the 1000 fathom depth contour line. Data collection and analysis methods used were described in Palka (1996).

An abundance of 343 (CV=1.03) for pantropical spotted dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ}$ N) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of $12,774(\mathrm{CV}=0.57)$ for pantropical spotted dolphins was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed $5,570 \mathrm{~km}$ of track line in waters south of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for pantropical spotted dolphins is the sum of the estimates from the two 1998 USA Atlantic surveys, $13,117(\mathrm{CV}=0.36)$, where the estimate from the northern USA Atlantic is $343(\mathrm{CV}=1.03)$ and from the southern USA Atlantic is $12,774(\mathrm{CV}=0.57)$. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

Table 1. Summary of abundance estimates for both undifferentiated spotted dolphins (1995), and differentiated pantropical spotted dolphins (1998). Month, year, and area covered during each abundance survey, and resulting abundance estimate $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| Jul-Sep 1995 | Virginia to Gulf of St. Lawrence | $4,772^{1}$ | 1.27 |
| Jul-Sep 1998 | Maryland to Gulf of St. Lawrence | $343^{2}$ | 1.03 |
| Jul-Aug 1998 | Florida to Maryland | $12,774^{2}$ | 0.57 |
| Jul-Aug 1998 | Gulf of St. Lawrence to Florida (COMBINED) | $13,117^{3}$ | 0.56 |

${ }^{1}$ Because of uncertain species identification in the 1995 survey, all spotted dolphins were lumped together.
${ }^{2}$ This represents the first estimates for pantropical spotted dolphin.
${ }^{3}$ This represents the combined estimates for both regions.

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally 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 pantropical spotted dolphins is 13,117 $(\mathrm{CV}=0.56)$. The minimum population estimate for pantropical spotted dolphins is $8,450(\mathrm{CV}=0.56)$.

## Current Population Trend

There are insufficient data to determine the population trends for this species, because prior to 1998 spotted dolphins (Stenella spp) were not differentiated during surveys.

## 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 pantropical spotted dolphins is $8,450(\mathrm{CV}=0.56)$. 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 pantropical dolphins is 84 .

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 was 7.8 undifferentiated spotted dolphins (Stenella sp.) CV=0.01; Table 2).

## Fisheries Information

No spotted dolphin mortalities were observed in 1977-1991 foreign fishing activities. Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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 USA 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.

Bycatch 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, Northeast 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, 1996, and 1998 were 233, 243, 232, 197, 164, 149, 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10 and 13 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 $1995,64 \%$ in 1996, and $99 \%$ 1998. 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 bycatch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch 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 fisheries information. Variances were estimated using bootstrap re-sampling techniques. Forty-nine spotted dolphin mortalities were observed in the drift gillnet fishery between 1989 and 1998 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, 2 in 1996 (0.06), NA in 1997, and 0 in 1998; average annual mortality and serious injury during 1994-1998 was 7.8 (0.01) (Table 2).

## Pelagic Longline

The pelagic longline fishery operates in the USA Atlantic (including Caribbean) and Gulf of Mexico EEZ (SEFSC unpublished data). 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,
excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, 9,869 sets in 1992, 9,862 sets in 1993, 9,481 sets in 1994, 10,129 sets in 1995, 9,885 sets in 1996, 8, 023 sets in 1997, and 6,675 sets in 1998 (Cramer 1994; Scott and Brown 1997; Johnson et al.1999; Yeung, 1999a). Since 1992, this fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, within every statistical reporting area within the EEZ and beyond. Off the USA Atlantic coast, 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. The 1994-1998, estimated take was based on a revised analysis of the observed incidental take and self-reported incidental take and effort data, and replace previous estimates for the 19921993 and 1994-1995 periods (Cramer 1994; Scott and Brown 1997; Johnson et al. 1999; Yeung 1999b). Further, Yeung (1999b), revised the 1992-1997 fishery mortality estimates in Johnson et al. (1999) to include seriously injured animals. The 1998 bycatch estimates were from Yeung (1999a). Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod (Johnson et al. 1999). Excluding the Gulf of Mexico where one animal was hooked and released alive (Appendix 1), no pantropical spotted dolphin bycatches were observed for 1992-1998.

Table 2. Summary of the incidental mortality of undifferentiated 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 | $\begin{gathered} \text { Data } \\ \text { Type }^{1} \end{gathered}$ | Observed <br> Serious Injury | Observer Coverage ${ }^{2}$ | Observed <br> Mortality | Estimated Mortality ${ }^{5}$ | $\begin{aligned} & \text { Estimated } \\ & \text { CVs } \end{aligned}$ | Mean <br> Annual Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pelagic ${ }^{6}$ Drift Gillnet | 94-98 | $\begin{aligned} & 1994=11^{3} \\ & 1995=12 \\ & 1996=10 \\ & 1998=13 \end{aligned}$ |  | $\begin{gathered} 0,0,0,0 \\ 0 \end{gathered}$ | .87, .99, .64, NA, . 99 | $\begin{gathered} 29,0,2, \\ \text { NA, } 0 \end{gathered}$ | $\begin{gathered} 29,0,2^{4} \\ \text { NA, } 0 \end{gathered}$ | $\begin{aligned} & .01,0,0, \\ & \text { NA, } 0 \end{aligned}$ | $\begin{gathered} 7.8 \\ (0.01) \end{gathered}$ |
| TOTAL |  |  |  |  |  |  |  |  | $\begin{gathered} 7.8 \\ (0.01) \end{gathered}$ |

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, 1995, 1996 and 1998 shown, other years not available on an annual basis.
4 Estimates were based on two seasons. The two observed takes were during the winter season when observer coverage was $100 \%$.
5 Annual mortality estimates include animals seriously injured and released alive.
${ }^{6} \quad$ The fishery did not operate in 1997; the average annual mortality is based on the number of years (4; 1994-1998 that the fishery operated.

## Other Mortality

From 1995-1998, 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 (NMFS unpublished data).

## STATUS OF STOCK

The status of pantropical spotted dolphins, relative to OSP in the USA 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 less than $10 \%$ of the calculated PBR and, 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

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.
Johnson, D. R., C. A. Brown, and C. Yeung. 1999. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1992-1997. SEFSC PRD-98/99-03. 68 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.
Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

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. 40ENNF500160.
Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Rep. int Whal. Commn. Special Issue 16:2750.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.
Palka, D., G. Waring, and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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. Mammal 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.
Scott, G. P. and C. A. Brown. 1997. Estimates of marine mammal and marine turtle catch by the U.S. 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 .
Yeung, C. 1999a. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Technical Memorandum NMFS-SEFSC-430, 26 pp.

Yeung, C. 1999b. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. NOAA Technical Memorandum NMFS-SEFSC-429, 23 pp.

## STRIPED DOLPHIN (Stenella coeruleoalba): Western North Atlantic Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The striped dolphin, Stenella coeruleoalba, is distributed worldwide in warm-temperate to tropical seas (Archer and Perrin 1997). 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 very little information concerning striped dolphin stock structure in the western North Atlantic (Archer and Perrin 1997).

In waters off the northeastern USA 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 $1,000 \mathrm{~m}$ 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 $20^{\circ}$ and $27^{\circ} \mathrm{C}$ and deeper than 900 m .

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

Total numbers of striped dolphins off the USA or Canadian Atlantic coast are unknown, although four estimates from selected regions of the habitat do exist for select time periods. Sightings were almost exclusively in the continental shelf edge and continental slope areas west of Georges Bank (Figure 1). An abundance of 36,780 striped dolphins ( $\mathrm{CV}=0.27$ ) 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 (CETAP 1982). An abundance of 25,939 ( $\mathrm{CV}=0.36$ ) 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 (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. As recommended in the GAMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, therefore should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates

An abundance of $31,669(\mathrm{CV}=0.73)$ striped dolphins was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane


Figure 1. Distribution of striped dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$.
that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Table 1; Palka et al. in review). Total track line length was $32,600 \mathrm{~km}$. 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 midAtlantic 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. Data collection and analysis methods used were described in Palka (1996).

An abundance of $39,720(\mathrm{CV}=0.45)$ for striped dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed $15,900 \mathrm{~km}$ of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of $21,826(\mathrm{CV}=0.78)$ for striped dolphins was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed $5,570 \mathrm{~km}$ of track line in waters south of Maryland $\left(38^{\circ} \mathrm{N}\right)$ (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for striped dolphins is the sum of the estimates from the two 1998 USA Atlantic surveys, $61,546(\mathrm{CV}=0.40)$, where the estimate from the northern USA Atlantic is $39,720(\mathrm{CV}=0.45)$ and from the southern USA Atlantic is $21,826(\mathrm{CV}=0.78)$. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' 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 $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| Jul-Sep 1995 | Virginia to Gulf of St. Lawrence | 31,669 | 0.73 |
| Jul-Sep 1998 | Maryland to Gulf of St. Lawrence | 39,720 | 0.45 |
| Jul-Aug 1998 | Florida to Maryland | 21,826 | 0.78 |
| Jul-Sep 1998 | Florida to Gulf of St. Lawrence <br> (combined) | 61,546 | 0.40 |

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormally 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 61,546 (CV=0.40). The minimum population estimate for the western North Atlantic striped dolphin is $44,500(\mathrm{CV}=0.40)$.

## 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 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 $44,500(\mathrm{CV}=0.40)$. 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 0.5 because this stock is of unknown status. PBR for the western North Atlantic striped dolphin is 445.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality to this stock during 1994-1998 was 7.3 striped dolphins; $\mathrm{CV}=0.08$ ) Table 2).

## Fishery Information <br> USA

No mortalities were observed in 1977-1991 foreign fishing activities off the northeast USA 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 USA 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.

Bycatch 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, Northeast multispecies sink gillnet, and mid-Atlantic coastal sink gillnet 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, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine vessels participated in this fishery between 1989 and 1993. Since 1994, between 10 and 13 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 $1995,64 \%$ in 1996 , NA in 1997 , and $99 \%$ in 1998 . 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 bycatch, 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). Estimates of total annual bycatch 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 1998 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), 7 in 1996 (CV=0.22), NA in 1997, and 4 in 1998 (CV=0). The 1994-1998 average annual mortality and serious injury to striped dolphins in the pelagic drift gillnet fishery was 7.3 (CV=0.08) (Table 2).

## 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 ( $\mathrm{CV}=0.97$ ); average annual mortality and serious injury during 1994-1998 was zero.

Total estimated average annual fishery-related mortality and serious injury to this stock in the Atlantic during 1994-1998 was $7.3(\mathrm{CV}=0.08)$ (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 14,211 sets), 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 striped dolphins was $0.014 /$ set.

Table 2. Summary of the incidental mortality of striped dolphins (Stenella coeruleoalba) 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 | Number <br> Vessel | Data <br> Type $^{1}$ | Range of <br> Observer <br> Coverage $^{2}$ | Observed <br> Serious <br> Injury | Observed <br> Mortality | Estimated <br> Mortality | CVs | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pelagic <br> Drift <br> Gillnet | $94-98$ | $1994=12$ <br> $1995=11$ <br> $1996=10$ <br> $1998=13$ | Obs <br> Lata <br> Logbook | $.87, .99$, <br> .64, NA, <br> .99 | $0,0,0,0$, <br> 0 | $12,2,7$, <br> NA, 4 | $13,2.0^{3}$, <br> 10, NA, 4 | $.06,0$, <br> .22, NA, <br> 0 | 7.3 <br> $(0.08)$ |
| TOTAL |  |  |  |  |  |  |  | 7.3 <br> $(0.08)$ |  |

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.
${ }^{3}$ 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 1995-1998, seven striped dolphins were stranded between Massachusetts and Florida (NMFS unpublished data).

In eastern Canada, ten strandings were reported off eastern Canada from 1926-1971, and nineteen from 19911996 (Sergeant et al. 1970; Baird et al. 1997; Lucas and Hooker 1997). In both time periods, most of the strandings were on Sable Island, Nova Scotia.

## STATUS OF STOCK

The status of striped dolphins, relative to OSP, in the USA 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.
Archer, F. I., II and W. F. Perrin. 1997. Species account of striped dolphins (Stenella coeruleoalba). Paper SC/49/SM27 presented to the IWC Scientific Committee, September 1997. 27 pp.
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. 1994. 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 .
Lucas, A. N. and S. K. Hooker. 1997. Cetacean strandings on Sable Island, Nova Scotia, 1990-1996. Paper SC/49/06 presented to the IWC Scientific Committee, September 1997. 10 pp.
Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

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. Rep. int. Whal. Commn. Special Issue 16:2750.

Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC. Ref. Doc. 96-04; 37p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 025431026.

Palka, D.L. 1997. A review of striped dolphins (Stenella coeruleoalba) in U.S. Atlantic waters. IWC Doc. SC/49/SM26, 13 pp .
Palka, D., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
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.
Sergeant, D.E., A.W. Mansfield and B. Beck. 1970. Inshore records of cetacea for eastern Canada, 1949-68. J. Fish. Res. Brd. of Can. 27: 1903-1915.
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.
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, 21 pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.

## 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 water ecotype and a deep 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 $>25 \mathrm{~m}$ 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 unpublished data). Recent information from Wells et al. (1999) indicates that the range of the offshore bottlenose dolphin may include waters beyond the continental slope and that offshore bottlenose dolphins


Figure 1. Distribution of bottlenose dolphin sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$. may move between the Gulf of Mexico and the Atlantic. 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 USA Exclusive Economic Zone (EEZ) waters south of Cape Hatteras.

## POPULATION SIZE

An abundance of $16,689(\mathrm{CV}=0.32)$ for bottlenose dolphins was estimated from a line transect sighting survey conducted during July 6 to September 6, 1998 by a ship and plane that surveyed 15,900 km of track line in waters north of Maryland ( $38^{\circ} \mathrm{N}$ ) (Figure 1; Palka et al. in review). Shipboard data were analyzed using the modified direct duplicate
method (Palka 1995) that accounts for school size bias and $g(0)$, the probability of detecting a group on the track line. Aerial data were not corrected for $g(0)$.

An abundance of 13,944 (CV=0.38) for bottlenose dolphins was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed $5,570 \mathrm{~km}$ of track line in waters south of Maryland $\left(38^{\circ} \mathrm{N}\right)$ (Figure 1; Mullin in review). Abundance estimates were made using the program DISTANCE (Buckland et al. 1993; Laake et al. 1993) where school size bias and ship attraction were accounted for.

The best available abundance estimate for bottlenose dolphins is the sum of the estimates from the two 1998 USA Atlantic surveys, $30,633(\mathrm{CV}=0.25)$, where the estimate from the northern USA Atlantic is $16,689(\mathrm{CV}=0.32)$ and from the southern USA Atlantic is $13,944(\mathrm{CV}=0.38)$. This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

## 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 30,633 (CV=0.25). The minimum population estimate for the western North Atlantic offshore bottlenose is 24,897 .

## Current Population Trend

The data are insufficient to determine population trends. Previous estimates cannot be applied to this process because previous survey coverage of the species' habitat was incomplete.

## 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 24,897 . 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 249.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 was 5.3 bottlenose dolphins ( $\mathrm{CV}=0.03$ ).

## 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 USA prior to 1977. A fisheries observer program which recorded fishery data and information on incidental bycatch of marine mammals was established with implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) in 1977. DWF effort in the USA 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 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 USA east coast. Between 1983 and 1991, the number of foreign fishing vessels operating within the USA 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 198386. 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 USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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.

Bycatch 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 been documented in the Northeast multispecies sink gillnet and pelagic longline fisheries.

## Pelagic Longline

The pelagic longline fishery operates in the USA Atlantic (including Caribbean) and Gulf of Mexico EEZ (SEFSC unpublished data). Interactions between the pelagic longline fishery and bottlenose 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. Total effort, excluding the Gulf of Mexico, for the pelagic longline fishery, based on mandatory self-reported fisheries information, was 11,279 sets in 1991, 9,869 sets in 1992, 9,862 sets in 1993, 9,481 sets in 1994, 10,129 sets in 1995, 9,885 sets in 1996, 8,023 sets in 1997, and 6,765 in 1998 (Cramer 1994; Scott and Brown 1997; Johnson et al. 1999, Yeung 1999a). Since 1992, this fishery has been monitored with about 5\% observer coverage, in terms of trips observed, within every statistical reporting area within the EEZ and beyond. Off the USA Atlantic coast, 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. Yeung (1999a) provides estimates of mortality for 1998, based on a treatment which includes seriously injured animals as mortalities, following guidelines proposed by the NOAA Fisheries Office of Protected Resources (Federal Register Docket No., I.D. 051398C). Yeung (1999b) provides revised estimates of mortality for 19931997. These estimates, which treat serious injured animals as mortalities, replace the 1993-1997 estimates which were based on a revised analysis of the observed incidental take and self-reported incidental take and effort data (Johnson et al. 1999), and which replaced previous estimates for the 1992-1993 (Cramer 1994) and 1994-1995 periods (Scott and Brown 1997). Most of the estimated marine mammal bycatch was from EEZ waters between South Carolina and Cape Cod (Johnson et al. 1999). During 1993-1998, in waters not including the Gulf of Mexico, one bottlenose dolphin was caught and released alive during 1993, and one was caught and released alive during 1998.

## 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, 1996, and 1998 were 233, 243, 232, 197, 164, 149, and 113 respectively. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. Further, in January 1999 NMFS issued a Final Rule to prohibit the use of driftnets (i.e., permanent closure) in the North Atlantic swordfish fishery (50 CFR Part 630). Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-13 vessels have participated in the fishery (Table 1). 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 $1995,64 \%$ in 1996, 1997 (NA), and $99 \%$ in 1998. 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 bycatch, from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual bycatch 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 fisheries information. Variances were estimated using bootstrap re-sampling techniques. Sixty bottlenose dolphin mortalities have been observed between 1989 and 1998. 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), zero in 1996, and 3 in 1998 (0). Mean annual estimated fishery-related mortality for this fishery in 1994-1998 was 5.3 bottlenose dolphins (CV=0.03) (Table 1).

## 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 JuneNovember 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 $1995,52 \%$ and $55 \%$, respectively, of the sets were observed. Nineteen vessels have operated in this fishery. The fishery extends from $35^{\circ} \mathrm{N}$ to $41^{\circ} \mathrm{N}$, and from $69^{\circ} \mathrm{W}$ to $72^{\circ} \mathrm{W}$. Approximately $50 \%$ of the total effort was within a one degree square at $39^{\circ} \mathrm{N}, 72^{\circ} \mathrm{W}$, around Hudson Canyon. Examination of the locations and species composition of the bycatch, 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 ). Since this fishery no longer exists, it has been excluded from Table 1. 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 ( $\mathrm{CV}=0.04$ ) 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.

## Squid, Mackerel and Butterfish:

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 USA 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 19771988, there were no fishery-related mortalities of bottlenose dolphins reported in the self-reported fisheries information from the mackerel trawl fishery between 1990-1992.

Table 1. 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 Serious Injury | Observed <br> Mortality | Estimated Mortality ${ }^{4}$ | $\begin{aligned} & \text { Estimated } \\ & \text { CVs } \end{aligned}$ | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Pelagic Drift Gillnet | 94-98 | $\begin{gathered} 1994=12 \\ 1995=11 \\ 1996=10 \\ 1997=\text { N/A } \\ 1998=13 \end{gathered}$ | Obs. Data Logbook | $\begin{gathered} .87, .99 \\ .64, \text { NA, } \\ .99 \end{gathered}$ | $\begin{aligned} & 0,0,0, \\ & \text { NA, } 0 \end{aligned}$ | $\begin{gathered} 12,5,0 \\ \text { NA, } 3 \end{gathered}$ | $\begin{gathered} 13,5.0^{3}, 0 \\ \text { NA, } 3 \end{gathered}$ | $\begin{gathered} .05,0,0, \\ \mathrm{NA}, 0 \end{gathered}$ | $\begin{gathered} 5.3 \\ (0.03) \end{gathered}$ |
| TOTAL |  |  |  |  |  |  |  |  | $\begin{gathered} 5.3 \\ (0.03) \end{gathered}$ |

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 is measured in terms of sets. The proportion of trips sampled by the NEFSC Sea Sampling Program are reported here.
3 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.
4 Annual mortality estimates do not include any animals injured and released alive.
5 The fishery did not operate in 1997; the average annual mortality is based on the number of years $(4 ; 1994-1996,1998)$ that the fishery operated.

## Other Mortality

Bottlenose dolphins are one of the most frequently-stranded small cetaceans 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 is 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. This level is less than $10 \%$ of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. Average 1994-1998 annual fishery-related mortality and serious injury does not exceed the PBR; therefore, this 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 .
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., S. H. Ridgway and L. H. Cornell. 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.
Goudey, C.A. 1995. The 1994 experimental pair trawl fishery for tuna in the northwest Atlantic, Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, Cambridge, MA. 10 pp.
Goudey, C.A. 1996. The 1995 experimental pair trawl fishery for tuna in the northwest Atlantic, Massachusetts Institute of Technology, Sea Grant, MITSG 95-6, 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.
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.
Johnson, D. R., C. A. Brown and C. Yeung. 1999. Estimates of marine mammal and marine turtle catch by the U.S. Atlantic pelagic longline fleet in 1992-1997. NOAA Tech. Mem. NOAA-SEFSC-418, 70 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.
Mullin, K. D. (in review). Abundance and distribution of cetaceans in the southern U.S. Atlantic Ocean during summer 1998. Fish. Bull., U.S.

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. Rep. int Whal. Commn. Special Issue 16:27-50
Palka, D., G. Waring and D. Potter. (in review). Abundances of cetaceans and sea turtles in the northwest Atlantic during summer 1995 and 1998. Fish. Bull., U.S.
Scott, G.P. and C.A. Brown. 1997. Estimates of marine mammal and marine turtle catch by the U.S 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., 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.
Wells, R.S., H.L. Rhinehart, P. Cunningham, J. Whaley, M. Baran, C. Koberna and D.P. Costa. 1999. Long distance offshore movements of bottlenose dolphins. Marine Mammal Science, 15(4):1098-1114.
Yeung, C. 1999a. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Technical Memorandum NMFS-SEFSC-430, 26 pp.

Yeung, C. 1999b. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. NOAA Technical Memorandum NMFS-SEFSC-429, 23 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. 1999); a shallow water ecotype and a deep water ecotype which correspond to nearshore and offshore forms, respectively. Both ecotypes have been shown to inhabit waters in the western North Atlantic Ocean (Hersh and Duffield 1990; Mead and Potter 1995; Hoelzel et al. 1998; Walker et al. 1999). The inshore and offshore forms, of all age classes, can be positively identified based on differences in morphometrics, parasite loads, and prey (Mead and Potter 1995). Hoelzel et al. (1998) found significant differentiation between the nearshore and offshore forms in both nuclear and mtDNA markers, and concluded the two forms were distinct. Curry (1997) concluded that, based on differences in mtDNA haplotypes, the nearshore animals in the northern Gulf of Mexico and the western North Atlantic were significantly different stocks. 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 USA 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 or nearshore form. Furthermore, Hoelzel et al. (1998) genetically identified a sample of animals captured or incidentally caught in nearshore waters as the nearshore form. Currently, data are insufficient to allow separation of locally resident bottlenose dolphins found in bays, sounds and estuaries (such as those from the Indian/Banana River) from the coastal stock in the western North Atlantic; Hoelzel et al. (1998) found less variation in nuclear and mtDNA markers among their sample of nearshore animals, which likely included resident and coastal animals, than their sample of offshore animals.


Figure 1. Sightings of bottlenose dolphins during aerial surveys from shore to the 25 m isobath north of Cape Hatteras during summer 1994, shore to 9 km past the western Gulf Stream wall south of Cape Hatteras during winter 1992, three coastal surveys within one km of shore from New Jersey to mid-Florida during the summer in 1994, and during vessel surveys from about the 30 m isobath to the offshore extent of the USA EEZ in 1998.

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. Some 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 there are two concentrations of animals north of Cape Hatteras, one inshore of the 25 m isobath and the other offshore of the 25 m isobath, which were observed during aerial surveys of the region (CETAP 1982)
and vessel surveys (NMFS unpublished data). 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 USA Atlantic coast. Figure 1 illustrates the distribution of 696 bottlenose dolphin herd sightings during aerial and vessel surveys conducted during 1992-1998. 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. Gathering information to distinguish between coastal and offshore


Figure 2. Illustration of stock structure hypotheses of Atlantic coastal bottlenose dolphins: one stock ranging from New Jersey to Florida or Science Center (SEFSC), as is research to multiple stocks which may include: 1) year-round residents with small determine the relationship between home ranges; 2) multiple, contiguous, seasonally resident groups with bottlenose dolphin that inhabit bays, sounds relatively large home ranges; and 3) groups with long-range migratory and estuaries and those that are believed to pattern.
comprise the coastal stock (Hohn 1997).
A multi-disciplinary, multi-investigator research program to understand the stock structure of Atlantic coastal bottlenose dolphins was initiated in late 1996. Several different hypotheses about stock structure are being considered (Figure 2). The experimental design for the program is based on: 1) obtaining samples from live captures, photoidentification, projectile biopsy, and incidental take (strandings and observer programs); 2) conducting independent analyses including genetics, isotope ratios, contaminants, movement patterns, morphometrics, telemetry, and life history; and 3) merging of the disassociated results to describe stock structure (Hohn 1997). Based on current information, it is expected that multiple stocks exist and include year-round residents, seasonal residents, and migratory groups.

Site-specific, year-round residents have been reported only in the southern part of the range, from Charleston, South Carolina (Zolman 1996) and Georgia (Petricig 1995) to central Florida (Odell and Asper 1990); seasonal residents and migratory or transient animals also occur in these areas. In the northern part of the range the patterns reported include seasonal residency, year-round residency with large home range, and migratory or transient movements (Barco and Swingle 1996, Sayigh et al. 1997). Table I lists the locations and the patterns of residency and movement that have been documented through photo-identification of naturally-marked animals, and of 31

Table 1. Residency and movement patterns of bottlenose dolphins documented from photoidentification (from Hohn 1997).

| Location | Year-round <br> Residents | Seasonal <br> Residents | Migratory/ <br> Transient |
| :--- | :---: | :---: | :---: |
| Virginia Beach, VA | No | Jun-Sept | Jun-Sept |
| Beaufort, NC, "coastal" | No | Oct-Apr | $?$ |
| Beaufort, NC, <br> "estuarine" | Possible large home <br> range |  |  |
| Wilmington, NC | Yes |  |  |
| Charleston, SC | Yall- |  |  |
| winter | spring, fall |  |  |
| Bull Creek, SC | Yes | Yes |  |

individuals animals that were live-captured and freeze-branded in Beaufort, NC in 1995 (Hansen and Wells 1996). Complex patterns of movement and residency were observed in a sample of 10 of the animals live-captured in Beaufort that were radio-tagged and tracked for up to 31 days: some left the area immediately, some were located up to 120 km distant within a few days of tagging, and others remained in the area (Read et al. 1996).

The observed patterns of year-round residency and seasonal residency, and migratory and transient movements likely represent a population that consists of a complex mosaic of biologically-meaningful stocks. The patterns are in some cases essentially identical or very similar to patterns observed in recognized stocks or communities identified in embayments and coastal areas in the northern Gulf of Mexico (e.g. Scott et al. 1990; Weller 1998; Wells et al. 1996). Sufficient information exists to identify year-round resident communities in several bay and estuarine areas; however, much of the suitable bay and estuarine habitats along the Atlantic coast have not yet been studied sufficiently. Although numerous research efforts are underway, it will require several years of photographic identification, genetic and radiotracking research to provide sufficient information for interpretation. The entire range(s) and number of migratory and transient stocks are unknown, but much of the current research effort is directed towards determining stock structure, movements, and degree of mixing of these presumed stocks. As the research efforts are completed, it is likely that a number of stocks or communities will be identified, including year-round and resident stocks in embayments, and transient or migratory stocks. This will necessitate a revision of the stock assessment report of the western North Atlantic Coastal Stock of bottlenose dolphins to reflect the number of stocks described.

## POPULATION SIZE

Mitchell (1975) estimated that the coastal bottlenose dolphin population which was exploited by a shore-based net fishery until 1925 (Mead 1975) numbered at least 13,748 bottlenose dolphins in the 1800 s . Recent estimates of bottlenose dolphin abundance in the USA 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 1992 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 about $89,900 \mathrm{~km}^{2}$ 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 1992 survey. Preliminary analysis (following the same procedures described above) resulted in an abundance estimate of 21,128 dolphins ( $\mathrm{CV}=0.22$ ) 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 ( $\mathrm{CV}=0.40$ ) (Blaylock 1995) within the approximately $25,600 \mathrm{~km}^{2}$ 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 $(C V=0.19)$ with a log-normal $95 \%$ confidence interval of 8,695-18,173.

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.

A vessel survey to obtain abundance, distribution, and biopsy information from pelagic cetaceans in USA waters south of Delaware Bay was conducted during July and August 1998 (NMFS unpublished data). The survey included waters from approximately the 30 m isobath out to the offshore extent of the USA EEZ. A total of 56 herds or groups of bottlenose dolphins were sighted; an unknown number of these herds were likely the offshore bottlenose dolphin ecotype. One of the herds sighted was exceptionally large and was estimated to consist of 251 individuals. The data from the survey are currently being analyzed; abundance estimates should be available in late 1999.

It is not currently possible to distinguish the two bottlenose dolphin ecotypes with certainty during visual aerial and vessel surveys, as the distribution of the two ecotypes in USA Atlantic EEZ waters is uncertain. Because of this difficulty, the resulting abundance estimates may include dolphins from the offshore stock. Until additional research provides information to determine the range of habitat utilized by both ecotypes and their degree of mixing along the Atlantic coast, it will not be possible to assess the abundance of either type with any certainty. Determining the degree of geographic mixing of these two ecotypes is currently an active area of research by NMFS, SEFSC.

## Minimum Population Estimate

Reasonable assurance of a minimum population estimate can not be provided by line transect surveys because the proportion of dolphins from the offshore stock which might have been observed is unknown. The risk averse approach is to assume that the minimum population size is 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 USA 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 1992 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. Therefore, PBR for the USA Atlantic coastal bottlenose dolphin stock is 25 dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 was 45.8 bottlenose dolphins ( $\mathrm{CV}=0.67$ ).

## Fishery Information <br> Menhaden Purse Seine

The Atlantic menhaden purse seine fishery targets the Atlantic menhaden, Brevortia tyrannus, in Atlantic coastal waters approximately $3-18 \mathrm{~m}$ in depth. Twenty-two vessels operate off northern Florida to New England from AprilJanuary (NMFS 1991, pp. 5-73). Menhaden purse seiners have reported an annual incidental take of one to five bottlenose dolphins (NMFS 1991, pp. 5-73), although observer data are not available.

## Mid-Atlantic Coastal Gillnet

Coastal gillnets operate in different seasons targeting different species in different states throughout the range of this stock. Most nets are anchored 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 JanuaryMarch. Similar mixed-species gillnet fisheries, under state jurisdiction, operate seasonally along the coast from Florida to New Jersey, with the exclusion of Georgia.

The mid-Atlantic coastal gillnet fishery is actually a combination of small vessel fisheries that target a variety of fish species. Some of the fishery operates right off the beach. Although observer coverage of the fishery was initiated in July, 1993, there was no coverage in 1994 and bycatch estimates are available only for 1995-1998. Observer coverage of the fishery ranged from $3 \%$ in 1997 to $5 \%$ in 1995 and 1998. One take of a bottlenose dolphin was observed in 1995 and 1996, none in 1997, and three in 1998. The annual estimated mortalities with associated CVs in parentheses by year are as follows: 1995, 56 (1.66); 1996, 64 ( 0.83 ); 1997, $0 ; 1998,63$ ( 0.94 ); estimated 1995-1998 mean annual estimated take is $45.8, \mathrm{CV}=0.67$ (Table 2).

## Shrimp Trawl

The shrimp trawl fishery operates from North Carolina through northern Florida virtually year around, moving seasonally up and down the coast. One bottlenose dolphin was recovered dead from a shrimp trawl in Georgia in 1995 (Southeast USA Marine Mammal Stranding Network unpublished data), but no bottlenose dolphin mortality or serious injury has been previously reported to NMFS.

## Beach Seine

A beach seine fishery operates along northern North Carolina beaches during the spring and fall targeting mullet, spot, weakfish, sea trout, and bluefish. The North Carolina beach seine has been observed since April 7, 1998. The fishery, based on the Outer Banks of North Carolina, occurs primarily in the spring (April through June) and fall (October through December). This fishery has two types of setup systems: a "beach anchored gill net" and a "beach seine". Both systems utilize a gill net anchored to the beach. The beach seine system also uses a bunt and wash net that are attached to the beach and are in the surf. This fishery was observed by patrolling the beaches on a daily basis. During April 1998, 12 hauls were observed: 9 were the gill net system and 3 were the beach seine system. During May 1998, 26 hauls were observed: 14 gill net and 12 beach seine hauls. During October 1998, 7 hauls were observed, all the gill net system. During November 1998, 1 gillnet system haul was observed. During December 1998, 14 hauls were observed: 12 gill net and 2 beach seine hauls. The only observed take was a freshly killed bottlenose dolphin during May 1998. The beach seine observer data is currently being audited and is unavailable for analysis. The beach seine fishery bycatch mortality estimate will be available for the 2001 stock assessment report.

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 <br> Coverage ${ }^{2}$ | Observed <br> Serious Injury | Observed <br> Mortality | Estimated <br> Mortality | $\begin{aligned} & \text { Estimated } \\ & \text { CVs } \end{aligned}$ | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Mid-Atlantic Coastal Sink Gillnet | 94-98 | NA | Obs. Data <br> Weighout | $\begin{gathered} \mathrm{NA}, .05, .04, \\ .03, .05 \end{gathered}$ | $\begin{gathered} \mathrm{NA}, 0,0, \\ 0,0 \end{gathered}$ | $\begin{gathered} \mathrm{NA}, 1,1, \\ 0,3 \end{gathered}$ | $\begin{gathered} \mathrm{NA}, 56 \\ 64,0,63 \end{gathered}$ | $\begin{aligned} & \text { NA, 1.66, } \\ & .83,0, .94 \end{aligned}$ | $\begin{gathered} 45.8 \\ (0.67) \end{gathered}$ |
| TOTAL |  |  |  |  |  |  |  |  | $\begin{gathered} 45.8 \\ (0.67) \end{gathered}$ |

Observer data (Obs. data) are used to measure bycatch rates; the USA data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. The NEFSC collects weighout (Weighout) landings data that are used as a measure of total effort for the USA sink gillnet fisheries.
The observer coverage for the mid-Atlantic coastal sink gillnet fishery is measured in tons of fish landed.

## Other Mortality

Bottlenose dolphins are known to interact with commercial fisheries and occasionally are taken in various kinds of fishing gear including gillnets, seines, long-lines, shrimp trawls, and crab pots (Read 1994, Wang et al. 1994) especially in near-shore areas where dolphin densities and fishery efforts are greatest. These interactions are due in part to the species' gregarious nature and habits of feeding on discarded bycatch and from baited gear (e.g., long-line and crab pots). However, 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. 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

From 1993-1997, two hundred and eighty-eight bottlenose dolphins were reported stranded in waters north of Cape Hatteras (Virginia to Massachusetts, NE Region) (NMFS, unpublished data). The majority of the strandings within this northern area occurred in Virginia $(\mathrm{n}=182,63 \%)$. An unknown number of the animals reported stranded during 1993-1995 have shown signs of entanglement with fishing gear or interactions with fishing activities; however, limited information was available for 1993, and complete information was available for 1996-1997. 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). In 1996, seventy-four bottlenose dolphins were reported stranded in the NE Region. The cause of death could be determined for 44 animals and of these, 16 or $36 \%$ were reported due to human interactions (including 13 gear entanglements). In 1997, seventy-four bottlenose dolphins were also reported stranded in the NE Region. The
cause of death could be determined for 54 animals and of these, 14 or $26 \%$ were reported due to human interactions. If the percentages are consistent for animals for which cause of death could not be determined, it is likely that during 1996 about 27 (36\%), and during 1997 about 19 (26\%), of the stranded animals in the NE Region died due to human interactions.

Evidence of interaction with fisheries (entanglement, net marks, mutilations, gun shots, etc.) were present in 178 of 1353 of the bottlenose dolphin strandings investigated in the USA Southeast Atlantic region (North Carolina to Florida) from 1993 to 1998 (Table 3) as determined from evidence of entanglement in fishing gear and/or other human related causes (e.g., net marks, entanglement, mutilations, boat strikes, gunshot wounds) (NMFS unpublished information). This does not take into account those animals for which cause of death could not be determined so the number of animals that stranded due to human interaction is likely greater.

North Carolina stranding records show the highest incidence of fishery interactions from the SE Atlantic Region. North Carolina data from 1993 through 1998 indicate that 120 of 489 animals, or $25 \%$ showed evidence of human interactions. In 1997, 127 bottlenose dolphin stranded in North Carolina. Cause of death could be determined for only 58 of these animals, and of these 36 or $62.1 \%$ exhibited positive signs of fisheries interactions. The results for 1998 were similar; of the 83 animals stranded, cause of death could be determined for only 35 and of these 19 or $54.3 \%$ exhibited positive signs of fishery interactions. If this percentage is consistent for all North Carolina stranded animals, it is possible that approximately 78 or $62 \%$ of the stranded animals died from fisheries interactions in 1997, and in 1998 approximately 45 or $54 \%$ died from fisheries interactions.

In recent years reports of strandings with evidence of interactions between bottlenose dolphins and both recreational and commercial crab-pot fisheries have been increasing in the Southeast Region (McFee and Brooks 1998).

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, $\mathrm{P}>0.10$ ), but these estimates may have included an unknown proportion of the offshore stock. Population trends cannot be determined due to insufficient data.

Although there are limited observer data directly linking serious injury and mortality to fisheries (e.g., in the coastal gillnet fishery complex in the mid-Atlantic), the total number of bottlenose dolphin assumed from this stock which stranded showing signs of fishery or human-related mortality exceeded PBR in 1993, 1996, 1997, and by the end of

October in 1998. 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

Barco, S. G. and W. M. Swingle. 1996. Sighting patterns of coastal migratory bottlenose dolphins (Tursiops truncatus) in the nearshore waters of Virginia and North Carolina. Final Report to the Virginia Dept. of Environmental Quality, Coastal Resources Management Program through Grant\#NA47OZ0287-01 from NOAA, Office of Ocean and Coastal Resource Management. 32 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.
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.
Curry, B.E. 1997. Phylogenetic relationships among bottlenose dolphins (genus Tursiops) in a world-wide context. Ph.D. dissertation, Texas A\&M University, Texas, USA. 138 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/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.
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.
Hansen, L. J. and R.S. Wells. 1996. Bottlenose dolphin health assessment: Field report on sampling in and around Beaufort, North Carolina, during July, 1995. NOAA Tech. Memo. NMFS-SEFSC-382, 24 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.
Hoelzel, A. R., C. W. Potter and P. B. Best. 1998. Genetic differentiation between parapatric 'nearshore' and 'offshore' populations of the bottlenose dolphin. Proceedings of the Royal Society of London. 265:1177-1183.
Hohn, A. A. 1997. Design for a multiple-method approach to determine stock structure of bottlenose dolphins in the midAtlantic. 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. 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.
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, 22 pp. +8 Tables, 5 Figures, 6 Appendices.
McFee, W. E. and W. Brooks, Jr. 1998. Fact finding meeting of marine mammal entanglement in the crab pot fishery: a summary. U.S. Fish and Wildlife Service. Unpublished Report.

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. Pages 515-540 in S. Leatherwood and R. R. Reeves (eds), The bottlenose dolphin, Academic Press, San Diego, 653 pp.
Petricig, R. O. 1995. Bottlenose dolphins (Tursiops truncatus) in Bull Creek, South Carolina. Ph.D. Dissertation. University of Rhode Island, USA. 298 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.
Read, A. J., A. J. Westgate, K. W. Urian, R. S. Wells, B. M. Allen and W. J. Carr. 1996. Monitoring movements and health status of bottlenose dolphins in Beaufort, NC using radio telemetry. Final Contract Report, Contract No. 40-GENF-500160, Southeast Fisheries Science Center, Miami, FL, 36 pp.
Reif, J. S., L. J. Hansen, S. Galloway, G. Mitchum and 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.
Sayigh, L., K. W. Urian, A. Bocconcelli, G. Jones, D. Koster, K. Halbrook and A. J. Read. 1997. Photo-identification of dolphins near Wilmington, NC. Abstract. Fifth Annual Atlantic Coastal Dolphin Conference.
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.
Scott, M. D., R. S. Wells and A. B. Irvine. 1990. A long-term study of bottlenose dolphins on the west coast of Florida. Pp. 235-244 In: S. Leatherwood and R. R. Reeves. The Bottlenose Dolphin. Academic Press, San Diego. 653 pp.
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. 1999. The diets of modern and historic bottlenose dolphin populations reflected through stable isotopes. Mar. Mammal Sci. 15(2): 335-350.
Wang, K. R., P. M. Payne and V. G. Thayer. 1994. Coastal stock(s) of Atlantic bottlenose dolphin: status review and management: Proceedings and recommendations from a workshop held in Beaufort, North carolina, 13-14 September 1993. U.S. Department of Commerce, NOAA, NMFS Tech. Mem NMFS-OPR-4, 120 pp.
Weller, D. W. 1998. Global and regional variation in the biology and behavior of bottlenose dolphins. Ph.D. dissertation, Texas A\&M University, Galveston, TX. 142 pp.
Wells, R. S., K. W. Urian, A. J. Read, M. K. Bassos, W. J. Carr and M. D. Scott. 1996. Low-level monitoring of bottlenose dolphins (Tursiops truncatus), in Tampa Bay, Florida: 1998-1993. NOAA Tech. Mem. NMFS-SEFSC-385, 25 pp. + 6 Tables, 8 Figures, and 4 Appendices.
Zolman, E. S. 1996. Residency patterns, relative abundance and population ecology of bottlenose dolphins (Tursiops truncatus) in the Stono River Estuary, Charleston County, South Carolina. Master of Science thesis. University of Charleston, South Carolina, USA. 128 pp.

## HARBOR PORPOISE (Phocoena phocoena): Gulf of Maine/Bay of Fundy Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

This stock is found in USA 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 (OctoberDecember) 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 to deep waters (>1800m; Westgate et al. 1998), although the majority of the population is found over the continental shelf. 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 waters around the 92 m 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; Rosel et al. 1999), organochlorine contaminants (Westgate et al.1997; Westgate and Tolley 1999), heavy metals (Johnston 1995), and life history parameters (Read and Hohn 1995) support Gaskin's proposal. Genetic studies using mitochondrial DNA (Rosel et al. 1999) and contaminant studies using total PCBs (Westgate and Tolley 1999) indicate that the Gulf of Maine/Bay of Fundy females were distinct from females from the other populations in the NW Atlantic. While Gulf of Maine/Bay of Fundy males were distinct from Newfoundland and Greenland males, but not from Gulf of St. Lawrence males according to studies comparing mtDNA (Rosel et al. 1999; Palka et al. 1996) and CHLORs, DDTs, PCBs and CHBs (Westgate and Tolley 1999). Analyses of stranded animals from the mid-Atlantic states suggest that this aggregation of harbor porpoises consists of animals from more than just the Gulf of Maine/Bay of Fundy stock (Rosel et al. 1999). However, the majority of the samples used in the Rosel et al. (1999) study were from stranded juvenile animals. Further work is underway to examine adult animals from this region. Nuclear microsatellite markers have also been applied to samples from these four populations, but this analysis failed to detect significant population sub-division in either sex (Rosel et al. 1999). This pattern may be indicative of female philopatry coupled with dispersal of male harbor porpoises. 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.

Figure 1. Distribution of harbor porpoise sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$.

## POPULATION SIZE

To estimate the population size of harbor porpoises 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 $1991(\mathrm{CV}=0.29,95 \%$ confidence interval (CI) $=26,700-$ 86,400) (Palka 1995a), 67,500 harbor porpoises in $1992(\mathrm{CV}=0.23,95 \% \mathrm{CI}=32,900-104,600)$, and 74,000 harbor porpoises in $1995(\mathrm{CV}=0.20,95 \% \mathrm{CI}=40,900-109,100)($ Palka 1996). The inverse variance weighted-average abundance estimate (Smith et al. 1993) was 54,300 harbor porpoises (CV=0.14, $95 \% \mathrm{CI}=41,300-71,400$ ). Possible reasons for interannual differences in abundance and distribution include experimental error between inter-annual changes in water temperature and availability of primary prey species (Palka 1995b), and movement among population units (e.g. between the Gulf of Maine and Gulf of St. Lawrence).

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 section of the region was surveyed by airplane while the rest of the region was surveyed by ship, as in previous years. The 1995 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.

Kingsley and Reeves (1998) estimated there were $12,100(\mathrm{CV}=0.26)$ harbor porpoises in the entire Gulf of St. Lawrence during 1995 and 21,700 (CV=0.38) in the northern Gulf of St. Lawrence during 1996. These estimates are presumed to be of the Gulf of St. Lawrence stock of harbor porpoises. The highest densities were north of Anticosti Island, with lower densities in the central and southern Gulf. During the 1995 survey, 8427 km of track lines were flown in an area of $221,949 \mathrm{~km}^{2}$ during August and September. During the 1996 survey, $3,993 \mathrm{~km}$ of track lines were flown in an area of $94,665 \mathrm{~km}^{2}$ during July and August. Data were analyzed using Quenouille's jackknife bias reduction procedure on line transect methods that modeled the left truncated sighting curve. These estimates were uncorrected for visibility biases, such as $\mathrm{g}(0)$.

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 $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :---: | :---: | :---: |
| Jul-Aug 1991 |  <br> lower Bay of Fundy | 37,500 | 0.29 |
| Jul-Sep 1992 |  <br> lower Bay of Fundy | 67,500 | 0.23 |
| Jul-Sep 1995 |  <br> lower Bay of Fundy | 74,000 | 0.20 |
| Inverse variance-weighted average of <br> 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 20 th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for harbor porpoises is $54,300(\mathrm{CV}=0.14)$. The minimum population estimate for the Gulf of Maine/Bay of Fundy harbor porpoise is $48,289(\mathrm{CV}=0.14)$.

## 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 a potential population growth rate that incorporates 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. The median potential annual rate of increase was approximately $10 \%$, with a $90 \%$ confidence interval of $3-15 \%$. This analysis underscored the considerable uncertainty that exists regarding the potential rate of increase in this population. Consequently, for the purposes of this assessment, the maximum net productivity rate 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, and following a recommendation from the Atlantic Scientific Review Group. 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).

## 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 $48,289(\mathrm{CV}=0.14)$. 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 USA Northeast multispecies sink gillnet, mid-Atlantic coastal gillnet, Atlantic pelagic drift gillnet fisheries, and in the Canadian Bay of Fundy groundfish sink gillnet and herring weir fisheries. The USA average annual mortality estimate for 1994 to 1998 from the above USA fisheries is $1,521(\mathrm{CV}=0.10)$ harbor porpoises (Table 2). The Canadian average annual mortality estimate for 1994 to 1998 from the above Canadian fisheries is 57 harbor porpoises. It was not possible to estimate variance of the Canadian estimate. The total average annual mortality estimate for 1994 to 1998 from the USA and Canadian fisheries is 1,578 (Table 2).

## USA

Recent data on incidental takes in USA fisheries are available from several sources.The only source that documented harbor porpoise bycatch is the Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program that was initiated in 1989, and since that year, several fisheries have been covered by the program.

## Northeast Multispecies Sink Gillnet

Before 1998, most of the harbor porpoise takes from USA fisheries were from the Northeast multispecies sink gillnet fishery. In 1984 the Northeast multispecies sink gillnet fishery was investigated by a sampling program that collected information concerning marine mammal bycatch. 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 NMFS to investigate marine mammal takes in the Northeast multispecies sink gillnet fishery. There have been 423 harbor porpoise mortalities related to this fishery observed between 1990 and 1998 and one was released alive and uninjured. In 1993, there were approximately 349 full and part-time vessels in the Northeast multispecies sink gillnet fishery(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. During 1998, it was estimated there were

301 full and part-time vessels participating in this fishery. This is the number of unique vessels in the commercial landings database (Weighout) that reported catch from this fishery during 1998 from the states of Rhode Island to Maine. This does not include a small percentage of records where the vessel number was missing. Observer coverage in terms of trips has been $1 \%, 6 \%, 7 \%, 5 \%, 7 \%, 5 \%, 4 \%, 6 \%$ and $5 \%$ for years 1990 to 1998 , respectively. Bycatch in the northern Gulf of Maine occurs primarily from June to September; while in the southern Gulf of Maine bycatch occurs from January to May and September to December. Annual estimates of harbor porpoise bycatch in the Northeast multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Bycatch estimates included 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 bycatch 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 bycatch estimates replace those published earlier (Smith et al. 1993). Estimates presented here 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 bycatch (CV in parentheses) from this fishery during 1990-1998 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), 1200 ( 0.25 ) in 1996, 782 ( 0.22 ) in 1997, and $332(0.46)$ in 1998. The increase in the 1998 CV is mainly due to the small number of observed takes. Average estimated harbor porpoise mortality and serious injury in the Northeast multispecies sink gillnet fishery during 1994-1998 was 1,163 (0.11).

There appeared to be no evidence of differential mortality in USA 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 bycatch (Read and Hohn 1995). However, with a larger sample, from harbor porpoises examined by necropsy or from tissues received from sea sampling observers ( $\mathrm{n}=171$ between 1989 and 1997), the sex ratio is now 58 females and 113 males (A. Read, pers. comm.). 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 and 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 that did not follow the experimental protocol (Table 2). From 1995 to 1997, experimental fisheries were conducted where all nets in a designated area were required to use 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 1995, all takes from pingered nets were added directly to the estimated total bycatch for that year. 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. During 1997, experimental fisheries were allowed in the mid-coast region during March 25 to April 25 and November 1 to December 31. During the 1997 spring experimental fishery, 180 hauls were observed with active pingers and 220 hauls were controls (silent). All observed harbor porpoise takes were in silent nets: 8 in nets with control (silent) pingers, and 3 in nets without pingers. Thus, there was a statistical difference between the catch rate in nets with pingers and silent nets (Kraus and Brault in press). During the 1997 fall experimental fishery, out of 125 observed hauls using pingered nets no harbor porpoises were taken.

From 95 stomachs of harbor porpoises collected in groundfish gillnets in the Gulf of Maine between September and December 1989-94, Atlantic herring (Clupea harengus) was the most important prey. Pearlsides (Maurolicus weitzmani), silver hake (Merluccius bilinearis) and red and white hake (Urophycis spp.) were the next most common prey species (Gannon et al. 1998).

## Mid-Atlantic Coastal Gillnet

Before an observer program was in place, Polacheck et al. (1995) reported one harbor porpoise incidentally taken in shad nets in the York River, Virginia. In July 1993 an observer program was initiated in the mid-Atlantic coastal gillnet fishery by the NEFSC Sea Sampling program. 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 the vessels operate right off the beach. During 1998, it was estimated that there were 302 full and part-time vessels participating in this fishery. This is the number of unique vessels in the commercial landings database (Weighout) that reported catch from this fishery during 1998 from
the states of Connecticut to North Carolina. This does not include a small percentage of records where the vessel number was missing. Twenty trips were observed during 1993. During 1994 and 1995, 221 and 382 trips were observed, respectively. Observer coverage, expressed as percent of tons of fish landed, was 5\% for 1995, 4\% for 1996, 3\% for 1997, and $5 \%$ for 1998 (Table 2). No harbor porpoises were taken in observed trips during 1993 and 1994. During 1995 to 1998, respectively, $6,19,32$, and 53 harbor porpoises were observed taken (Table 2). Observed fishing effort has been concentrated off New Jersey and scattered between Delaware and North Carolina from the beach to 50 miles off the beach. Documented bycatches during 1995 to 1998 were from December to May. Bycatch estimates were calculated using methods similar to that used for bycatch estimates in the Northeast multispecies gillnet fishery (Bravington and Bisack 1996; Bisack 1997a). During 1998 a separate bycatch estimate was made for the drift gillnet and set gillnet sub-fisheries. The number presented here is the sum of these two sub-fisheries. The estimated annual mortality (CV in parentheses) attributed to this fishery was $103(0.57)$ for 1995, $311(0.31)$ for 1996, $572(0.35)$ for 1997, and 446 (0.36) for 1998. Average estimated harbor porpoise mortality and serious injury from the mid-Atlantic coastal gillnet fishery during 1995 to 1998 was 358 (CV=0.20) (Table 2).

## Pelagic Drift Gillnet

Because no harbor porpoises were taken in this fishery during the most recent five year period, 1994 to 1998, this section will be removed during the next update. In 1996 and 1997, NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery operated during 1998. Then, in January 1999 NMFS issued a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery (50 CFR Part 630). One harbor porpoise was observed taken from the Atlantic pelagic drift gillnet fishery during 1991-1998. 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 to 1998 there were $11,12,10,0$, and 11 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 observed was $8 \%$ in 1989, $6 \%$ in 1990, 20\% in 1991, $40 \%$ in $1992,42 \%$ in $1993,87 \%$ in 1994, $99 \%$ in $1995,64 \%$ in 1996 , and $99 \%$ in 1998 . The decline in observer coverage in 1996 is attributable to trips made by vessels that were deemed unsafe for observers due to the size or condition of the fishing vessel. 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 bycatch, 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 bycatch after 1993 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 re-sampling techniques (Bisack 1997b). The one observed bycatch was notable because it occurred in continental shelf edge waters adjacent to Cape Hatteras (Read et al. 1996). Estimated annual fisheryrelated 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 ), 0 in 1994 to 1996, and 0 in 1998. The fishery was closed during 1997. Average estimated harbor porpoise mortality and serious injury in the Atlantic pelagic drift gillnet fishery during 1994-1998 was 0.0 (Table 2).

## North Atlantic Bottom Trawl

One harbor porpoise mortality was observed in the North Atlantic bottom trawl fishery between 1989 and 1998. 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 $970(\mathrm{CV}=0.04)$ 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, the estimated bycatch for this fishery is 0 .

## CANADA

Hooker et al. (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on between $25-40 \%$ of large Canadian fishing vessels (greater than 100 feet long), and on approximately $5 \%$ of smaller Canadian fishing vessels. No harbor porpoises were observed taken.

## Bay of Fundy Sink Gillnet

During the early 1980's, Canadian harbor porpoise bycatch in the Bay of Fundy sink gillnet fishery, based on casual observations and discussions with fishermen, was thought to be low. The estimated harbor porpoise bycatch 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 bycatch estimate of 424 harbor porpoises ( $\pm 1$ SE: 200-648) from 62 observed trips, (approximately $11.3 \%$ coverage of the Bay of Fundy trips) (Trippel et al. 1996).

During 1994, the observer program was expanded to cover $49.4 \%$ of the gillnet trips ( 171 observed trips). The bycatch was estimated to be 101 harbor porpoises ( $95 \%$ confidence limit: 80-122), and the fishing fleet consisted of 28 vessels (Trippel et al. 1996).

During 1995, due to groundfish quotas being exceeded, the gillnet fishery was closed from July 21 to August 31, 1995. During the open fishing period of $1995,89 \%$ of the trips were observed, all in the Swallowtail region. Approximately $30 \%$ of these observed trips used pingered nets. The estimated bycatch was 87 harbor porpoises (Trippel et al. 1996). No confidence interval was computed due to lack of coverage in the Wolves fishing grounds.

During 1996, the Canadian gillnet fishery was closed during July 20-31 and August 16-31 due to reduced groundfish quotas. From the 107 monitored trips, the bycatch in 1996 was estimated to be 20 harbor porpoises (Trippel et al. 1999; DFO 1998). Trippel et al. (1999) estimated that during 1996, gill nets equipped with acoustic alarms reduced harbor porpoise bycatch rates by $68 \%$ over nets without alarms in the Swallowtail area of the lower Bay of Fundy.

During 1997, the fishery was closed to the majority of the gillnet fleet during July 18-31 and August 16-31, due to reduced groundfish quotas. In addition a time-area closure to reduce porpoise bycatch in the Swallowtail area occurred during September 1-7, 1997. From the 75 monitored trips during 1997, 19 harbor porpoises were observed taken. After accounting for total fishing effort, the estimated bycatch in 1997 was 43 animals (DFO 1998). Trippel et al. (1999) estimated that during 1997, gill nets equipped with acoustic alarms reduced harbor porpoise bycatch rates by $85 \%$ over nets without alarms in the Swallowtail area of the lower Bay of Fundy.

During 1998, the number of fishing vessels was appreciably lower than in previous years due to very poor groundfish catch rates, even though the fishery was open throughout July to September. Seventeen trips were monitored and one harbor porpoise mortality was observed. Fishers independently reported an additional four porpoises. The Wolves and Head Harbour area had seven fishing trips in July and did not receive observer coverage. A preliminary total bycatch for Bay of Fundy in 1998 was estimated at 10 porpoises. Estimates of variance are not available (DFO 1998).

Average estimated harbor porpoise mortality in the Canadian groundfish sink gillnet fishery during 1994-1998 was 52 (Table 2). An estimate of variance is not possible.

## Herring Weirs

Harbor porpoises takes have been observed frequently in Canadian herring weirs, though not recently in USA herring weirs. However, no program has been set up to observer USA fishing weirs. In the Bay of Fundy, weirs are 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). According to state of Maine officials, in 1998, the number of weirs in Maine waters has dropped to nearly zero due to the limited herring market (Jean Chenoweth, pers. comm.). According to Canadian DFO officials, for 1998, there were 225 licenses for herring weirs on the New Brunswick side and 30 from the Nova Scotia side of the Bay of Fundy (In New Brunswick: 60 from Grand Manan Island, 95 from Deer and Campobello Islands, 30 from Passamaquoddy Bay, 35 from East Charlotte area, and 5 from the Saint John area). The number of licenses has been fairly consistent since 1985 (Ed Trippel, pers. comm.). The number of active weirs is less than the number of licenses, and decreasing every year (A. Read, pers. comm.).

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). Due to the cooperative program, out of 263 documented harbor porpoises caught in herring weirs during 1992 to 1994, 57 died while the rest were either released or escaped. The numbers that died during the seining process (and were released alive) were 11 (and 50) in 1992, 33 (and 113) in 1993, and 13 (and 43) in 1994 (Neimanis et al. 1995). Out of 125 documented harbor porpoises caught in herring weirs during 1995 to 1998, 11 died while the rest were either released or escaped. The numbers that died (and
were released alive or escaped) were 5 (and 60) in 1995; 2 (and 4) in 1996; 2 (and 24) in 1997; and 2 (and 26) in 1998 (Westgate, pers. comm.).

Clinical hematology values from 29 harbor porpoises released from Bay of Fundy herring weirs indicated that values were different than that reported in the literature for captive porpoises (Koopman et al. 1999). These data represent a baseline for free-ranging harbor porpoises that can be used as a reference for long-term monitoring of the health of this population, a mandate by the MMPA.

Average estimated harbor porpoise mortality in the Canadian herring weir fishery during 1994-1998 was 4.8 (Table 2). An estimate of variance is not possible.

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 <br> Mortality | Estimated <br> Mortality | $\begin{aligned} & \text { Estimated } \\ & \text { CVs } \end{aligned}$ | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| USA |  |  |  |  |  |  |  |  |
| Northeast Multispecies Sink Gillnet | 94-98 | $\begin{aligned} & 1993=349 \\ & 1998=301 \end{aligned}$ | Obs. Data Weighout, Trip Logbook | $\begin{gathered} .07, .05, .04, \\ .06, .05 \end{gathered}$ | $\begin{gathered} 99^{3}, \\ 43^{3}, 52^{3}, \\ 47^{3}, 12^{3} \end{gathered}$ | $\begin{gathered} 2100^{3}, 1400^{3}, \\ 1200^{3}, 782^{3} \\ 332^{3} \end{gathered}$ | $\begin{gathered} .18, .27, \\ .25, .22, \\ .46 \end{gathered}$ | $\begin{aligned} & 1163 \\ & (.11) \end{aligned}$ |
| Mid-Atlantic Coastal Sink Gillnet | 95-98 ${ }^{4}$ | $1998=302$ | Obs. Data Weighout | $\begin{gathered} .05, .04, .03, \\ .05 \end{gathered}$ | $\begin{aligned} & 6,19 \\ & 32,53 \end{aligned}$ | $\begin{aligned} & 103,311, \\ & 572,446 \end{aligned}$ | $\begin{aligned} & .57, .31, \\ & .35, .36 \end{aligned}$ | $\begin{gathered} 358 \\ (0.20) \end{gathered}$ |
| Pelagic Drift Gillnet | 94-98 | $\begin{aligned} 1994 & =11 \\ 1995 & =12 \\ 1996 & =10 \\ 1997 & =\text { NA }^{5} \\ 1998 & =13 \end{aligned}$ | Obs. Data Logbook | $\begin{gathered} .87, .99, .64, \\ \mathrm{NA}^{5}, .99 \end{gathered}$ | $\begin{gathered} 0, \\ 0,0, \\ \mathrm{NA}^{5}, 0 \end{gathered}$ | $\begin{gathered} 0, \\ 0,0, \\ \mathrm{NA}^{\mathrm{s}}, 0 \end{gathered}$ | $\begin{gathered} 0, \\ 0,0, \\ \mathrm{NA}^{5}, 0 \end{gathered}$ | $\begin{gathered} 0.0^{5} \\ (0) \end{gathered}$ |
| USA TOTAL |  |  |  |  |  |  |  | $\begin{gathered} 1521 \\ (0.10) \end{gathered}$ |
| CANADA |  |  |  |  |  |  |  |  |
| Groundfish Sink Gillnet | 94-98 | $1994=28$ | Obs. Data Can. Trips | $\begin{gathered} .49, .89, .8 \\ .8, .8 \end{gathered}$ | $\begin{gathered} 49,25, \\ 13,19,1 \end{gathered}$ | $\begin{gathered} 101,87,20 \\ 43,10 \end{gathered}$ | NA | $\begin{gathered} 52 \\ \text { (NA) } \end{gathered}$ |
| Herring Weir | 94-98 | $\begin{aligned} & 1998=255 \\ & \text { licenses }^{6} \end{aligned}$ | Coop. Data | NA | $\begin{aligned} & 13,5, \\ & 2,2,2 \end{aligned}$ | $\begin{aligned} & 13,5, \\ & 2,2,2 \end{aligned}$ | NA | $\begin{gathered} 4.8 \\ \text { (NA) } \end{gathered}$ |
| CANADIAN TOTAL |  |  |  |  |  |  |  | $\begin{gathered} 57 \\ \text { (NA) } \end{gathered}$ |
| TOTAL |  |  |  |  |  |  |  | $\begin{array}{r} 1578 \\ \text { (NA) } \\ \hline \end{array}$ |

NA = Not available.
Observer data (Obs. Data) are used to measure bycatch rates; the USA data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program, the Canadian data are collected by DFO. NEFSC collects Weighout (Weighout) landings data, that are used as a measure of total effort for the USA sink gillnet fisheries. The Canadian DFO catch and effort statistical system collected the total number of trips fished by the Canadians (Can. trips), which was the measure of total effort for the Canadian groundfish gillnet fishery. Mandatory trip logbook (Trip Logbook) data are used to determine the spatial distribution of some fishing effort in the Northeast multispecies sink gillnet fishery. Mandatory logbook (Logbook) data, used to measure total effort for the pelagic drift gillnet fishery, are collected at the Southeast Fisheries Science Center (SEFSC). Observed mortalities from herring weirs are collected by a cooperative program between fishermen and Canadian biologists (Coop. Data).
2 The observer coverage for the USA and Canadian sink gillnet fishery is measured in trips, for the pelagic drift gillnet fishery the unit of effort is a set, and for the mid-Atlantic coastal sink gillnet fishery the unit of effort is tons of fish landed.
3 Harbor porpoise taken before 1997 in observed pinger trips were added directly to the estimated total bycatch for that year. During1997, harbor porpoises were taken on non-pingered scientific experimental strings within a time/area stratum that require pingers; and during 1998, harbor porpoises were taken on a pingered string within a stratum that did not require
pingers. In both cases, a weighted bycatch rate was applied to effort from both pingered and non-pingered hauls within that stratum. The weighted bycatch rate was:

$$
\sum_{i}^{\text {ping,non-ping }} \frac{\text { p porpoise }_{i}}{\text { sslandings }_{i}} \cdot \frac{\# \text { hauls }_{i}}{\text { total\#hauls }^{2}}
$$

There were 10, 33, 44, 0, 11, , 0 and 2 observed harbor porpoise takes on pinger trips from 1992 to 1998, respectively, that are included in the observed mortality column. In addition, there were 9,2 , and 1 observed harbor porpoise takes in 1995, 1997, and 1998, respectively, on trips dedicated to fish sampling versus marine mammals, that are included in the observed mortality column (Bisack 1997a).
4 Only data after 1994 are reported because the observed coverages during 1993 and 1994 were negligible during the times of the year when harbor porpoise takes were possible.
$5 \quad$ Fishery closed during 1997. So average bycatch is from 1994, 1995, 1996 and 1998.
6 There were 255 licenses for herring weirs in the Canadian Bay of Fundy region.

## Other Mortality <br> USA

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 have been small. Up until the early 1980's, small kills by native hunters (Passamaquoddy Indians) were reported. In recent years it was believed to have nearly stopped (Polacheck 1989) until recent public media reports in September 1997 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.

During 1993, seventy-three harbor porpoises were reported stranded on beaches from Maine to North Carolina (Table 3; Smithsonian Marine Mammal Database ). Sixty-three of those harbor porpoises were reported stranded in the USA mid-Atlantic region from New York to North Carolina between February and May. Many of the mid-Atlantic 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, one hundred and seven harbor porpoise carcasses were recovered from beaches in Maryland, Virginia, and North Carolina and investigated by scientists. Only juvenile harbor porpoises were present in this sample. Of the 40 harbor porpoises for which cause of death could be established, twenty-five 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).

Records of harbor porpoise strandings prior to 1997 are stored in the Smithsonian's Marine Mammal Database and records from 1997 to present are stored in the NE Regional Office/NMFS strandings and entanglement database. According to these records, the number of harbor porpoises that stranded on beaches from North Carolina to Maine during 1994 to 1998 were 106, 85, 94, 109 and 58, respectively (Table 3). Of these, three stranded alive on a Massachusetts beach in 1996, were tagged, and subsequently released. In 1998, two porpoises that stranded on a New Jersey beach had tags on them indicating they were originally taken on an observed mid-Atlantic coastal gill net vessel. The largest annual number of recorded strandings were from Massachusetts beaches. The states with the next largest numbers were Virginia, New Jersey and North Carolina, in that order. The percent of these strandings that show signs of human interactions is presently being determined.

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.

Table 3. Summary of number of stranded harbor porpoises during January 1, 1994 to December 31, 1998, by state

| State | Year |  |  |  |  | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1994 | 1995 | 1996 | 1997 | 1998 |  |
| Maine | 0 | 0 | 5 | 6 | 5 | 16 |
| New Hampshire | 0 | 0 | 2 | 0 | 0 | 2 |
| Massachusetts ${ }^{1}$ | 9 | 26 | 31 | 20 | 17 | 103 |
| Rhode Island | 3 | 0 | 1 | 1 | 0 | 5 |
| Connecticut | 0 | 0 | 1 | 0 | 0 | 1 |
| New York | 7 | 6 | 3 | 10 | 5 | 31 |
| New Jersey ${ }^{2}$ | 17 | 18 | 12 | 21 | 16 | 84 |
| Delaware | 3 | 4 | 4 | 3 | 7 | 21 |
| Maryland | 10 | 4 | 3 | 10 | 1 | 28 |
| Virginia | 42 | 18 | 20 | 12 | 3 | 95 |
| North Carolina | 15 | 9 | 12 | 26 | 4 | 66 |
| TOTAL | 106 | 85 | 94 | 109 | 58 | 452 |

During 1996 three animals stranded alive on a Massachusetts beach. They were tagged and released.
Two of the porpoises that stranded on a New Jersey beach in 1998 had been previously tagged and released from an observed mid-Atlantic coastal gill net fishing vessel.

## CANADA

Whales and dolphins stranded between 1991 and 1996 on the coast of Nova Scotia were documented by the Nova Scotia Stranding Network (Hooker et al. 1997). Strandings on the beaches of Sable Island were documented by researchers with Fisheries and Oceans, Canada (Lucas and Hooker 1997). Sable Island is approximately 170 km southeast of mainland Nova Scotia. On the mainland of Nova Scotia, a total of eight stranded harbor porpoises were recorded between 1991 and 1996 (Table 4); of these, two were released alive. On Sable Island, two stranded dead harbor porpoises were documented, both in January (Table 4). The harbor porpoises that stranded in the winter (January) were on Sable Island, those in the spring (March to May) were in the Bay of Fundy (2 in Minas Basin and 1 near Yarmouth), and those in the summer (July to September) were scattered along the coast from the Bay of Fundy to Halifax.

Table 4. Documented number of stranded harbor porpoises, by month and year, along the coast of Nova Scotia (Hooker et al. 1997), and on Sable Island (Lucas and Hooker 1996).

| Year | Month | Number of strandings |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Nova <br> Scotia | Sable <br> Island |  |  |  |
| 1991 | May | 1 | 0 |  |  |  |
| 1992 | Jan | 0 | 1 |  |  |  |
| 1993 | Jan | 0 | 1 |  |  |  |
|  | July | 1 | 0 |  |  |  |
|  | Sep | 1 | 0 |  |  |  |
| 1994 | Aug | $1^{*}$ | 0 |  |  |  |
| 1995 | Aug | 1 | 0 |  |  |  |
| 1996 | Mar | 1 | 0 |  |  |  |
|  | Apr | 1 | 0 |  |  |  |
|  | Jul | $1^{*}$ | 0 |  |  |  |
| TOTAL |  |  |  |  | 8 | 2 |

* Released alive.


## USA Management Measures Taken to Reduce Bycatch

A ruling to reduce harbor porpoise bycatch in USA Atlantic gill nets was published in the Federal Register (63 FR 66464) on 01 December 1998 and became effective 01 January1999. The Gulf of Maine portion of the plan pertains to all fishing with sink gillnets and other gillnets capable of catching multispecies in New England waters, from Maine through Rhode Island. This portion of the rule includes time and area closures, some of which are complete closures; others are closed to multispecies gillnet fishing unless pingers are used in the prescribed manner. Also the rule requires those who intend to fish using pingers to attend training and certification sessions on the use of the technology. The mid-Atlantic portion of the plan pertains to waters west of $72^{\circ} 30^{\prime} \mathrm{W}$ longitude to the mid-Atlantic shore line from New York to North Carolina. This portion of the rule includes time and area closures, some of which are complete closures; others are closed to gillnet fishing unless the gear meets certain specifications.

## STATUS OF STOCK

The status of harbor porpoises, relative to OSP, in the USA Atlantic EEZ is unknown. On January 7, 1993, the National Marine Fisheries Service (NMFS) proposed listing the Gulf of Maine harbor porpoise as threatened under the Endangered Species Act (NMFS 1993). On January 5, 1999, NMFS determined the proposed listing was not warranted (NMFS 1999). On or before July 31, 2001, NMFS will make available a review of the biological status of the Gulf of Maine/Bay of Fundy harbor porpoise population. 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 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. Mammal 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 bycatch 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 84(4):1226-1238.
Cox, T. M., A. J. Read, S. Barco, J. Evans, D. P. Gannon, H. N. Koopman, W.A . McLellan, K. Murray, J. Nicolas, D. A. Pabst, C. W. Potter, W. 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. U.S. 96(4):727-734.

CUD [Conservation and Utilization Division]. 1994. Estimating harbor porpoise bycatch in the Gulf of Maine sink gillnet fishery, NOAA, NMFS, NEFSC Ref. Doc. 94-24, Woods Hole, Massachusetts.
DFO [Department of Fisheries and Oceans]. 1998. Harbour porpoise bycatch in the lower Bay of Fundy gillnet fishery. DFO Maritimes Regional Fisheries Status Report 98/7E. [Available from Department of Fisheries and Oceans, Resource management Branch, P.O. Box 550, Halifax, NS B3J 2S7, Canada.]
Gannon, D. P., J. E. Craddock and A. J. Read. 1998. Autumn food habits of harbor porpoises, Phocoena phocoena, in the Gulf of Maine. Fish. Bull. U.S. 96(3):428-437.
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.
Hooker, S. K., R. W. Baird and M. A. Showell. 1997. Cetacean strandings and bycatches in Nova Scotia, Eastern Canada, 1991-1996. Meeting document SC/49/O5 submitted to the 1997 International Whaling Commission Scientific Committee meeting in Bournemouth, UK.
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. 152 pp.
Kingsley, M. C. S. and R. R. Reeves. 1998. Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. Can. J. Zool. 76:1529-1550.

Koopman, H. N., A. J. Westgate and A. J. Read. 1999. Hematology values of wild harbor porpoise (Phocoena phocoena) from the Bay of Fundy Canada. Mar. Mammal Sci. 15(1):52-64.
Kraus, S. D. and S. Brault. (in press). A springtime field test of the use of pingers to reduce incidental mortality of harbor porpoises in gillnets. Rep. int. Whal. Comm
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.
Lucas, Z. N. and S. K. Hooker. 1997. Cetacean strandings on Sable Island, Nova Scotia, 1990-1996. Meeting document SC/49/O6 submitted to the 1997 International Whaling Commission Scientific Committee meeting in Bournemouth, UK.
Neimanis, A. S., A. J. Read, A. J. Westgate, H. N. Koopman, J. Y. Wang, L. D. Murison and D. E. Gaskin. 1995. Entrapment of harbour porpoises (Phocoena phocoena) in herring weirs in the Bay of Fundy, Canada. Working paper SC/47/Sm18 for the International Whaling Commission, Dublin, Ireland.
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]. 1999. Listing of Gulf of Maine/Bay of Fundy population of harbor porpoise as threatened under the Endangered Species Act. Federal Register 64 (2): 465-471, January 05, 1999.
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. Final report to the Northeast Fisheries Science Center, Contract No. 40ENNF500160.
Palka, D. 1996. Update on abundance of Gulf of Maine/Bay of Fundy harbor porpoises. NOAA/NMFS/NEFSC Ref. Doc. 96-04; 37 pp. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 025431026.

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. (ed). 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. .
Palka, D. L., A. J. Read, A. J. Westgate and D. W. Johnston. 1996. Summary of current knowledge of harbour porpoises in U.S. and Canadian Atlantic waters. Rep. int Whal. Commn 46:559-565.
Polacheck, T. 1989. Harbor porpoises and the gillnet fishery. Oceanus 32(1):63-70.
Polacheck, T., F. W. Wenzel, and G. Early. 1995. What do stranding data say about harbor porpoises (Phocoena phocoena). 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. U.S. 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. Mammal Sci. 11(4)423-440.
Rosel, P. E., S. C. France, J. Y. Wang and T. D. Kocher. 1999. Genetic structure of harbour porpoise Phocoena phocoena populations in the northwest Atlantic based on mitochondrial and nuclear markers. Molecular Ecology 8: S41S54.
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 bycatch 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.

Trippel, E. A., M. B. Strong, J. M. Terhune and J. D. Conway. 1999. Mitigation of harbour porpoise (Phocoena phocoena) bycatch in the gillnet fishery in the lower Bay of Fundy. Can. J. Fish. Aquat. Sci. 56:113-123.
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 Sciences 53:1632-45.
Walden, J. 1996. The New England gillnet effort study. NOAA, NMFS, NEFSC Ref. Doc. No. 96-10, 38 pp. Northeast Fisheries Science Center, Woods Hole, Massachusetts.
Westgate, A. J. and K. A. Tolley. 1999. Geographical differences in organochlorine contaminants in harbour porpoises Phocoena phocoena from the western North Atlantic. Marine Ecology-Progress Series 177:255-268.
Westgate, A. J., A. J. Read, T. M. Cox, T. D. Schofield, B. R. Whitaker and K. E. Anderson. 1998. Monitoring a rehabilitated harbor porpoise using satellite telemetry. Mar. Mammal Sci. 14(3):599-604.
Westgate, A. J., D. C. G. Muir, D. E. Gaskin and M. C. S. 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. 48:2429-35.

## HARBOR SEAL (Phoca vitulina): Western North Atlantic Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The harbor seal is found in all nearshore waters of the Atlantic Ocean and adjoining seas above about 30 degrees latitude (Katona et al. 1993). In the western North Atlantic, they are distributed 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 USA and Canadian coasts represent one population (Temte et al. 1991). Breeding and pupping normally occur 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). In recent years, their seasonal interval along the southern New England to New Jersery coasts has increased (Barlas 1999; Hoover et al. 1999; Slocum et al. 1999). (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; Barlas 1999). 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; Barlas 1999). The overall geographic range throughout coastal New England has not changed significantly during the last century (Payne and Selzer 1989).

The majority of animals seals moving into southern New England and mid-Atlantic waters are are subadults and juveniles (Whitman and Payne 1990; Katona et al. 1993; Slocum et al. 1999). 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 fivefold. 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 between the Maine/New Hampshire border to eastern Long Island, and New Jersey (Payne and Selzer 1989; Rough 1995; Barlas 1999; Kerri et al. 1999; Slocum et al. 1999) (Table 1). Canadian scientists counted harbor seals during an August 1992 aerial survey in the Bay of Fundy (Stobo and Fowler 1994) (Table 1), 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 $\left(\mathrm{N}_{\text {min }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\min }$ | CV |
| :--- | :--- | ---: | ---: |
| 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 |
| Spring 1999 | Southern New England | 6,083 | 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 by 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). Further, the best estimate of harbor seals in southern New England is 6,083 (Table 1) is $23 \%$ greater than the peak count $(4,915)$ reported by Payne and Selzer (1989). Possible factors contributing to harbor seal population 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 recovery factor $\left(\mathrm{F}_{\mathrm{R}}\right)$ for this stock is 1.0 , the value for stocks of unknown status, but known to be increasing. PBR for USA waters is 1,859 .

## ANNUAL HUMAN-CAUSED MORTALITY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 was 873 harbor seals ( $\mathrm{CV}=0.12$; Table 2).

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 mariculture industry (i.e., salmon farming), and by deliberate shooting (NMFS unpublished data).

## Fishery Information <br> USA

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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.

## Northeast Multispecies Sink Gillnet:

In 1993, there were approximately 349 full and part-time vessels in the Northeast 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. In 1998, there were approximately 301 vessels in this fishery (NMFS unpublished data). Observer coverage in terms of trips has been $1 \%, 6 \%$, $7 \%, 5 \%, 7 \%, 5 \%, 4 \%, 6 \%$, and $5 \%$ for 1990 to 1998 , respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. There were 287 harbor seal mortalities, excluding three animals taken in the 1994 pinger experiment (NMFS unpublished data), observed in the Northeast multispecies sink gillnet fishery between 1990 and 1998. Annual estimates of harbor seal bycatch in the Northeast multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990-1998 were 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), 911 in 1996 ( 0.27 ), 598 in 1997 ( 0.26 ), and 332 in 1998 ( 0.33 ). The 1994 and 1995 bycatches, 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 bycatch 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 1994-1998 was 870 harbor seals (CV=0.12). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The bycatch occurred in Massachusetts Bay, south of Cape Ann and west of Stellwagen Bank during January-March. Bycatch 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 OctoberDecember.

## Mid-Atlantic Coastal Gillnet

Observer coverage of the USA 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 1995221 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\% 4\%, and 3\%, and 5\% for 1995, 1996, 1997, and 1998 (Table 2).

No harbor seals were taken in observed trips during 1993-1997. Two harbor seals were observed taken in 1998 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 0 in 1995-1997, and 11 in 1998 (0.77). Average annual estimated fisheryrelated mortality attributable to this fishery during 1995-1998 was 3 harbor seals ( $\mathrm{CV}=0.77$ )

## 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 bycatches 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 <br> Coverage $^{2}$ | Observed <br> Mortality | Estimated <br> Mortality | Estimated <br> CVs | Mean <br> Annual <br> Mortality |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| New England <br> Multispecies <br> Sink Gillnet | $94-98$ | 301 | Obs. Data <br> Weighout, <br> Logbooks | $.07, .05$, <br> $.04, .06$, <br> .05 | 86,56, <br> $36,48,15$ | 1330,1179, <br> 911,598, <br> 332 | $.25, .21$, <br> $.27, .26$, <br> .33 | 870 <br> $(0.12)$ |
| Mid-Atlantic <br> Coastal Sink <br> Gillnet | $95-98$ | NA | Obs. Data <br> Weighout | $.05, .04$, <br> $.03, .05$ | $0,0,0,2$ | $0,0,0,11$ | $0,0,0, .77$ | 3 <br> $(0.77)$ |
| TOTAL |  |  |  |  | 8 |  |  |  |

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 sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of some fishing effort in the Northeast multispecies sink gillnet fishery.
2 The effort for the Northeast multispecies sink gillnet fishery is measured in trips. Observer coverage of the midAtlantic coastal sink gillnet fishery is measured in tons of fish landed.
3 In 1994, 1995, 1996, and 1997 respectively, observed mortality on "marine mammal trips" was 59, 41, 37, and 14 animals. Only these mortalities were used to estimate total harbor seal bycatch. 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". In 1997, one animal was taken on a "fish trip," and 14 harbor seals were taken on pingered trips. See Bisack (1997) for "trip" type definitions. In 1998 two observed animals were taken of "fish trips" and one common dolphin was taken on pingered trip.

## Other Mortality

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 USA waters (Katona et al. 1993).

Annually, small numbers of harbor seals regularly strand throughout their migratory range. Most reported strandings, however, occur during the winter period in southern New England and mid- Atlantic regions (NMFS unpublished data). Sources of mortality include human interactions (boat strikes and fishing gear, power plant intake (1220 per year; NMFS unpublished data), oil, shooting (around salmon aquaculture sites and fixed fishing gear), 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).

The 1992-1996 harbor seal strandings data are currently under review. In 1995 one stranding was in South Carolina. In 1997 and 1998, 153 and 256, respectively, harbor seal stranding were reported. Strandings were reported in all states between Maine and North Carolina, and in 1997 one each was in Georgia and Florida. Maine (174/409), Massachusetts (83/409), New York (53/409) and New Jersey (25/409) accounted for most of the strandings, reflecting both
long coastlines and habitat use. Forty-one of the stranded animals during this two year period showed signs of human interactions: fishery (10), vessel strike (3), power plant (16), and other (12).

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 USA 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 fishery-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. MC. 70 pp.
Barlas, M.E. 1999. The distribution and abundance of harbor seals (Phoca vitulina concolor) and gray seals (Halichoerus grypus) in southern New England, winter 1998- summer 1999. MA Thesis, Boston University, Graduate School of Arts and Sciences., Boston, MA. 52 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 bycatch 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.
Hoover, K., S. Sadove and P. Forestell. 1999. Trends of harbor seal, Phoca vitulina, abundance from aerial surveys in New York waters: 1985-1999. Proceedings of the $13^{\text {th }}$ Biennial Conference on the Biology of Marine Mammals, Wailea, Hawaii, Nov. 28 - Dec. 3, 1999. (Abstract).
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. Final Report Contract No. 50-EANF-2-00064, NOAA, NMFS, NEFSC, Woods Hole, MA. 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. Mammal 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.

Slocum, C.J., R. Schoelkopf, S. Tulevech, M. Stevens, S. Evert and M. Moyer. 1999. Seal populations wintering in New Jersey (USA) have increased in abundance and diversity. Proceedings of the $13^{\text {th }}$ Biennial Conference on the Biology of Marine Mammals, Wailea, Hawaii, Nov. 28 - Dec. 3, 1999. (Abstract).
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. 38 pp.
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 on both sides of the North Atlantic, with three major populations: in eastern Canada; northwestern Europe and the Baltic Sea (Katona et al. 1993). The western North Atlantic population occurs from New England to Labrador and is centered in the Sable 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 North Atlantic stock is distributed and breeds principally in eastern Canadian waters (Mansfield 1966). There are two breeding concentrations in eastern Canada; one at Sable Island, and a second that breeds on the pack ice in the Gulf of St. Lawrence (Hammill et al. 1998). Tagging studies indicate that there is little intermixing between the two breeding groups (Zwanenberg and Bowen 1990), and for management purposes, they are treated as separate populations (Mohn and Bowen 1996). 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 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 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). From December 1998 to July 1999 the Northeast Fisheries Science Center conducted aerial surveys in the same region surveyed by Payne and Selzer (1989) and Rough (1995). The peak gray seal count in the region between Isle of Shoals, New Hampshire and Woods Hole, Massachusetts was 5,611 (5/21/99). No gray seals were recorded at haulout sites between Newport, Rhode Island and Montauk Pt., New York (Barlas 1999). The 1999 count is 2.8 times greater than the 1994 count. Ninety three percent of the gray seals were located at two sites in the eastern end of Nantucket Sound. Fifty-four percent of the seasonal count was on Muskeget Island and adjacent sand bars in Nantucket sound, and $39 \%$ was on Monomoy Island.

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 $\left(\mathrm{N}_{\text {min }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\min }$ | CV |
| :---: | :---: | :---: | :---: |
| 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 <br> (only USA portion of stock) | 2,010 | none reported |
| Spring 1999 | Muskeget Island and Monomoy, MA <br> (only USA portion of stock) | 5,611 | none reported |

## Minimum Population Estimate

At the November 1998 meeting of the Atlantic Scientific Review Group (SRG), the SRG recommended that the minimum estimate $(2,010)$ used in previous assessments be discontinued, because it can not be determined what part of the mortality comes from the Massachusettes, Maine, and Sable Island portions of the population. Therefore, present data are insufficient to calculate the minimum population estimate for USA waters. It is estimated that there are at least 143,000 gray seals in Canada (Mohn and Bowen 1996).

## Current Population Trend

Gray seal abundance is likely increasing in the USA Atlantic Exclusive Economic Zone (EEZ), but the rate of 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 (Stobo and Zwanenberg 1990; Mohn and Bowen 1996); whereas, in the Gulf of St. Lawrence it is increasing at a slower rate of $7.4 \%$ (Hammill et al. 1998). 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). Gray seal pups were recorded on three flight days during the 1998/99 winter surveys ( 26 January, 9 February, and 10 March). On 9 February, 77 gray seal pups ( 59 on Muskeget Island and 18 on South Monomoy) were recorded (Barlas 1999). These observations continue the increasing trend in pup production reported by Rough (1995). The change in gray seal counts at Muskeget and Monomoy from 2,010 in 1994 to 5,611 in 1999 represents an annual increase rate of $20.5 \%$, however it can not be determined what proportion of the increase represents growth and immigration.

## 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 unknown. The maximum productivity rate is 0.12 , the default value for pinnipeds. The recovery factor $\left(\mathrm{F}_{\mathrm{R}}\right)$ for this stock is 1.0 , the value for stocks of unknown status, but known to be increasing. PBR for the western North Atlantic gray seals in USA waters is unknown. Applying the formula to the minimum population estimate for Canadian waters results in a "PBR" of 8,850 gray seals.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 was 75 gray seals (CV=0.28; Table 2).

## Fishery Information

## USA

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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.

## Northeast Multispecies Sink Gillnet:

In 1993, there were approximately 349 full and part-time vessels in the Northeast 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. In 1998, there were approximately 301 vessels in this fishery (NMFS unpublished data). Observer coverage in terms of trips has been $1 \%, 6 \%$, $7 \%, 5 \%, 7 \%, 5 \%, 4 \%, 6 \%$, and $5 \%$ for 1990 to 1998 , respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. There were 35 gray seal mortalities observed in the Northeast multispecies sink gillnet fishery between 1993-1998 (Table 2). Nineteen 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.

Annual estimates of gray seal bycatch in the Northeast 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 ), 49 in 1996 ( 0.49 ), 131 in 1997 ( 0.50 ), and 61 in 1998 ( 0.98 ). The 1995 bycatch 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 bycatch 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 1994-1998 was 75 gray seals ( $\mathrm{CV}=0.28$ ). 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 bycatches 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 <br> Coverage $^{2}$ | Observed <br> Mortality $^{3}$ | Estimated <br> Mortality $^{3}$ | Estimated <br> CVs | Mean Annual <br> Mortality |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Northeast <br> Multispecies <br> Sink Gillnet | $94-98$ | 301 | Obs. Data <br> Weighout, | $.07, .05$, <br> $.04, .06$, <br> Logbooks | $3,7,3$, <br> 16,4 | $19,117,49$, <br> 131,61 | $.95, .42$, <br> $.49, .50$, <br> .98 | $75(0.28)$ |
| TOTAL |  |  |  |  |  |  |  |  |

> 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 sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of some fishing effort in the Northeast multispecies sink gillnet fishery.
> 2 The observer coverage for the Northeast multispecies sink gillnet fishery is measured in trips.
> 3 In 1994, 1995 and 1998 respectively, observed mortality on "marine mammal trips" was 2, 6 and 3 animals. Only these mortalities were used to estimate total gray seal bycatch. In 1994, 1995 and 1998 one mortality in each year was recorded on a "fish trip." See Bisack (1997) for "trip" type definitions. In 1997 all observed takes were on marine mammal trips, including 12 taken on pingered trips. In 1998 takes from nonpingered nets within a marine mammal time/area closure that required pingers were pooled with the takes from nets with pingers from the same stratum. The pooled bycatch rate was weighted by the total number of samples taken from the stratum and used to estimate the mortality. In 1998 one take was observed in a net without a pinger that was within a marine mammal closure that required pingers.

## Other Mortality

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 USA waters (Rough 1995). 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).

The 1992-1996 gray seal strandings data are currently under review. In 1997-1998, 103 gray seal stranding were recorded, extending from Maine (17) to Maryland (2). Most of the stranding were in Maine (17), Massachusetts (28), and New York (28). Thirteen animals showed signs of human interactions: fishery (3), power plant (2), oil spill (4), shot (1), mutilated (1), other (2). 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 USA Atlantic EEZ waters is unknown, but the populations appear to be increasing in Canadian and USA waters. The species is not listed as threatened or endangered under the Endangered Species Act. Recent data indicate that this population is increasing. 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 USA 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. 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.
Bonner, W. N. 1981. Grey seal, Halicoerus grypus. In: S. H. Ridgway and R. J. Harrison (eds.), Handbook of Marine Mammals, Vol. 2. Pp. 111-144. London: Academic Press.
Barlas, M.E. 1999. The distribution and abundance of harbor seals (Phoca vitulina concolor) and gray seals (Halichoerus grypus) in southern New England, winter 1998- summer 1999. MA Thesis, Boston University, Graduate School of Arts and Sciences., Boston, MA. 52 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.

Bravington, M. V. and K. D. Bisack. 1996. Estimates of harbor porpoise bycatch 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. Ridgway 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.
Hammill, M.O., G.B. Stenson, R.A. Myers and W.T. Stobo. 1998. Pup production and population trends of the grey seal (Halichoerus grypus) in the Gulf of St. Lawrence. Can. J. Fish. Aquat. Sci. 55:423-430.
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 .
Mansfield, A.W. 1966. The grey seal in eastern Canadian waters. Can. Audubon Mag. 28:161-166.
Mohn, R. and W. D. Bowen. 1996. Grey seal predation on the eastern Scotian Shelf: Modelling the impact on Atlantic cod. Can. J. Aquat. Sci. 53:2722-2738.
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. Mammal 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.
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 (ed), 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. 38 pp.
Zwanenberg, K.C.T. and W.D. Bowen. 1990. Population trends of the grey seal (Halichoerus grypus) in eastern Canada. Pgs. 185-197 in: W.D. Bowen (ed.), Population Biology of Sealworm (Pseudoterranova decipiens) in Relation to its Intermediate and Seal Hosts. Can. Bull. Fish. and Aq. Sci. 222.

## 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 most southern 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 USA Atlantic Exclusive Economic Zone (EEZ) during winter and spring. The increase in numbers and geographic distribution of harp seals in New England to midAtlantic waters is based primarily on strandings, and secondarily on fishery bycatch (McAlpine and Walker 1990; Rubinstein 1994).

## 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 that 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).

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). 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 (Table1).

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 $\left(\mathrm{N}_{\min }\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\min }$ | CV |
| :---: | :---: | :---: | :---: |
| 1994 | Eastern Atlantic Canada-Labrador | 702,900 pups | 0.09 |
| 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 USA waters. It is estimated there are at least 4.8 million harp seals in Canada (Shelton et al. 1996).

## Current population trend

The population appears to be increasing in USA waters, judging from the increased number of stranded harp seals, but the magnitude of the suspected increase is unknown. 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 "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) was set at 1.0 because it was believed that harp seals are within OSP. PBR for the western North Atlantic harp seal in USA 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

Total annual estimated average fishery-related mortality or serious injury to this stock during 1994-1998 was 402 harp seals $\mathrm{CV}=0.26$; Table 2).

## Fishery Information

USA
Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries 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 bycatch has been observed by NMFS Sea Samplers in the Northeast 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.

## Northeast Multispecies Sink Gillnet:

In 1993, there were approximately 349 full and part-time vessels in the Northeast 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. In 1998, there were approximately 310 vessels in this fishery (NMFS unpublished data). Observer coverage in terms of trips has been $1 \%, 6 \%$, $7 \%, 5 \%, 7 \%, 5 \%, 4 \%, 6 \%$, and $5 \%$ for 1990 to 1998, respectively. The fishery has been observed in the Gulf of Maine and in Southern New England. There were 114 harp seal mortalities observed in the Northeast multispecies sink gillnet fishery between 1990 and 1998. Annual estimates of harp seal bycatch in the Northeast multispecies sink gillnet fishery reflect seasonal distribution of the species and of fishing effort. Estimated annual mortalities (CV in parentheses) from this fishery during 1990-1998 was zero (1990-1993), 861 in 1994 (0.58), 694 in 1995 ( 0.27 ), 89 in 1996 (0.55), 269 in 1997
(0.50), and 78 in 1998 (0.48). The 1994 and 1995 bycatches, 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 bycatch 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 19941998 was 398 harp seals (CV=0.26). The stratification design used is the same as that for harbor porpoise (Bravington and Bisack 1996). The bycatch occurred principally in winter (January-May) and was mainly in waters between Cape Ann and New Hampshire. One observed winter mortality was in waters south of Cape Cod.

## Mid-Atlantic Coastal Gillnet:

Observer coverage of the USA 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 1995221 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 $5 \% 4 \%$, and $3 \%$, and $5 \%$ for 1995, 1996, and 1997, and 1998 (Table 2).

No harp seals were taken in observed trips during 1993-1997. One harp seal was observed taken in 1998 (Table 2). Observed effort was concentrated off NJ and scattered between DE and NC from 1 to 50 miles off the beach. All bycatches were documented during January to April. Using the observed takes, the estimated annual mortality (CV in parentheses) attributed to this fishery was 0 in 1995-1997 (0), and 17 in 1998 (1.02). Average annual estimated fisheryrelated mortality attributable to this fishery during 1995-1998 was 4.3 harp seals ( $\mathrm{CV}=1.02$ )

## 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 bycatches 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 <br> Coverage $^{2}$ | Observed <br> Mortality $^{3}$ | Estimated <br> Mortality | Estimated <br> CVs | Mean Annual <br> Mortality |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Northeast <br> Multispecies <br> Sink Gillnet | $94-98$ | 301 | Obs. Data <br> Weighout, <br> Logbooks | $.07, .05$, <br> $.04, .06$, <br> .05 | $33,27,9$, <br> 40,4 | 861,694, <br> $89,269,78$ | $.58, .27$, <br> .55, <br> .48 | $398(0.26)$ |
| Mid Atlantic <br> Coastal Sink <br> Gillnet | $95-98$ | Unk $^{4}$ | Obs. Data <br> Weighout | $.05, .04$, <br> $.03, .05$ | $0,0,0,1$ | $0,0,0,17$ | $0,0,0$, <br> 1.02 | $4(1.02)$ |
| TOTAL |  |  |  |  | $402(0.26)$ |  |  |  |

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 sink gillnet fishery. Mandatory logbook (Logbook) data are used to determine the spatial distribution of some fishing effort in the Northeast multispecies sink gillnet fishery.
${ }^{2}$ The observer coverage for the Northeast multispecies sink gillnet fishery is measured in trips. Observer coverage for the Mid Atlantic coastal sink gillnet fishery is measured in tons of fish landed.
${ }^{3}$ In the New England sink gillnet fishery thirty-one and zero harp seals were taken on pingered trips during 1997 and 1998, respectively. During 1997 and 1998 thirty-one and four harp seals were observed on "mammal trips", respectively. See Bisack (1997) for "trip" type definitions.
4 Number of vessels is not known.

## Other Mortality

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 19711982, 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, and animals that are killed but not landed (struck and lost) (Lavine 1999).

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, New England Aquarium, pers. comm.). In addition, in 1996 there was a stranding in North Carolina. From 1997-1998 224 strandings were recorded, including one in North Carolina. Most of the strandings occurred in Maine (27), Massachusetts (51), New Jersey (21), and New York (92). Few animals showed signs of human interactions, and except for one shot animal the interactions were classified as other. The increased number of strandings may indicate a possible shift in distribution or expansion southward into USA waters.

## STATUS OF STOCK

The status of the harp seal stock, relative to OSP, in the USA 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 USA 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 bycatch in the Gulf of Maine sink gillnet fishery, 1990-93. Rep. int Whal. Commn. 46:567-574.
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. 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. 1999. Estimating total kill of Northwest Atlantic harp seals, 1994-1998. Mar. Mammal Sci., 15(3):871878.

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 .
McAlpine, D. F. and R. H. Walker. 1990. Extralimital records of the harp seal, Phoca groenlandica, from the western North Atlantic: a review. Mar. Mammal Sci. 6:243-247.
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. 38 pp.

# BOTTLENOSE DOLPHIN (Tursiops truncatus): Gulf of Mexico Bay, Sound, and Estuarine Stocks 

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Bottlenose dolphins are distributed throughout the bays, sounds, and estuaries of the Gulf of Mexico (Mullin 1988). The identification of biologically-meaningful "stocks" of bottlenose dolphins in these waters is complicated by the high degree of behavioral variability exhibited by this species (Shane et al. 1986; Wells and Scott 1999), and by the lack of requisite information for much of the region.

Previous stock assessment reports have provisionally identified distinct stocks in each of 33 areas of contiguous, enclosed, or semi-enclosed bodies of water adjacent to the Gulf of Mexico (Table 1, Waring et al. 1997), based on descriptions of relatively discrete dolphin "communities" in some of these areas. A "community" includes resident dolphins that regularly share large portions of their ranges, exhibit similar distinct genetic profiles, and interact with each other to a much greater extent than with dolphins in adjacent waters. The term, as adapted from Wells et al. (1987), emphasizes geographic, genetic, and social relationships of dolphins. Bottlenose dolphin communities do not constitute closed demographic populations, as individuals from adjacent communities are known to interbreed. Nevertheless, the geographic nature of these areas and long-term stability of residency patterns suggest that many of these communities exist as functioning units of their ecosystems and, under the Marine Mammal Protection Act, must be maintained as such. Also, the stable patterns of residency observed within communities suggest that long periods would be required to repopulate the home range of a community were it eradicated or severely depleted. Thus, in the absence of information supporting management on a larger scale, it is appropriate to adopt a risk-averse approach and focus management efforts at the level of the community rather than at some larger demographic scale. Support for this risk-averse approach derives from several sources. Long-term (year-round, multi-year) residency by at least some individuals has been reported from nearly every site where photographic identification or tagging studies have been conducted in the Gulf of Mexico. In Texas, some of the dolphins in the Matagorda-Espiritu Santo Bay area (Gruber 1981; Lynn 1995; Würsig and Lynn 1996), Aransas Pass (Shane 1977; Weller 1998), San Luis Pass (Maze 1997), and Galveston Bay (Bräger 1993; Bräger et al. 1994; Fertl 1994) have been reported as long-term residents. Hubard (1998) reported sightings of dolphins tagged 12-15 years previously in Mississippi Sound. In Florida, long-term residency has been reported from Choctawhatchee Bay (1989-1993, F. Townsend unpublished data), Tampa Bay (Wells 1986a; Wells et al. 1996a), Sarasota Bay (Irvine and Wells 1972; Irvine et al. 1981; Wells 1986a, 1991; Scott et al. 1990; Wells et al. 1987), Lemon Bay (Wells et al. 1996b), and Charlotte Harbor/Pine Island Sound (Shane 1990; Wells et al. 1996b, 1997). In many cases, residents emphasize use of the bay, sound, or estuary waters, with limited movements through passes to the Gulf of Mexico (Shane 1977, 1990; Gruber 1981; Irvine et al. 1981; Lynn 1995, Maze 1997). These habitat use patterns are reflected in the ecology of the dolphins in some areas; for example, residents of Sarasota Bay, Florida lacked squid in their diet, unlike non-resident dolphins stranded on nearby Gulf beaches (Barros and Wells 1998).

Genetic data also support the concept of relatively discrete bay, sound, and estuary stocks. Analyses of mitochondrial DNA haplotype distributions indicate the existence of clinal variations along the Gulf of Mexico coastline (Duffield and Wells In press). Differences in reproductive seasonality from site to site also suggest genetic-based distinctions between communities (Urian et al. 1996). Mitochondrial DNA analyses suggest finer-scale structural levels as well. For example, Matagorda Bay, Texas dolphins appear to be a localized population (NMFS unpublished data), and differences in haplotype frequencies distinguish between adjacent communities in Tampa Bay, Sarasota Bay, and Charlotte Harbor/Pine Island Sound, along the central west coast of Florida (Duffield and Wells 1991; in press). Examination of protein electrophoretic data resulted in similar conclusions for the Florida dolphins (Duffield and Wells 1986).

The long-term structure and stability of at least some of these communities is exemplified by the residents of Sarasota Bay, Florida. This community has been observed since 1970 (Irvine and Wells 1972; Scott et al. 1990; Wells 1991). The number of dolphins regularly occupying the Sarasota Bay area has remained consistently at about 100. At least four generations of identifiable residents currently inhabit the region, including half of those first identified in 1970. Maximum immigration and emigration rates of about 2-3\% have been estimated (Wells and Scott 1990).

Genetic exchange occurs between resident communities; hence the application of the demographically and behaviorally-based term "community" rather than "population" (Wells 1986a). Some of the calves in Sarasota Bay apparently have been sired by non-residents (Duffield and Wells, in press). A variety of potential exchange mechanisms
occur in the Gulf. Small numbers of inshore dolphins traveling between regions have been reported, with patterns ranging from traveling through adjacent communities (Wells 1986b; Wells et al. 1996a,b) to movements over distances of several hundred km in Texas waters (Gruber 1981; Würsig and Lynn 1996; Würsig unpublished data). In many areas year-round residents co-occur with non-resident dolphins, providing potential opportunities for genetic exchange. About $17 \%$ of group sightings involving resident Sarasota Bay dolphins include at least one non-resident as well (Wells et al. 1987). Similar mixing of inshore residents and non-residents is seen off San Luis Pass, Texas (Maze 1997). Non-residents exhibit a variety of patterns, ranging from apparent nomadism recorded as transience in a given area, to apparent seasonal or nonseasonal migrations. Passes, especially the mouths of the larger estuaries, serve as mixing areas. For example, several communities mix at the mouth of Tampa Bay, Florida (Wells 1986a), and most of the dolphins identified in the mouths of Galveston Bay and Aransas Pass, Texas were considered transients (Henningsen 1991; Bräger 1993; Weller 1998).

Seasonal movements of dolphins into and out of some of the bays, sounds, and estuaries provide additional opportunities for genetic exchange with residents, and complicate the identification of stocks in coastal and inshore waters. In small bay systems such as Sarasota Bay, Florida and San Luis Pass, Texas residents move into Gulf coastal waters in fall/winter, and return inshore in spring/summer (Irvine et al. 1981; Maze 1997). In larger bay systems, seasonal changes in abundance suggest possible migrations, with increases in more northerly bay systems in summer, and in more southerly systems in winter. Fall/winter increases in abundance have been noted for Matagorda Bay (Gruber 1981; Lynn 1995; Würsig and Lynn 1996), Aransas Pass (Shane 1977; Weller 1998), Tampa Bay (Scott et al. 1989), and Charlotte Harbor/Pine Island Sound (Thompson 1981; Scott et al. 1989). Spring/summer increases in abundance have been reported for Galveston Bay (Henningsen 1991; Bräger 1993; Fertl 1994) and Mississippi Sound (Hubard 1998). M u c h uncertainty remains regarding the structure of bottlenose dolphin stocks in many of the Gulf of Mexico bays, sounds, and estuaries. Given the apparent co-occurrence of resident and non-resident dolphins in these areas, and the demonstrated variations in abundance, it appears that consideration should be given to the existence of a complex of stocks, and to the roles of bays, sounds, and estuaries for stocks emphasizing Gulf of Mexico coastal waters. A starting point for management strategy should be the protection of the long-term resident communities, with their multi-generational geographic, genetic, demographic, and social stability. These localized units would be at greatest risk from geographically-localized impacts. Complete characterization of many of these basic units would benefit from additional photo-identification, telemetry, and genetic research (Wells 1994).

The current provisional stocks follow the designations in Table 1, with a few revisions. Available information suggests that Block B35, Little Sarasota Bay, can be subsumed under Sarasota Bay, and B36, Caloosahatchee River, can be considered a part of Pine Island Sound. As more information becomes available, additional combination or division may be warranted. For example, a number of geographically and socially distinct subgroupings of dolphins in regions such as Tampa Bay, Charlotte Harbor, Pine Island Sound, Aransas Pass, and Matagorda Bay have been identified, but the importance of these distinctions to stock designations remain undetermined (Shane 1977; Gruber 1981; Wells et al. 1996a,b, 1997; Würsig and Lynn 1996).

Understanding the full complement of the stock complex using the bay, sound, and estuarine waters of the Gulf of Mexico will require much additional information. The development of biologically-based criteria to better define and manage stocks in this region should integrate multiple approaches, including studies of ranging patterns, genetics, morphology, social patterns, distribution, life history, stomach contents, isozyme analyses, and contaminant concentrations. Spatially-explicit population modeling could aid in evaluating the implications of community-based stock definition. As these studies provide new information on what constitutes a bottlenose dolphin "biological stock," current provisional definitions will likely need to be revised. As stocks are more clearly identified, it will be possible to conduct abundance estimates using standardized methodology across sites (thereby avoiding some of the previous problems of mixing results of aerial and boat-based surveys), identify fisheries and other human impacts relative to specific stocks, and perform individual stock assessments. As recommended by the Atlantic Scientific Review Group (November 1998, Portland, Maine), a workshop was held from March 13-15, 2000 in Sarasota, FL to review current information pertaining to bottlenose dolphin stock structure in Gulf of Mexico bays, sounds, and estuaries. As a result of this, efforts are being made to conduct simulations of alternative stock structure and, if warranted, propose a new stock structure.

Table 1. Bottlenose dolphin abundance $\left(\mathrm{N}_{\mathrm{BEST}}\right)$, coefficient of variation (CV), minimum population estimate $\left(\mathrm{N}_{\text {miN }}\right)$, and Potential Biological Removal (PBR) in USA Gulf of Mexico bays, sounds, and other estuaries. Blocks refer to aerial survey blocks illustrated in Fig. 1. Blocks with an abundance of zero were surveyed but not considered stocks at this time (but see Note 1 below).

| Blocks | Gulf of Mexico Estuary | $\mathbf{N}_{\text {beST }}$ | CV | $\mathbf{N}_{\text {MIN }}$ | PBR | Year | Reference |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| B51 | Laguna Madre | 80 | 1.57 | 31 | 0.3 | 1992 | A |
| B52 | Nueces Bay, Corpus Christi Bay | 58 | 0.61 | 36 | 0.4 | 1992 | A |
| B50 | Compano Bay, Aransas Bay, San Antonio Bay, Redfish Bay, Espiritu Santo Bay | 55 | 0.82 | 30 | 0.3 | 1992 | A |
| B54 | Matagorda Bay, Tres Palacios Bay, Lavaca Bay | 61 | 0.45 | 42 | 0.4 | 1992 | A |
| B55 | West Bay | 29 | 1.10 | 14 | 0.1 | 1992 | A |
| B56 | Galveston Bay, East Bay, Trinity Bay | 152 | 0.43 | 107 | 1.1 | 1992 | A |
| B57 | Sabine Lake | $0{ }^{1}$ | - |  |  | 1992 | A |
| B58 | Calcasieu Lake | $0^{1}$ | - |  |  | 1992 | A |
| B59 | Vermillion Bay, West Cote Blanche Bay, Atchafalaya Bay | $0^{1}$ | ${ }^{-}$ |  |  | 1992 | A |
| B60 | TerreBonne Bay, Timbalier Bay | 100 | 0.53 | 66 | 0.7 | 1993 | A |
| B61 | Barataria Bay | 219 | 0.55 | 142 | 1.4 | 1993 | A |
| B30 | Mississippi River Delta | $0^{1}$ | - |  |  | 1993 | A |
| B02-05, | Bay Boudreau, Mississippi Sound | 1,401 | 0.13 | 1,256 | 13 | 1993 | A |
| 29,31 |  |  |  |  |  |  |  |
| B06 | Mobile Bay, Bonsecour Bay | 122 | 0.34 | 92 | 0.9 | 1993 | A |
| B07 | Perdido Bay | $0{ }^{1}$ | - |  |  | 1993 | A |
| B08 | Pensacola Bay, East Bay | 33 | 0.80 | 18 | 0.2 | 1993 | A |
| B09 | Choctawhatchee Bay | 242 | 0.31 | 188 | 1.9 | 1993 | A |
| B10 | St. Andrew Bay | 124 | 0.57 | 79 | 0.8 | 1993 | A |
| B11 | St. Joseph Bay | $0^{1}$ | - |  |  | 1993 | A |
| B12-13 | St. Vincent Sound, Apalachicola Bay, St. Georges Sound | 387 | 0.34 | 293 | 2.9 | 1993 | A |
| B14-15 | Apalachee Bay | 491 | 0.39 | 358 | 3.6 | 1993 | A |
| B16 | Waccasassa Bay, Withlacoochee Bay, Crystal Bay | 100 | 0.85 | 54 | 0.5 | 1994 | A |
| B17 | St. John's Sound, Clearwater Harbor | 37 | 1.06 | 18 | 0.2 | 1994 | A |
| B32-34 | Tampa Bay | 559 | 0.24 | 458 | 4.6 | 1994 | A |
| B20 | Sarasota Bay | 97 | na ${ }^{3}$ | 97 | 1.0 | 1992 | B |
| B35 | Little Sarasota Bay | $2^{2}$ | 0.24 | 2 | 0.0 | 1985 | C |
| B21 | Lemon Bay | $0^{1}$ | - |  |  | 1994 | A |
| B22-23 | Pine Sound, Charlotte Harbor, Gasparilla Sound | 209 | 0.38 | 153 | 1.5 | 1994 | A |
| B36 | Caloosahatchee River | $0^{1,2}$ | - |  |  | 1985 | C |
| B24 | Estero Bay | 104 | 0.67 | 62 | 0.6 | 1994 | A |
| B25 | Chokoloskee Bay, Ten Thousand Islands, Gullivan Bay | 208 | 0.46 | 144 | 1.4 | 1994 | A |
| B27 | Whitewater Bay | 242 | 0.37 | 179 | 1.8 | 1994 | A |
| B28 | Florida Keys (Bahia Honda to Key West) | 29 | 1.00 | 14 | 0.1 | 1994 | A |

References: A- Blaylock and Hoggard 1994; B- Wells 1992; C- Scott et al. 1989
Notes:
1 During earlier surveys (Scott et al. 1989), the range of seasonal abundances was as follows: B57, 0-2 (CV=0.38); B58, 0-6 (0.34); B59, 0-0; B30, 0-182(0.14); B07, 0-0; B21, 0-15(0.43); and B36, 0-0.
2 Block not surveyed during surveys reported in Blaylock and Hoggard 1994.
3 No CV because $\mathrm{N}_{\text {BEST }}$ was a direct count of known individuals.


Figure 1. USA Gulf of Mexico bays and sounds. Each of the alpha-numerically designated blocks corresponds to one of the NMFS Southeast Fisheries Science Center logistical aerial survey areas listed in Table 1. The bottlenose dolphins inhabiting each bay and sound are considered to comprise a unique stock for purposes of this assessment.

## POPULATION SIZE

Population size (Table 1) for all of the stocks except Sarasota Bay, Florida, was estimated from preliminary analyses of line-transect data collected during aerial surveys conducted in September-October 1992 in Texas and Louisiana; in September-October 1993 in Louisiana, Mississippi, Alabama, and the Florida panhandle (Blaylock and Hoggard 1994); and in September-November 1994 along the west coast of Florida (NMFS unpublished data). Standard line-transect perpendicular sighting distance analytical methods (Buckland et al. 1993) and the computer program DISTANCE (Laake et al. 1993) were used. Stock size in Sarasota Bay, Florida, was obtained through direct count of known individuals (Wells 1992).

## Minimum Population Estimate

The minimum population estimate (Table 1) is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normally distributed abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The minimum population estimate was calculated for each block from the estimated population size and its associated coefficient of variation. Where the population size resulted from a direct count of known individuals, the minimum population size was identical to the estimated population size.

## Current Population Trend

The data are insufficient to determine population trends for all of the Gulf of Mexico bay, sound, and estuary bottlenose dolphin communities. The Sarasota Bay community, however, has been monitored since 1970 and has remained relatively constant over the last 20+ years at approximately 105 animals (Wells 1998). Three anomalous mortality events have occurred among portions of these dolphin communities between 1990 and 1994; however, it is not possible to accurately partition the mortalities between bay and coastal stocks, thus the impact of these mortality events on communities is not known.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for the dolphin communities that comprise these stocks. While productivity rates may be estimated for individual females within communities, such estimates are confounded at the stock level due to the influx of dolphins from adjacent areas which balance losses, and the unexplained loss of some individuals which offset births and recruitment (Wells 1998). Continued monitoring and expanded survey coverage will be required to address and develop estimates of productivity for these dolphin communities. 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 "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 0.5 because these stocks are of unknown status. PBR for each stock is given in Table 1.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

There are a number of difficulties associated with the interpretation of stranding data. It is possible that some or all of the stranded dolphins may have been from a nearby coastal stock; however, the proportion of stranded dolphins belonging to another stock cannot be determined because of the difficulty of determining from where the stranded carcass originated. 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, and the condition of the carcass if badly decomposed can inhibit the interpretation of cause of death.

A total of 1,881 bottlenose dolphins were found stranded in the USA Southeast Gulf of Mexico from 1993 to 1997 (Table 2) (NMFS unpublished data). Of these, 57 or $3 \%$ showed evidence of human interactions as the cause of death (e.g., gear entanglement, mutilation, gunshot wounds). Bottlenose dolphin are known to become entangled in recreational and commercial fishing gear (Wells et al. 1998; Gorzelany 1998; Wells and Scott 1994) and some are struck by recreational and commercial vessels (Wells and Scott 1997). In 1998 alone, two resident bottlenose dolphins and an associated calf were killed by vessel strikes and a resident young-of-the-year died from entanglement in a crab-pot float line (R.S. Wells, pers. comm.).

The Gulf of Mexico menhaden fishery was observed to take 9 bottlenose dolphins (three fatally) between 1992 and 1995 (NMFS unpublished data). There were 1,366 sets observed out of 26,097 total sets, which if extrapolated for all years suggests that as many as 172 bottlenose dolphins could have been taken in this fishery with up to 57 animals killed. An observer program is urgently needed to obtain statistically reliable information for this fishery on the number of sets annually, the incidental take and mortality rates, and the communities from which bottlenose dolphins are being taken.

Some of the bay, sound and estuarine communities were the focus of a live-capture fishery for bottlenose dolphins which supplied dolphins to the U.S. Navy and to oceanaria for research and public display for almost two decades (NMFS unpublished data). During the period between 1972-89, 490 bottlenose dolphins, an average of 29 dolphins annually, were removed from a few locations in the Gulf of Mexico, including the Florida Keys. Mississippi Sound sustained the highest level of removals with 202 dolphins taken from this stock during this period, representing $41 \%$ of the total and an annual average of 12 dolphins (compared to a current PBR of 13). The annual average number of removals never exceeded current PBR levels, but it may be biologically significant that $73 \%$ of the dolphins removed during 1982-88 were females. The impact of those removals on the stocks is unknown.

## Fishery Information

Annual fishing effort for the shrimp trawl fishery in the USA Gulf of Mexico bays, sounds, and estuaries during 1988-1993 averaged approximately 2.20 million hours of tows (CV=0.11) (NMFS unpublished data). There have been very low numbers of incidental mortality or injury in the stocks associated with the shrimp trawl fishery.

A fishery for blue crabs operates in estuarine areas throughout the Gulf of Mexico coast employing traps attached to a buoy with rope. Bottlenose dolphins have been reported stranded with polypropylene rope around their flukes (NMFS 1991; McFee and Brooks, Jr. 1998; NMFS unpublished data), indicating the possibility of entanglement with crab pot lines. This fishery has not been monitored by observers and there are no estimates of bottlenose dolphin mortality or serious injury for this fishery.

Gillnets are not used in Texas, and gillnets over $46 \mathrm{~m}^{3}$ in area were not allowed in Florida past July 1995, but fixed and runaround gillnets are currently in use in Louisiana, Mississippi, and Alabama. These fisheries, for the most part, operate year around. They are state-controlled and licensed, and vary widely in intensity and target species. No marine
mammal mortalities associated with gillnet fisheries have been reported in these states, but stranding data suggest that gillnet and marine mammal interaction does occur, causing mortality and serious injury.

Table 2. Bottlenose dolphin strandings in the USA Gulf of Mexico (West Florida to Texas) from 1993 to 1997. Data are from the Southeast Marine Mammal Stranding Database (SESUS).


## Other Mortality

The near shore habitat occupied by many of these stocks is adjacent to areas of high human population, and in some bays, such as Mobile Bay in Alabama and Galveston Bay in Texas, is highly industrialized. The area surrounding Galveston Bay, for example, has a coastal population of over 3 million people. More than $50 \%$ of all chemical products manufactured in the USA are produced there and $17 \%$ of the oil produced in the Gulf of Mexico is refined there (Henningsen and Würsig 1991). Many of the enclosed bays in Texas are surrounded by agricultural lands which receive periodic pesticide applications.

Concentrations of chlorinated hydrocarbons and metals were examined in conjunction with an anomalous mortality event of bottlenose dolphins in Texas bays in 1990 and found to be relatively low in most; however, some had concentrations at levels of possible toxicological concern (Varanasi et al. 1992). No studies to date have determined the amount, if any, of indirect human-induced mortality resulting from pollution or habitat degradation. However, a recent health assessment of 35 bottlenose dolphins from Matagorda Bay, Texas associated high levels of chlorinated hydrocarbons
with low health assessment scores (Reif et al. in review). Morbillivirus has also been implicated in the deaths of bottlenose dolphins in some of these communities (Duignan et al. 1996).

## STATUS OF STOCK

The status of these stocks relative to OSP is unknown and this species is not listed as threatened or endangered under the Endangered Species Act. The occurrence of three anomalous mortality events among bottlenose dolphins along the USA Gulf of Mexico coast since 1990 (NMFS unpublished data) is cause for concern; however, the effects of the mortality events on stock abundance have not yet been determined. The available evidence suggests that bottlenose dolphin stocks in the northern and western coastal portion of the USA Gulf of Mexico may have experienced a morbillivirus epidemic in 1993 (Lipscomb 1993; Lipscomb et al. 1994). Seven of 35 live-captured bottlenose dolphins (20\%) from Matagorda Bay, Texas, in 1992, tested positive for previous exposure to cetacean morbillivirus (Reif et al. in review), and it is possible that other estuarine resident stocks have been exposed to the morbillivirus (Duignan et al. 1996).

The relatively high number of bottlenose dolphin deaths which occurred during the mortality events in the last decade suggests that some of these stocks may be stressed. Fishery-related mortality and serious injury for each of these stocks is not known, but considering the evidence from stranding data, the total fishery-related mortality and serious injury exceeds $10 \%$ of the total PBR, and, therefore, it is not insignificant and approaching the zero mortality and serious injury rate. For these reasons, and because the PBR for most of these stocks would be exceeded with the incidental capture of a single dolphin, each of these stocks 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. NOAA Technical Memorandum. NMFS-OPR-6, 73 pp.
Barros, N. B. and R. S. Wells. 1998. Prey and feeding patterns of resident bottlenose dolphins (Tursiops truncatus) in Sarasota Bay, Florida. J. Mamm. 79(3):1045-1059.
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 Technical Memorandum. NMFS-SEFSC-356, 10 pp.
Bräger, S. 1993. Diurnal and seasonal behavior patterns of bottlenose dolphins (Tursiops truncatus). Mar. Mammal Sci. 9: 434-440.
Bräger, S., B. Würsig, A. Acevedo and T. Henningsen. 1994. Association patterns of bottlenose dolphins (Tursiops truncatus) in Galveston Bay, Texas. J. Mamm. 75(2): 431-437.
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.
Duffield, D. A. and R. S. Wells. 1986. Population structure of bottlenose dolphins: Genetic studies of bottlenose dolphins along the central west coast of Florida. Contract Report to National Marine Fisheries Service, Southeast Fisheries Center, Contract No. 45-WCNF-5-00366, 16 pp.
Duffield, D. A. and R. S. Wells. 1991. The combined application of chromosome, protein and molecular data for the investigation of social unit structure and dynamics in Tursiops truncatus. Pages 155-169 in A.R. Hoelzel (ed), Genetic Ecology of Whales and Dolphins. Rep. int. Whal. Commn., Special Issue 13, Cambridge, U.K.
Duffield, D. A. and R. S. Wells. In press. The molecular profile of a resident community of bottlenose dolphins, Tursiops truncatus. In C.J. Pfeiffer (ed), Cell and Molecular Biology of Marine Mammals.
Duignan, P. J., C. House, D. K. Odell, R. S. Wells, L. Hansen, M. T. Walsh, D. J. St. Aubin, B. K. Rima and J. R. Geraci. 1996. Morbillivirus infection in bottlenose dolphin: evidence for recurrent epizootics in the Western Atlantic and Gulf of Mexico. Mar. Mammal Sci. 12(4):499-515.
Fertl, D. C. 1994. Occurrence, movements, and behavior of bottlenose dolphins (Tursiops truncatus) in association with the shrimp fishery in Galveston Bay, Texas. M. Sc. thesis, Texas A\&M University, College Station. 117 pp.
Gorzelany, J. F. 1998. Unusual deaths of two free-ranging Atlantic bottlenose dolphins (Tursiops truncatus) related to ingestion of recreational fishing gear. Marine Mammal Sci. 14(3):614-6167.
Gruber, J. A. 1981. Ecology of the Atlantic bottlenosed dolphin (Tursiops truncatus) in the Pass Cavallo area of Matagorda Bay, Texas. M. Sc. thesis, Texas A\&M University, College Station. 182 pp.
Henningsen, T. 1991. Zur Verbreitung und Ökologie des Großen Tümmlers (Tursiops truncatus) in Galveston, Texas. Diploma thesis, Christian-Albrechts-Universität, Kiel, Germany. 80 pp.

Henningsen, T. and B. Würsig. 1991. Bottle-nosed dolphins in Galveston Bay, Texas: Numbers and activities. Pages 36-38 in P. G. H. Evans (ed), European research on cetaceans - 5. Proceedings of the Fifth Annual Conference of the European Cetacean Society, Sandefjord, Norway, 21-23 February, 1991. Cambridge, UK.
Hubard, C. W. 1998. Abundance, distribution, and site fidelity of bottlenose dolphins in Mississippi Sound, Mississippi. M. Sc. thesis, University of Alabama, Tuscaloosa. 101 pp.

Irvine, B. and R. S. Wells. 1972. Results of attempts to tag Atlantic bottlenose dolphins (Tursiops truncatus). Cetology 13:1-5.
Irvine, A. B., M. D. Scott, R. S. Wells and J. H. Kaufmann. 1981. Movements and activities of the Atlantic bottlenose dolphin, Tursiops truncatus, near Sarasota, Florida. Fish. Bull. U.S. 79:671-688.
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. 72 pp.
Lipscomb, T. P. 1993. Some answers to questions about morbillivirus. Pages 4-5 in R. A. Blaylock, B. Mase, and D. K. Odell (eds), Strandings, Vol. 2, No. 3, SEFSC Miami Laboratory, Miami, Florida, 7 pp.
Lipscomb, T. P. 1994. Morbilliviral disease in an Atlantic bottlenose dolphin (Tursiops truncatus) from the Gulf of Mexico. Journal of Wildlife Diseases 30(4): 572-576.
Lynn, S. K. 1995. Movements, site fidelity, and surfacing patterns of bottlenose dolphins on the central Texas coast. M. Sc. thesis, Texas A\&M University, College Station. 92 pp.
Maze, K. S. 1997. Bottlenose dolphins of San Luis Pass, Texas: Occurrence patterns, site fidelity, and habitat use. M. Sc. thesis, Texas A\&M University, College Station. 79 pp.
McFee, W. E. and W. Brooks Jr. 1998. Fact finding meeting of marine mammal entanglement in the crab pot fishery: A summary. U.S. Fish and Wildlife Service unpublished report.
Mullin, K. D. 1988. Comparative seasonal abundance and ecology of bottlenose dolphins (Tursiops truncatus) in three habitats of the north-central Gulf of Mexico. Ph. D. dissertation, Mississippi State University, Starkville. 135 pp.
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.
Reif, J. S., L. J. Hansen, S. Galloway, G. Mitchum and 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, L. J. Hansen and R. E. Owen. 1989. Estimates of bottlenose dolphin abundance in the Gulf of Mexico from regional aerial surveys. CRD 88/89-07.
Scott, G. P. 1990. Management-oriented research on bottlenose dolphins by the Southeast Fisheries Center. Pages 623639 in S. Leatherwood and R. R. Reeves (eds), The bottlenose dolphin. Academic Press, San Diego. 653 pp.
Scott, M. D., R. S. Wells and A. B. Irvine. 1990. A long-term study of bottlenose dolphins on the west coast of Florida. Pages 235-244 in: S. Leatherwood and R. R. Reeves (eds), The bottlenose dolphin. Academic Press, San Diego. 653 pp.
Shane, S. H. 1977. The population biology of the Atlantic bottlenose dolphin, Tursiops truncatus, in the Aransas Pass area of Texas. M. Sc. thesis, Texas A\&M University, College Station. 238 pp.
Shane, S. H. 1990. Behavior and ecology of the bottlenose dolphin at Sanibel Island, Florida. Pages 245-265 in S. Leatherwood and R.R. Reeves (eds), The bottlenose dolphin. Academic Press, San Diego. 653 pp.
Shane, S. H., R. S. Wells and B. Würsig. 1986. Ecology, behavior, and social organization of the bottlenose dolphin: A review. Mar. Mammal Sci. 2(1):34-63.
Thompson, N.B. 1981. Estimates of abundance of Tursiops truncatus in Charlotte Harbor, Florida. NOAA/NMFS/SEFSC/Miami Laboratory, Fishery Data Analysis Technical Report.
Urian, K.W., D.A. Duffield, A.J. Read, R.S. Wells and D.D. Shell. 1996. Seasonality of reproduction in bottlenose dolphins, Tursiops truncatus. J. Mamm. 77:394-403.
Varanasi, U., K. L. Tilbury, D. W. Brown, M. M. Krahn, C. A. Wigren, R. C. Clark and S. L. Chan. 1992. Pages 56-86 in: L. J. Hansen (ed), Report on Investigation of 1990 Gulf of Mexico Bottlenose Dolphin Strandings, Southeast Fisheries Science Center Contribution MIA-92/93-21, 219 pp.
Wade, P. R. and R. P. Angliss. 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, Seattle, Washington. NOAA Technical Memorandum. 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 -- 1996. NOAA Technical Memorandum. NMFS-NE-114.
Weller, D. W. 1998. Global and regional variation in the biology and behavior of bottlenose dolphins. Ph. D. dissertation, Texas A\&M University, College Station. 142 pp.
Wells, R. S. 1986a. Population structure of bottlenose dolphins: behavioral studies along the central west coast of Florida. Contract report to NMFS, SEFSC. Contract No. 45-WCNF-5-00366, 58 pp.
Wells, R. S. 1986b. Structural aspects of dolphin societies. Ph. D. dissertation, University of California, Santa Cruz. 234 pp.
Wells, R. S. 1991. The role of long-term study in understanding the social structure of a bottlenose dolphin community. Pages 199-225 in: K. Pryor and K.S. Norris (eds), Dolphin Societies: Discoveries and Puzzles. University of California Press, Berkeley. 397 pp.
Wells, R. S. 1992. The marine mammals of Sarasota Bay. Pages 9.1-9.23 in: Sarasota Bay: Framework for action. Sarasota Bay National Estuary Program, Sarasota, Florida.
Wells, R. S. 1994. Determination of bottlenose dolphin stock discreteness: Application of a combined behavioral and genetic approach. Pages 16-20 in: K. R. Wang, P. M. Payne, and V. G. Thayer (compilers), Coastal Stock(s) of Atlantic Bottlenose Dolphin: Status Review and Management. Proceedings and Recommendations from a Workshop held in Beaufort, NC, 13-14 September 1993. NOAA Technical Memorandum. NMFS-OPR-4. 120 pp.
Wells, R. S. 1998. Progress report: Sarasota long-term bottlenose dolphin research. Unpublished contract report to the U.S. Department of Commerce, NOAA Fisheries, Southeast Fisheries Science Center, Miami. 5 pp.

Wells, R. S. and M. D. Scott. 1990. Estimating bottlenose dolphin population parameters from individual identification and capture-release techniques. Pages 407-415 in: P. S. Hammond, S. A. Mizroch and G. P. Donovan (eds), Individual Recognition of Cetaceans: Use of Photo-Identification and Other Techniques to Estimate Population Parameters. Rep. int. Whal. Commn., Special Issue 12, Cambridge, U.K. 440 pp.
Wells, R. S. and M.D . Scott. 1999. Bottlenose dolphins. Pages 137-182 in S.H. Ridgway and R. Harrison (eds), Handbook of Marine Mammals, Vol. 6, the Second Book of Dolphins and Porpoises. Academic Press, San Diego.
Wells, R. S., M. D. Scott and A. B. Irvine. 1987. The social structure of free-ranging bottlenose dolphins. Pages 247-305 in: Genoways, H. (ed), Current Mammalogy, Vol. 1. New York, Plenum Press.
Wells, R. S., K. W. Urian, A. J. Read, M. K. Bassos, W. J. Carr and M. D. Scott. 1996a. Low-level monitoring of bottlenose dolphins, Tursiops truncatus, in Tampa Bay, Florida: 1988-1993. NOAA Technical Memorandum. NMFS-SEFSC-385, 25 pp. +6 Tables, 8 Figures, and 4 Appendices.
Wells, R. S., M. K. Bassos, K. W. Urian, W. J. Carr and M. D. Scott. 1996b. Low-level monitoring of bottlenose dolphins, Tursiops truncatus, in Charlotte Harbor, Florida: 1990-1994. NOAA Technical Memorandum. NMFS-SEFSC-384, 36 pp. +8 Tables, 10 Figures, and 5 Appendices.
Wells, R. S., M. K. Bassos, K. W. Urian, S. H. Shane, E. C. G. Owen, C. F. Weiss, W. J. Carr and M. D. Scott. 1997. Low-level monitoring of bottlenose dolphins, Tursiops truncatus, in Pine Island Sound, Florida: 1996. Contract report to National Marine Fisheries Service, Southeast Fisheries Center. Contribution No. 40-WCNF601958
Würsig, B. and S. K. Lynn. 1996. Movements, site fidelity, and respiration patterns of bottlenose dolphins on the central Texas coast. NOAA Technical Memorandum. NMFS-SEFSC-383, 43 pp. +10 Tables, 15 Figures, and 6 Appendices.

## DWARF SPERM WHALE (Kogia simus): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The dwarf sperm whale appears 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, SEFSC, unpublished data). Dwarf sperm whales and pygmy sperm whales (Kogia breviceps) are difficult to distinguish and sightings of either species are often categorized as Kogia sp. Sightings of this category were documented in all seasons during seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Hansen et al. 1996). The few reliable sightings of dwarf sperm whales during those surveys were more numerous in spring, probably a result of greater survey efforts in that season (Jefferson and Shapiro 1997). Pygmy and dwarf sperm whales have been sighted in the northwestern Gulf of Mexico in waters 1000 m deep, on average (Davis et al. 1998). However, these authors cautioned that inferences on preferred bottom depths should await surveys for the entire Gulf of Mexico. The difficulty in sighting pygmy and dwarf sperm whales may be exacerbated by their avoidance reaction towards ships, and change in behavior towards approaching survey aircraft (Würsig et al. 1998). In a recent study using hematological and stable-isotope data, Barros et al. (1998) speculated that dwarf sperm whales may have a more pelagic distribution than pygmy sperm whales, and/or dive deeper during feeding bouts. There is no information on stock differentiation.

## POPULATION SIZE

Estimates of abundance of Kogia sp. 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 1991-1994 springsummer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Fig. 1 in Hansen et al. 1995), which includes data collected as part of the GulfCet program (Hansen et al. 1996). These surveys were conducted throughout the area from approximately the 200 m isobath along the USA coast to the seaward extent of the USA Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the species' range and therefore, these data were not used to estimate population size. Estimated abundance of Kogia sp. by survey year [coefficient of variation (CV) in parentheses] was 109 in 1991 (0.68), 1,010 in 1992 (0.40), 580 in 1993 (0.45), and 162 in 1994 (0.61) (Hansen et al. 1995). Survey effort-weighted estimated average abundance of Kogia sp. for all surveys combined was 547 (CV=0.28) (Hansen et al. 1995). Estimates of dwarf sperm whale abundance cannot be provided due to uncertainty of species identification at sea.

## Minimum Population Estimate

A minimum population estimate was not calculated because of uncertainty of species identification at sea.

## Current Population Trend

There is insufficient information to describe any population trend of this species in the Gulf of Mexico.

## 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 net 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 0.5 because this stock is of unknown status. PBR for the dwarf sperm whale is unknown because the minimum population estimate cannot be estimated.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of dwarf sperm whales in the northern Gulf of Mexico is unknown. Available information indicates there likely is little, if any, fisheries interaction with dwarf sperm whales in the northern Gulf of Mexico. There have been no logbook reports of fishery-related mortality or serious injury and no fishery-related mortality or serious injury has been observed.

There were no documented strandings of dwarf sperm whales in the northern Gulf of Mexico during 1987-October 1998 which were classified as likely caused by fishery interactions, but there have been stranding investigation reports of dwarf sperm whales which may have died as a result of other human-related causes. 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 fisheryinteraction. Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of fishery interaction.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the USA Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury of dwarf sperm whales by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## Other Mortality

A total of at least 16 dwarf sperm whale strandings were documented in the northern Gulf of Mexico from 1990 through October 1998.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. Although the PBR cannot be calculated, there is no known fishery-related mortality or serious injury to this stock and, therefore, total fishery-related mortality and serious injury can be considered insignificant and approaching zero mortality and serious injury rate. The total level of fishery-related mortality and serious injury is unknown, but it is believed to be insignificant.

## 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. Nearshore vs. offshore ecotype differentiation of Kogia breviceps and K. simus based on hemoglobin, morphometric and dietary analyses. Abstracts. World Marine Mammal Science Conference. Monaco. 20-24 January.
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 (eds), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, San Diego.
Cramer, J. 1994. Large pelagic logbook newsletter-1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.
Davis, R. W., G. S. Fargion, N. May, T. D. Leming, M. Baumgartner, W. E. Evans, L. J. Hansen and K. Mullin. 1998. Physical habitats of cetaceans along the continental slope of the north-central and western Gulf of Mexico. Mar. Mammal. Sci., 14:490-507.
Hansen, L. J., K. D. Mullin, T. A. Jefferson and G. P. Scott. 1996. Visual surveys aboard ships and aircraft. Pages 55-132. In: R.W. Davis and G.S. Fargion (eds). Distribution and abundance of marine mammals in the north-central and
western Gulf of Mexico: Final Report. Volume II: Technical Report. OCS Study MMS 96-0027. Prepared by the Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, LA. 357 pp.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Jefferson, T. J. and A. Schiro. 1997. Distribution of cetaceans in the northern Gulf of Mexico. Mammal Rev., 27:27-50.
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.
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.
Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behavior of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquat. Mammals, 24:41-50.

## PYGMY SPERM WHALE (Kogia breviceps): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The pygmy sperm whale appears 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, SEFSC, unpublished data). Pygmy sperm whales and dwarf sperm whales (Kogia simus) are difficult to distinguish and sightings of either species are often categorized as Kogia sp. Sightings of this category were documented in all seasons during seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Hansen et al. 1996). Pygmy and dwarf sperm whales have been sighted in the northwestern Gulf of Mexico in waters 1000 m deep, on average (Davis et al. 1998). However, these authors cautioned that inferences on preferred bottom depths should await surveys for the entire Gulf of Mexico. The difficulty in sighting pygmy and dwarf sperm whales may be exacerbated by their avoidance reaction towards ships, and change in behavior towards approaching survey aircraft (Würsig et al. 1998) In a recent study using hematological and stable-isotope data, Barros et al. (1998) speculated that dwarf sperm whales may have a more pelagic distribution than pygmy sperm whales, and/or dive deeper during feeding bouts. There is no information on stock differentiation.

## POPULATION SIZE

Estimates of abundance of Kogia sp. 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 1991-1994 springsummer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Hansen et al. 1996). These surveys were conducted throughout the area from approximately the 200 m isobath along the USA coast to the seaward extent of the USA Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the species' range and therefore, these data were not used to estimate population size. Estimated abundance of Kogia sp. by survey year [coefficient of variation (CV) in parentheses] was 109 in 1991 (0.68), 1,010 in $1992(0.40)$, 580 in $1993(0.45)$, and 162 in 1994 (0.61) (Hansen et al. 1995). Survey effort-weighted estimated abundance of Kogia sp. for all surveys combined was 547 (CV = 0.28) (Hansen et al. 1995). Estimates of pygmy sperm whale abundance cannot be provided due to uncertainty of species identification at sea.

## Minimum Population Estimate

A minimum population estimate could not be calculated because of uncertainty of species identification at sea.

## Current Population Trend

There is insufficient information to describe any population trend for this species in the Gulf of Mexico.

## 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 net 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 0.5 because this stock is of unknown status. PBR for the pygmy sperm whale is unknown because the minimum population estimate cannot be estimated.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of pygmy sperm whales in the northern Gulf of Mexico is unknown. Available information indicates there likely is little, if any, fisheries interaction with pygmy sperm whales in the northern Gulf of Mexico. There have been no logbook reports of fishery-related mortality or serious injury and no fishery-related mortality or serious injury has been observed.

There have been no documented strandings of pygmy sperm whales in the northern Gulf of Mexico during 1987October 1998 which have been classified as likely caused by fishery interactions, but there have been stranding investigation reports of pygmy sperm whales which may have died as a result of other human-related causes. 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.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the USA Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury of pygmy sperm whales by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## Other Mortality

At least 20 pygmy sperm whale strandings were documented in the northern Gulf of Mexico from 1990 through October 1998. Two of these animals had a plastic bag or pieces thereof in their stomachs (Tarpley and Marwitz 1993, Barros, unpublished data). Another animal stranded apparently due to injuries inflicted by impact, possibly with a vessel.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. Although the PBR cannot be calculated, the total known fishery-related mortality and serious injury for this stock is zero and, therefore, can be considered insignificant and approaching zero mortality and serious injury rate. The total level of fishery-related mortality and serious injury is unknown, but it is believed to be insignificant.

## 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. Nearshore vs. offshore ecotype differentiation of Kogia breviceps and K. simus based on hemoglobin, morphometric and dietary analyses. Abstract. World Marine Mammal Science Conference. Monaco. 20-24 January.
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 (eds), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, San Diego.
Cramer, J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.
Davis, R.W., G.S. Fargion, N. May, T.D. Leming, M. Baumgartner, W.E. Evans, L.J. Hansen, and K. Mullin. 1998. Physical habitats of cetaceans along the continental slope of the north-central and western Gulf of Mexico. Mar. Mamm. Sci., 14:490-507.

Hansen, L.J., K.D. Mullin, T.A. Jefferson and G.P. Scott. 1996. Visual surveys aboard ships and aircraft. Pages 55-132. In: R.W. Davis and G.S. Fargion (eds). Distribution and abundance of marine mammals in the north-central and western Gulf of Mexico: Final Report. Volume II: Technical Report. OCS Study MMS 96-0027. Prepared by the Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, LA. 357 pp.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
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.
Tarpley, R. J., and S. Marwitz. 1993. Plastic debris ingestion by cetaceans along the Texas coast: two case studies. Aquat. Mammals, 14:93-98.
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.
Würsig, B., S. K. Lynn, T. A. Jefferson and K. D. Mullin. 1998. Behavior of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquat. Mammals, 24:41-50.

APPENDIX 1. Observer Comments Relating to the Condition of Marine Mammals Observed Caught in 1992-1998 by USA Pelagic Longline Vessels Operating in the North Atlantic ${ }^{1}$

| Common name | area | trip | date | lat | lon | $\begin{gathered} \text { past } \\ \text { status } \end{gathered}$ | injury code | S.I. | $\begin{gathered} \text { estimated } \\ \text { length }(\mathrm{cm}) \end{gathered}$ | observer's comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 pilot whale | NEC | A27 | 9/3/92 | 3712 | 7429 | alive | 10?,13 | N | 335 | Small cut on part of the tail by mainline wrap. |
| 2 pilot whale | NEC | A27 | 9/4/92 | 3710 | 7426 | alive | 10?,13 | N | 375 | Tail cut slightly by mainline. |
| 3 pilot whale | NEC | A27 | 9/4/92 | 3710 | 7426 | dead |  |  | 300 | Dead, moderately decomposed. |
| 4 dolphin | NEC | A30 | 6/17/92 | 3951 | 6155 | alive |  | ? | 200 | Alive, condition unknown. |
| 5 pilot whale | NEC | A02 | 10/1/92 | 3653 | 7432 | alive | 6?,8? | ? | 300 | Seemed to be hooked. If so, it bit off the hook. It could also have been just feeding on discarded bait. |
| 6 pilot whale | NEC | A02 | 10/5/92 | 3703 | 7410 | alive | 8 | Y | 250 | Caught on hook. Gangion cut, hook left in mouth. |
| 7 common dolphin | NEC | A03 | 10/6/92 | 3955 | 7005 | alive |  | N | 305 | Mainline caught on tail, animal unhurt. |
| 8 pilot whale | NEC | A25 | 12/15/92 | 3607 | 7438 | alive |  | N | 244 | Mainline in mouth. Captain pulled mainline and freed whale. |
| 9 pilot whale | NEC | A40 | 10/22/92 | 3859 | 7248 | alive | 10?,11,13 | N | 250 | Tail caught in mainline. Cut off as much gear as possible in rough seas. Swam away, but line had cut into right side of tail flukes, which was bleeding slightly. |
| 10 pilot whale | NEC | A63 | 11/9/92 | 3751 | 7400 | alive |  | N |  | Caught on the mainline. Within $\sim 20 \mathrm{ft}$ of the boat it freed itself and swam away. |
| 11 pilot whale | NEC | A63 | 11/9/92 | 3753 | 7409 | alive | 6?,8?,10? | ? | 305 | Caught in a gangion and not necessarily hooked. Line was cut and it swam away. |
| 12 pilot whale | NEC | A63 | 11/9/92 | 3753 | 7409 | alive | 10 | Y | 366 | Tangled in mainline with a wrap or two around its body. It was hauled to the side of the boat and held for about one minute while the line was cut. Swam away, seemingly uninjured. |
| 13 Risso's dolphin | NEC | 102 | 11/9/92 | 3537 | 7437 | unk | 6?,8,10? | Y | 300 | Caught (hooked) on longline gear - was alive and well; was cut off line and swam away with in a pod of about 20 animals. |
| 14 Risso's dolphin | NEC | 102 | 11/9/92 | 3554 | 7420 | alive | 6?,8,10? | Y | 280 | Hooked on longline gear - alive and well; line was cut off and swam away. Was in a pod of about 15 animals. |
| 15 pilot whale | NEC | J03 | 11/4/92 | 3805 | 7345 | alive |  | ? |  | Alive, condition unknown |
| 16 pilot whale | NEC | J03 | 11/4/92 | 3813 | 7350 | alive |  | ? |  | Alive, condition unknown |
| 17 Risso's dolphin | GOM | J04 | 12/8/92 | 2554 | 8447 | alive |  | ? |  | Alive, condition unknown |
| 18 spotted dolphin | NEC | A01 | 1/7/93 | 3527 | 7449 | alive |  | ? |  | N/A |
| 19 bottlenose dolphin | NEC | A03 | 2/9/93 | 3543 | 7443 | alive | 6?,8?,10? | ? | 210 | Uninjured, immediately swam away after cutting monofilament $\sim 25 \mathrm{ft}$. from hook. |
| 20 pilot whale | NEC | A03 | 2/9/93 | 3541 | 7445 | alive | 10? | ? | 250 | Mainline wrapped several times around tail - cut free with no apparent injury. |
| 21 Risso's dolphin | GOM | 105 | 2/14/93 | 2456 | 8418 | dead | 5,9,10 |  | 200 | Animal was tail tied in mainline, drowned - fresh, no decomposition. |
| 22 pilot whale | NEC | A04 | 5/13/93 | 3939 | 6904 | alive | 10? | ? | 250 | Female, tail wrapped. A second female pilot whale was waiting alongside. |
| 23 pilot whale | NEC | A80 | 6/8/93 | 3548 | 7426 | alive |  | ? | 300 | Alive, uninjured |
| 24 pilot whale | NEC | A80 | 6/8/93 | 3548 | 7426 | alive |  | ? | 240 | Alive, uninjured |
| 25 pilot whale | NEC | A80 | 6/8/93 | 3555 | 7430 | alive | 10? | ? | 240 | Not hooked - tail tangled in mainline. Cut free and swam off. |
| 26 pilot whale | NEC | A80 | 6/8/93 | 3552 | 7447 | alive |  | ? | 210 | Alive, uninjured |
| 27 pilot whale | NEC | A80 | 6/8/93 | 3552 | 7447 | alive |  | ? | 240 | Alive, uninjured |
| 28 pilot whale | SEC | I10 | 6/18/93 | 2908 | 7952 | alive | 10 ? | ? | 200 | Animal was in a pod of about 8-10 individuals. Animal was tail tied, cut freed, and swam away alive. |
| 29 Risso's dolphin | NEC | B01 | 8/7/93 | 4016 | 6740 | alive | 10 ? | ? | 305 | Tail wrapped. Crew cut mainline. Only small amount of monofilament remained on tail. Swam away slowly. |
| 30 pilot whale | NEC | B02 | 8/15/93 | 3917 | 7000 | alive |  | N | 210 | Not hooked, but had a wrap of mainline around caudal peduncle. Released unharmed. |
| 31 Risso's dolphin | NEC | H08 | 8/2/93 | 3522 | 7444 | alive |  | ? |  | Alive, condition unknown |
| 32 bottlenose dolphin | NED | M02 | 7/26/93 | 4352 | 3953 | alive |  | ? | 205 | Alive, not injured |
| 33 pilot whale | NEC | A02 | 10/1/93 | 3904 | 7230 | alive |  | ? | 244 | Alive, condition unknown |


| Common name | area | trip | date | lat | lon | $\begin{gathered} \text { past } \\ \text { status } \end{gathered}$ | injury code | S.I. | estimated <br> length (cm) | observer's comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 34 pilot whale | NEC | A11 | 11/1/93 | 3654 | 7436 | alive | 6?,8?,10? | ? | 195 | Leader was cut and animal released unharmed |
| 35 pilot whale | NEC | A11 | 11/1/93 | 3656 | 7437 | alive |  | N | 180 | Wrapped in mainline and float drop, but not hooked. Line was worked free and animal released unharmed. |
| 36 pilot whale | NEC | A11 | 11/1/93 | 3815 | 7325 | alive | 6?,8?,10? | ? | 210 | Leader cut and animal released unharmed. |
| 37 pilot whale | NEC | A14 | 11/7/93 | 3720 | 7424 | alive | 6?,8?,10? | ? |  | Wrapped up but it dove under boat and crew cut line. |
| 38 pilot whale | NEC | A83 | 12/20/93 | 3537 | 7423 | alive | 6?,8,10? | Y | 305 | Mainline cut and hook, line and snap left in whale. |
| 39 pilot whale | NEC | A88 | 11/19/93 | 3717 | 7424 | alive |  | ? | 750 | Alive, uninjured |
| 40 pilot whale | NEC | A02 | 1/8/94 | 3715 | 7420 | alive |  | ? | 210 | Alive, condition unknown. |
| 41 pantropical spotted dolphin | GOM | F15 | 6/20/94 | 2737 | 8825 | alive |  | N | 168 | Tail wrapped in a float dropline, The dolphin was brought aboard and the captain removed the line from the tail and successfully released the dolphin, which swam off uninjured. |
| 42 pilot whale | NEC | A28030 | 8/9/94 | 3901 | 7241 | alive |  | N | 250 | Had mainline wrapped around its fluke; one end of the longline was cut while the other was pulled. This removed all of the mainline around the animal and it swam away. |
| 43 pilot whale | NEC | A28030 | 8/16/94 | 3855 | 7251 | alive | 1,10? | Y | 250 | Foul hooked in the pectoral fin. The gangion was cut and the animal swam away. |
| 44 pilot whale | SEC | A32006 | 8/11/94 | 3715 | 7429 | alive | 6?,8,10? | Y | 213 | Alive, gear in/around mouth. Took bait, gangion cut, whale freed |
| 45 pilot whale | SEC | A32006 | 8/11/94 | 3715 | 7429 | alive | 6?,8,10? | Y | 305 | Alive, gear in/around mouth. Took bait, gangion cut, whale freed |
| 46 pilot whale | SEC | A32006 | 8/11/94 | 3715 | 7429 | alive | 6?,8,10? | Y | 274 | Alive, gear in/around mouth. Took bait, gangion cut, whale freed. Remained at surface about one minute, then swam off. |
| 47 pilot whale | SEC | A32006 | 8/11/94 | 3715 | 7429 | alive | 6?,8,10? | Y | 213 | Alive, gear in/around mouth. Took bait, gangion cut, whale freed. |
| 48 pilot whale | SEC | A32006 | 8/11/94 | 3715 | 7429 | alive | 6?,8,10? | Y | 213 | Alive, gear in/around mouth. Took bait, gangion cut, whale freed. |
| 49 pilot whale | SEC | A32006 | 8/12/94 | 3720 | 7420 | alive | 1,10? | Y | 213 | Foul hooked, cut from gear. Tangled in mainline, cut free, "unharmed". |
| 50 Risso's dolphin | NEC | A32008 | 8/26/94 | 3845 | 7254 | dead | 5,9,10 |  | 185 | Wrapped in longline gear, mainline wrapped around body immediately adjacent to the flukes |
| 51 pilot whale | NEC | A44004 | 9/16/94 | 3824 | 7324 | alive | 1,10? | Y | 300 | Foul hooked in dorsal fin and release required cutting the mainline with gangion still attached. Animal was very much alive and swam off strongly. |
| 52 pilot whale | NEC | A44004 | 9/17/94 | 3816 | 7330 | alive | 1?,10 | Y | 300 | Had to be cut from mainline before release with 6 wraps of mainline and part of a gangion around the base of the tail flukes. Animal was alive and in fair condition and when released, sank a few feet before swimming off slowly. |
| 53 pilot whale | NEC | A44004 | 9/19/94 | 3750 | 7319 | alive | 6?,8,10 | Y | 300 | Was hooked in mouth and was hauled towards boat for about 10 minutes before it was cut from the mainline. It swam off strongly trailing approximately 50 fathoms of mainline from its mouth. Unlike previous takes of pilot whales, there were no sightings of additional animals in immediate area. |
| 54 Risso's dolphin | NEC | A44004 | 9/18/94 | 3802 | 7317 | alive | 8,10? | Y | 240 | Was hooked in mouth and broke gangion from mainline when brought to within 5 yards of boat. ID characteristics included bulbous head, shortened body, falcate fin and uniform light gray color with scars along flanks and head. |
| 55 Risso's dolphin | NEC | A44004 | 9/21/94 | 3952 | 7002 | alive | 1,10 | Y | 250 | Foul hooked in right tail fluke and mainline had to be cut to release. Some trailing mainline and leader still around tail. |
| 56 Risso's dolphin | NEC | A53037 | 9/21/94 | 3955 | 6920 | alive | 1?,6?,8?10? | Y | 300 | Removal requires cutting of gear/animal. Alive, gear in/around another single body part. |
| 57 Atlantic spotted dolphin | GOM | F16 | 7/17/94 | 2907 | 8720 | alive | 8 | Y | 152 | Hooked in the corner of the mouth with the gangion line wrapped around its snout 3 times. Successfully unwrapped the line around its snout but the hook remained it. The dolphin swam away hurriedly in what appeared to be very good condition. |
| 58 killer whale | NED | A54003 | 9/21/94 | 4724 | 4048 | alive | 8,10? | Y | 375 | Fell from gear before exiting water. Alive, gear in/around mouth. |
| 59 pilot whale | NEC | A54005 | 12/9/94 | 3542 | 7442 | alive | 6?,8,10? | Y | 250 | Alive, gear in/around mouth. Removal requires cutting of gear/animal |
| 60 pilot whale | NEC | A54005 | 12/9/94 | 3542 | 7442 | alive | 1?,10? | Y | 250 | Alive, gear in/around another single body part. Removal requires cutting of gear/animal |
| 61 Risso's dolphin | NEC | A62002 | 10/21/94 | 3948 | 6959 | alive | 10,11,13 | Y | 350 | Well-tangled about the fluke with a fair amount of mainline. Released with a good portion |


|  |  |  |  |  | of the mainline still wrapped around the fluke. The captain hoisted the animal up and cut <br> the mainline and it went off. It did not appear to be badly injured. There was a little bit of <br> blood dripping from the caudal peduncle as it was hoisted up. The mainline wrapped <br> around the flukes most probably came right off due to the nylon's rigid quality. The captain <br> and crew were extremely careful in approaching the animal and cutting the gear. Probably <br> young because did not display extensive scarring that an adult would characteristically <br> have. The scarring was concentrated around the head, and dorsally to the anterior margin <br> of the tall falcate dorsal. Photos show very well the line wrapped around tail tightly. May <br> indicate injury. |
| :--- | :--- | :--- | :--- | :--- | :--- |
| 62 Risso's dolphin | NEC | A62002 |  |  |  |


| Common name | area | trip | date | lat | lon | past status | injury code | S.I. | estimated <br> length (cm) | observer's comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 74 pilot whale | NEC | A62058 | 8/13/95 | 3701 | 7431 | alive | 6?,8,10? | Y | 270 | The whale jumped enough out of the water to see its upper flank and head. The animal was tethered to the mainline via a gangion, with hook stuck inside the mouth. The animal went under and the captain cut the gangion freeing the animal. This individual was probably a 2nd year sub-adult. It was freed with the hook in its mouth. It took off like an arrow when the gangion was cut. The observer commented that the only concern about this animal is the possibility of infection from the hook wound in the mouth, or hindrance of feeding efficiency due to the gear hanging from its mouth, if it was not dislodged. Also, this was the 4 out of 7 trips in which this observer has seen a marine mammal foul hooked in the mouth. Marine mammals taking the longline bait have been observed to devour everything but the gill plates, with hook stuck in either the lower or upper maxilla. |
| 75 pilot whale | NEC | A62058 | 8/14/95 | 3709 | 7424 | alive | $6 ?, 8 ? 10,13 ?$ | Y | 250 | Thoroughly and extensively wrapped. Quite a bit of mainline around its caudal peduncle. No evidence of having been hooked in its mouth or head. It was pulled up to the boat. The tangle of line around its peduncle was cut at, with little success. It was tight. We cut some outer strands and it severed the line leading to the vessel, and free line from the animal into the depths of the ocean. Young individual. Left side of vessel with deep breath and a powerful flick of the flukes and dove underneath the vessel. Appeared to be in fairly good shape. |
| 76 shortfin pilot whale | NEC | A62071 | 9/28/95 | 3828 | 7330 | alive | 1,10? | Y | 325 | Instead of having only the gangion wrapped around the caudal peduncle, the hook was imbedded into the peduncle itself. Only one or two wraps of the gangion along with the imbedded hook were left in the animal. The animal was pulled to the boat where unsuccessful attempts were made to dislodge the hook. The animal slowly moved away from the vessel as opposed to an aggressive kick of the tail and a dive. Lingered at the surface for nearly 1.5 minutes while boat steamed away and continued hauling in the gear. (Observer) feared the animal was exhausted physically and stressed out by the whole ordeal. This individual was full-grown. "This was probably the only time (the observer) actually fear for the health and safety of an incidentally-taken marine mammal." |
| 77 shortfin pilot whale | NEC | A62071 | 9/28/95 | 38297 | 7328 | alive | 1?,6?,8, 10? | Y | 225 | This young individual was hooked in the mouth. (Observer) could not exactly tell where (upper or lower mandible), however, it was clear this was the case. Obviously, this young individual was after the squid THAT was the bait the vessel was using. As we were coming upon the animal, it surfaced 3 times upside down. (Observer) had never seen this before in an entanglement situation with a pilot whale. The individual was pulled to the vessel with the intention of extracting the hook from its mouth. However, it was too strong. Thus, it was pulled as close to the vessel as possible and the gangion clipped as close to the mouth as possible. This animal shot off like a bullet to the deep as the gangion was cut. |
| 78 unidentified | NEC | F29 | 8/5/95 | 3924 | 7217 | alive | 1?,6?,8?10? | ? | 274 | The mammal was not seen by the observer until it swam off. The crew was pulling in the gangion and then noticed it was, as they identified it, a whale. There were large unidentified dolphins in the area also. The mammal pulled itself free at the same time the crew noticed it was a mammal. |
| 79 pilot whale | NEC | A41034 | 10/14/95 | 37007 | 7436 | alive | 1?,6?,8?10? | ? | 250 | As leader came to block, line stretched and snapped. Animal swam away after breaking off. |
| 80 pilot whale | NEC | A41034 | 10/14/95 | 35437 | 7437 | alive | 6?,8,10? | Y | 250 | Mouth hooked. Captain cut leader and it disappeared. |
| 81 pilot whale | NEC | A41034 | 10/14/95 | 35467 | 7442 | alive | 6?,8?,10? | Y | 250 | Freed by cutting leader. |
| 82 pilot whale | NEC | A41034 | 10/14/95 | 35467 | 7442 | alive | 1?,6?,8?10? | Y | 250 | Freed by cutting leader. When freed, it swam directly to join three other waitng animals and swam away together. |
| 83 pilot whale | NEC | A44048 | 10/16/95 | 37457 | 7325 | alive | 6?,8,10? | Y | 180 | Animal cut from line, hooked in mouth. Swam off trailing gangion and 100 ft of mainline. |


| 84 pilot whale | SEC | T12 | 10/28/95 26427940 | alive | 1?,10? | ? | 190 | Entangled in mainline; monofilament cut away; whale swam away. |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 85 Risso's dolphin | GOM | F38 | 7/28/96 29018747 | dead | 10 |  |  | Muscle tissue sample was taken from the head, and the lower jaw was also saved. The animal was entangled in the mainline and brought aboard dead. |
| 86 Risso's dolphin | NEC | F39 | 8/30/96 39247217 | alive |  | N | 213 | Mainline wrapped around flukes. Unwrapped flukes. Swam away uninjured. |
| 87 Risso's dolphin | NEC | F39 | 8/30/96 39247217 | alive |  | N | 213 | Mainline wrapped around flukes. Unwrapped flukes. Swam away uninjured. |
| 88 Risso's dolphin | NEC | F39 | 8/30/96 38157318 | alive | 6?,8,10? | Y | 244 | Hooked in mouth. Line cut -914 cm of line left attached (animal pulling very lively). Swam away uninjured. |
| 89 unidentified | SEC | K17 | 12/14/96 30267655 | alive |  | N |  | Unidentified mammal was tangled in line. Black tail section seen just before dive; animal was free with no line attached. |
| 90 short-beaked spinner dolphin | SEC | F45 | 2/25/97 32107803 | alive | 10 ? | N | 183 | Tail wrapped in mainline. Mainline cut free. Animal swam away healthy. |
| 91 pilot whale |  | B10045 | 8/3/97 39127225 | alive | 13 | N | 366 | Small pilot whale brought up; animal sluggish but swimming at side of vessel. Gear was tangled and wrapped around flukes only. Mainline and gangions were cut and all gear was removed. Animal then swam slowly away. Only injury suffered were small lacerations around flukes from gear, no knives used to free animal. |


| Common name | area | trip | date | lat | lon | $\begin{gathered} \text { past } \\ \text { status } \end{gathered}$ | injury code | S.I. | estimated length (cm) | observer's comments |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 92 bottlenose dolphin | NEC | L22 | 1/15/98 | 3607 | 7443 | N/A | 10 ? | N | 250 | female: when released dove straight down and did not come up in the vicinity of the boat: tail flipper entangled in mainline; 3 wraps on tail; no visible injury. |
| 93 bottlenose dolphin | GOM | P34 | 1/12/982 | 2650 | 9219 | N/A | 6?,8,10 | Y | 210 | hooked in mouty; excellent strength; approx. 70 ft . line cut off to release animal; also has a swivel in line attached to trailing gangion. |
| 94 Risso's dolphin | NEC | L26 | 8/1/98 | 3906 | 7236 | N/A | 8,10? | Y | 250 | hooked in lip; swam away strongly; cooperated by not struggling; cut leader and freed; no bleeding evident. |
| 95 Risso's dolphin | NEC | L26 | 8/1/98 | 3848 | 7253 | N/A |  | N | 250 | tail wrapped; retrieved and cut mono away; swam away strongly; no serious injury sustained; no bleeding evident. |
| 96 pilot whale | NEC | L28 | 10/11/98 | 3835 | 7309 | N/A |  | N | 300 | tail entangled in mainline; removed and swam away |
| 97 beaked whale | CAR | T41 | 12/7/98 | 2022 | 7334 | N/A |  | N | 455 | unidentified whale; possibly bottlnose, entered as beaked whale; wrapped only in mainline; unwrapped; swam away freely, good condition (some fatigue). |

${ }^{1}$ Information taken from:
Yeung, C. 1999. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1998. NOAA Technical Memorandum NMFS-SEFSC-430, 26 pp.
Yeung, C. 1999. Revised Mortality Estimates of Marine Mammal Bycatch in 1992-1997 based on Serious Injury Guidelines. NOAA Technical Memorandum NMFS-SEFSC-429, 23 pp.
Johnson, D. R., C. Yeung, C. A. Brown. 1999. Estimates of marine mammal and marine turtle bycatch by the U.S. Atlantic pelagic longline fleet in 1992-1997. NOAA Tech. Mem NMFS-SEFSC-418, 70 pp.

Common name of species taken, geographic area (area) of bycatch ( northeast coastal (NEC); southeast coastal (SEC); northeast distant (NED); Gulf of Mexico (GOM); Carribean (CAR)), unique trip identifier (TRIP \#), date landed, latitude (Lat), longitude (Lon), and estimated body length are given. Past status refers to the classification of the animal as "dead", "alive", or "unk(nown)" in Table 6 of Johnson et al. (1999) for the 1992-1997 data. Injury codes 1-15 refer to criteria used to classify animals as "seriously injured":
$1=$ Loss of/damage to appendage/jaw
$4=$ Rupture/puncture of eyeball
$7=$ Mouth is bound by the gear
$10=$ Line/net entangling the animal
is likely to further entangle the animal

2=Inability to use appendage(s)
$5=$ Inability to swim or dive
$8=$ Cetacean is hooked internally (e.g., in the mouth)
$11=$ Visible blood flow.
13=Laceration.
15=Equilibrium imbalance.

3=Asymmetry in body shape
6=Ingestion of gear
9=Animal is anchored
12=Swelling or hemorrhage.
14=Listlessness/inability to defend itself

A '?' beside the code number indicates that such injury was probably sustained. Animals with types of injury matching at least one of criteria 1-10 were considered to be seriously injured (S.I. = 'Y') and were assumed to have died. Other types of injury were not considered serious (S.I. = ' N ') and the animal was assumed to have survived.

# WEST INDIAN MANATEE (Trichechus manatus latirostris) FLORIDA STOCK <br> U.S. Fish and Wildlife Service, Jacksonville, Florida 

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Manatees are typically found in the temperate and equatorial waters of the southeastern U.S., the Caribbean basin, northern and northeastern South America, and equatorial West Africa. Their near relative, the dugong (Dugong dugon), is found in the Indo-Pacific region. At present, manatees of the genus Trichechus are represented by three allopatric species: T. senegalensis, the West African manatee, T. inunguis, the Amazonian manatee, and T. manatus, the West Indian manatee. The West Indian species is subdivided into two subspecies, the Antillean manatee (Trichechus manatus manatus) and the Florida manatee (Trichechus manatus latirostris) (U.S. Fish and Wildlife Service, 1989). Such subspeciation may reflect reproductive isolation brought on by the intemperate northern coast of the Gulf of Mexico and characteristically strong currents found in the Straits of Florida (Domning and Hayek, 1986).

Historically, the winter range of the Florida manatee (Trichechus manatus latirostris) was thought to focus on south Florida, with some animals ranging north of Charlotte Harbor on Florida's west coast and north of Sebastian on Florida's east coast. Extralimital movements occurred and were typically seasonal, with animals travelling north during warmer periods and travelling south as temperatures declined. While most manatees wintered in south Florida, some were known to winter in natural spring areas to the north (Hartman, 1974). With the advent of artificial warm water refugia, the spread of exotic submerged aquatic vegetation, and increased protective measures, the manatee's winter range has expanded significantly (Beeler and O'Shea, 1988). On the east coast, manatees are now known to winter as far north as southeastern Georgia and, on the west coast, as far north as Crystal River, Florida. Documentation of manatee movements between Gulf and Atlantic coast populations in far south Florida is lacking, presumably because lack of suitable habitat in Florida Bay is not conducive to such movements, but significant genetic variation between coastal populations has not been demonstrated (McClenaghan and O'Shea 1988). Range extremes extend north to Virginia on the Atlantic coast and west to Louisiana on the Gulf coast. The number of sighting reports outside of Florida has increased in recent years.

## POPULATION SIZE

## Minimum Population Estimate

The exact population size for Florida manatees is unknown but the minimum population is estimated at 1,822 animals, based on intensive statewide winter aerial surveys at warm-water refuges coordinated by the Florida Department of Environmental Protection in early February of 1995 (FDEP 1995). A previous high count of 1856 manatees was obtained in a survey conducted in 1992 (Ackerman, 1992). While not a statistical estimate, this count provides the best available data on the minimum size of the population.

## Population Trends

Manatee population trends are poorly known but, based on the results of a carcass recovery program, deaths have increased by an average of 5.9 percent per year in Florida from 1976 through 1992 (Ackerman et al. In press). Garrott et al.'s (1994) analysis of trends at winter aggregation sites suggest a mean annual increase of 7-12 percent in adjusted counts at sites on the east coast from 1978-1992, noting that this figure exceeds Packard's conservative estimate of maximum potential rate of increase for manatees of 2-7 percent annually (Packard 1985). Reynolds and Wilcox (1994) reported a decline in the percentage and number of calves seen at power plant aggregation sites during recent winter aerial surveys. It is not clear at this time whether this is related to increases in perinatal mortality or to some other factor.

Marmontel (1994) conducted a population viability analysis through computer simulations using 16 years of data and material collected by the carcass recovery program. This study yielded information on age-related aspects of mortality and reproduction for the Florida manatee population. A scenario, calculated from the data, having an initial population size of 2,000 individuals resulted in a gradually declining population ( $\mathrm{r}=-0.003$ ), a probability of persistence of 44 percent in 1,000 years, and a mean final population size of less than 10 percent of the original value. When adult mortality was reduced by 10 percent in the model, population growth improved considerably, but when adult mortality
was increased by 10 percent the population quickly dwindled. These results clearly indicate that the Florida manatee population is still at high risk of extinction in the long term. Any negative change in the population parameters, caused by environmental changes or a catastrophe, might tip the balance towards greater risk of extinction.

## ANNUAL HUMAN-CAUSED MORTALITY

Manatee deaths resulting from human activities are well documented through a carcass recovery program, initiated in 1974. Causes of death include collisions with large and small boats, crushing by barges and man made water control structures (flood gates/canal locks), entanglement in nets and lines, entrapment in culverts, poaching, entanglement in, and ingestion of marine debris (e.g., monofilament), and others (Ackerman et al., In press).

From 1974 through 1994, 2,456 manatee carcasses were recovered in the southeastern U.S. Eight hundred and two ( 33 percent) were attributed to human-related causes. Of these, 613 were caused by collisions with watercraft, 111 were flood gate/canal lock-related, and another 78 were categorized as other human-related. In Florida, humanrelated mortality accounted for the greatest proportion of deaths with identifiable causes ( 45 percent, with another 24 percent of deaths resulting from undetermined causes) from 1986-1992. Collisions with watercraft accounted for 83 percent of human-related causes of death during this period (Ackerman et al. 1994, Wright et al. 1994). Watercraftrelated deaths increased by an average of 9.3 percent per year from 1974 to 1992, increasing as a percentage of total deaths from 21 percent in 1976-1980 to 28 percent from 1986-1992 (Ackerman et al., In press). Overall, watercraft collisions account for approximately $25 \%$ of all manatee deaths.

The highest known annual mortality for the Florida manatee in any given year occurred in 1990 when 214 deaths (206 of which occurred in Florida) were recorded (Ackerman et al. 1994). In 1994, the second highest annual level of mortality on record occurred, when 193 carcasses were recovered (FDEP 1995).

## FISHERIES INFORMATION

Manatee deaths have been attributed to inshore and nearshore commercial fishing activity. Fisheries gear involved in these incidents include shrimp nets, crab trap lines, hoop nets, and a trotline (National Marine Fisheries Service, 1992; Beck, C.A. and N.B. Barros, 1991). Recreational fishing activities have also been implicated in manatee deaths; manatees have died as a result of ingesting monofilament line and fishing tackle and from entanglement in monofilament line, crab trap lines, and cast nets. Non-lethal entanglement associated with these gear types, sometimes resulting in the loss of a flipper due to constriction, is also known to occur. Collisions with fishing boats probably occur; however, it is not possible to determine the extent to which this occurs.

While fisheries have been implicated in the deaths of manatees, the number of such incidents is low. The manatee carcass recovery program has identified 17 manatee deaths which are directly attributable to commercial fisheries gear (FDEP Manatee Mortality Database, 1994). Fishing gear is suspected in three additional deaths. "Because total annual manatee mortality is increasing, the population is small, and reproduction is low, incidental mortality from commercial fisheries, when added to other human-related mortality, could be significant if not critical to the manatee population" (Young et al., 1993).

The majority of the manatee deaths attributed to commercial fisheries involve the shrimping industry. Mortalities have occurred in northeast Florida (Duval County), east central Florida (Volusia County), and the Florida Panhandle area (Franklin County), as well as in coastal waters of Georgia and South Carolina where shrimping is permitted. Other fishery interactions have occurred throughout the manatee's range in Florida. No distinct seasonality has been associated with these events (FDEP Manatee Mortality Database, 1994).

## STATUS OF STOCK

The Florida manatee is listed as "endangered" under provisions of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), as amended. The manatee is considered a "strategic stock" as defined in Section 12 of the Marine Mammal Protection Act of 1972, as amended. The basis for this designation is the high level of documented mortality (natural and human-related) relative to the estimated population level and continuing, severe threats to critical manatee habitats in the southeastern U.S.

## POTENTIAL BIOLOGICAL REMOVAL

Because of its endangered status, the recovery factor for the Florida manatee should be 0.1 , the lowest allowable figure. Given a minimum population estimate of 1,822 and an $\mathrm{R}_{\max }$ (maximum net productivity rate) of 0.04 , the Potential Biological Removal (PBR) rate for manatees is as follows:

$$
\operatorname{PBR}=(1822)\left(.02, \text { or } 1 / 2 R_{\max }\right)(.1)=3
$$

The calculated PBR level is greatly exceeded by known human-related manatee mortality (primarily watercraft collisions and water control structure deaths) every year in Florida. For this reason, and because current efforts of the Florida Manatee Recovery Team focus intensively on the reduction of these major types of mortality, the determination of the PBR level for manatees is of limited value. The excessive level of documented manatee mortality and the resulting unlikelihood of attaining Optimum Sustainable Population (OSP) make the calculation of meaningful PBR for manatees a difficult exercise. Marmontel's (1994) estimate of net productivity is essentially zero (-0.003). Substituting this value for the default value for maximum net productivity rate ( 0.04 ) in the above equation results in a PBR level of 0 .

The U.S. Fish and Wildlife Service has consistently concluded in Section 7 Biological Opinions, pursuant to the Endangered Species Act, that the take of a single manatee would "jeopardize the continued existence" of the species. We therefore believe that designating any level of take for manatees would be inappropriate and inconsistent with the revised Florida Manatee Recovery Plan.

## REFERENCES

Ackerman, B.B., S.D. Wright, R.K. Bonde, D.K. Odell, and D.J. Banowetz. (In press). Trends and patterns in mortality in Florida, 1974-1992. In T.J. O'Shea, B.B. Ackerman, and H. F. Percival, editors. Population Biology of the Florida manatee (Trichechus manatus latirostris). National Biological Service, Biological Report.
Ackerman, B.B. 1992. Ongoing manatee aerial survey programs: a progress report. In: O'Shea, T.J., B.B. Ackerman, and H.F. Percival (eds.). 1992. Interim report of the technical workshop on manatee population biology. Manatee Population Research Report No. 10. Florida Cooperative Fish and Wildlife Research Unit. University of Florida, Gainesville, FL 83 pp.
Beck, C.A. and N.B. Barros. 1991. The impact of debris on the Florida manatee. Marine Pollution Bulletin 22(10): 508-510.
Beeler, I.E. and T.J. O'Shea. 1988. Distribution and mortality of the West Indian Manatee (Trichechus manatus) in the Southeastern United States: a compilation and review of recent information. Natl. Tech. Inf. Ser., PB88207980/AS: Springfield, VA. Two volumes, 613 pp.
Domning, D.P. and L.C. Hayek. 1986. Interspecific and intraspecific morphological variation in manatees (Sirenia: Trichechus)," Marine Mammal Science. 2:87-144.
Florida Department of Environmental Protection. 1995. Manatee mortality database, 1974-1994. Florida Marine Research Institute, Marine Mammal Pathobiology Laboratory.
Florida Department of Environmental Protection. Press Release, February 9, 1995.
Garrott, R.A., B.B. Ackerman, J.R. Cary, D. M. Heisey, J.E. Reynolds, III, P.M. Rose, and J.R. Wilcox. 1994. 15-year trends in counts of Florida manatees at winter aggregation sites. Journal of Wildlife Management 58 (4):642654.

Hartman, D.S. 1974. Distribution, status, and conservation of the manatee in the United States. Natl. Tech. Inf. Ser., PB81-140725, Springfield, VA. 246 pp.
Marmontel, M. (In press). Age and reproductive parameter estimates in female Florida manatees. In: T.J. O'Shea, B.B. Ackerman, and H.F. Percival, eds. Population biology of the Florida manatee (Trichechus manatus latirostris). National Biological Service, Biological Report.
McClenaghan, L.R. and T.J. O'Shea. 1988. Genetic variability in the Florida manatee (Trichechus manatus). J. Mamm., 69 (3):481-488.
National Marine Fisheries Service. 1992. Proposed Regime to Govern Interactions Between Marine Mammals and Commercial Fishing Operations. Silver Spring, MD. 96 pp.
O'Shea, T.J., G.B. Rathbun, R.K. Bonde, C.D. Buergelt, and D.K. Odell. 1991. An epizootic of Florida manatees associated with a dinoflagellate bloom. Marine Mammal Science 7(2): 165-179.
Packard, J.M. 1985. Preliminary assessment of uncertainty involved in modeling manatee populations. Manatee population Research Report No. 9. Technical Report No. 8-9. Florida Cooperative Fish and Wildlife Research Unit. University of Florida, Gainesville, Florida. 19 pp.

Reynolds, J.E., III and J.R. Wilcox. 1994. Observations of Florida manatees (Trichechus manatus latirostris) around selected power plants in winter. Marine Mammal Science 10(2): 143-177.
U.S. Fish and Wildlife Service. 1989. Florida Manatee (Trichechus manatus latirostris) Recovery Plan. Prepared by the Florida Manatee Recovery Team for the U.S. Fish and Wildlife Service, Atlanta, GA. 98 pp.
Wright, S.D., B.B. Ackerman, R.K. Bonde, C.A. Beck, and D.J. Banowetz. (In press). Analysis of watercraft-related mortalities of manatees in Florida, 1979-1991. In: T.J. O'Shea, B.B. Ackerman, and H. F. Percival, editors. Population Biology of the Florida manatee (Trichechus manatus latirostris). National Biological Service, Biological Report.
Young, N.M., S. Iudicello, K. Evans, and D. Baur. 1993. The incidental capture of marine mammals in U.S. fisheries: problems and solutions. Center for Marine Conservation, Washington, D.C. 415 pp .

# WEST INDIAN MANATEE ((Trichechus manatus manatus) ANTILLEAN STOCK 

U.S. Fish and Wildlife Service, Jacksonville, Florida

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Manatees are typically found in the temperate and equatorial waters of the southeastern U.S., the Caribbean basin, northern and northeastern South America, and equatorial West Africa. Their nearest relative, the dugong (Dugong dugon), is found in the Indo-Pacific region. At present, manatees of the genus Trichechus are represented by three allopatric species: T. senegalensis, the West African manatee, T. inunguis, the Amazonian manatee, and T. manatus, the West Indian manatee (U.S. Fish and Wildlife Service, 1986). The West Indian species is subdivided into two subspecies, the Antillean manatee (Trichechus manatus manatus) and the Florida manatee (Trichechus manatus latirostris). Such subspeciation may reflect reproductive isolation brought on by the intemperate northern coast of the Gulf of Mexico and characteristically strong currents found in the Straits of Florida (Domning and Hayek, 1986).

The Antillean manatee is found in eastern Mexico, Central America, northern and eastern South America, and in the Greater Antilles (Lefebvre et al., 1989). In Puerto Rico, the manatee is most abundant along the south and east coasts, particularly in the area of Fajardo and Ceiba (Roosevelt Roads Naval Station) and in the Jobos Bay area between Guayama and Salinas. In general, manatees are not abundant on the north coast although they are infrequently seen in areas immediately to the west of San Juan (Mignucci Giannoni, 1989, Caribbean Stranding Network, unpubl. data). Manatees are rarely seen near Culebra Island and are generally absent from Mona Island and the Virgin Islands (Caribbean Stranding Network, unpubl. data). The U.S. has jurisdictional responsibilities for the Antillean subspecies only in Puerto Rico and the U.S. Virgin Islands.

## POPULATION SIZE

The exact number of Antillean manatees known to occur in Puerto Rico is unknown but, based on aerial surveys conducted on July 16 and 17, 1994, this population includes at least 86 individuals (Oland, pers. comm.). Manatees are virtually unknown from the U.S. Virgin Islands (Lefebvre et al., 1989). A rare sighting and stranding was reported here in 1988 (Caribbean Stranding Network, unpubl. data).

## Population Trends

Quantitative information is limited regarding trends in the abundance of the Antillean manatee, although "[h]istorical accounts indicate that manatees were once more common and that hunting has been responsible for declining numbers throughout much of their range" (Lefebvre et al., 1989).

In Puerto Rico, efforts have been made to assess the status of the Antillean manatee by conducting aerial surveys and by means of a carcass salvage program. Aerial surveys were initiated in 1978 and have continued sporadically to the present. Carcass salvage efforts were initiated in April 1974, by the U.S. Fish and Wildlife Service (Rathbun et al., 1986). In 1989, the Caribbean Stranding Network initiated a dedicated salvage, rescue, and rehabilitation program and has assumed responsibility for all carcass recovery efforts in Puerto Rico. Despite these assessments, limited information exists by which to determine trends in this population of manatees.

Based largely on historical accounts and increasing human pressures, the Antillean manatee as a subspecies appears to be in decline. However, efforts to quantify population levels and trends are preliminary and there are no conclusive indications as to whether or not the population of Antillean manatees is stable, increasing, or decreasing either in Puerto Rico or throughout its range.

## ANNUAL HUMAN-CAUSED MORTALITY

Since the inception of Puerto Rico's manatee carcass salvage program, 70 manatee deaths have been recorded from that area (Caribbean Stranding Network, unpubl. data). Many of the deaths have been attributed to human-related causes. Carcass collection efforts have documented mortalities associated with nets and watercraft ( $\mathrm{N}=37$ ). Many netrelated mortalities involve poaching and are not substantiated by the presence of a carcass (Rathbun et al., 1985). From 1974 until 1988, 41.5 percent of the documented mortality was attributed to poaching. Watercraft-related mortalities are increasing. During the period 1988 to 1991, watercraft-related mortalities accounted for 43 percent of the known mortalities (U.S. Fish and Wildlife Service, 1992).

## FISHERIES INFORMATION

In Puerto Rico, fisheries interactions have been documented through the carcass recovery program and in numerous anecdotal reports. Manatees are captured primarily in gill and/or turtle nets either intentionally or inadvertently during fishing activities. Reports indicate that manatee meat is sold to ready buyers, although the extent to which this occurs is unknown (Mignucci et al., 1993). Given the scarcity of detailed information, little is known about capture sites, seasonality of occurrence, etc. (Rathbun et al., 1985). Because these deaths account for a substantial proportion of known human-related mortalities (and because of the prevalence of fishery reports), it is apparent that fisheries interactions significantly affect the status of the manatee in Puerto Rico.

## STATUS OF STOCK

The manatee is listed as "endangered" under provisions of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), as amended. The manatee is considered a "strategic stock" as defined in Section 12 of the Marine Mammal Protection Act of 1972, as amended. The basis for this designation is the high level of documented mortality relative to the estimated population level and continuing, severe threats to critical manatee habitats throughout its range.

## POTENTIAL BIOLOGICAL REMOVAL

Because of its endangered status, the recovery factor for the Antillean manatee in Puerto Rico should be 0.1, the lowest allowable figure. Given a minimum population estimate of 86 and an $\mathrm{R}_{\max }$ (maximum net productivity rate) of 0.04, the Potential Biological Removal (PBR) rate for Antillean manatees in Puerto Rico and the U.S. Virgin Islands is as follows:

$$
\text { PBR }=(86)\left(.02, \text { or } 1 / 2 R_{\max }\right)(.1)=0
$$

We currently have insufficient knowledge of the Puerto Rican manatee population to determine the Optimum Sustainable Population. Inadequate information on population size and net productivity rate for manatees in Puerto Rico render the calculation of a PBR level for this population an exercise of limited value. Marmontel (1994) estimated net productivity for the Florida manatee population. This estimate, based largely on a long term sex and age dataset for that population, suggested that the net productivity was essentially zero $(-0.003)$. When the default value above $(0.2)$ is replaced with this empirical value, the equation results in a PBR level of zero.

The U.S. Fish and Wildlife Service has consistently concluded in Section 7 Biological Opinions, pursuant to the Endangered Species Act, that the take of a single manatee would "jeopardize the continued existence" of the species. We therefore believe that designating any level of take for Antillean manatees would be inappropriate and inconsistent with manatee recovery plans.

## REFERENCES

Ackerman, B.B., S.D. Wright, R.K. Bonde, D.K. Odell, and D.J. Banowetz. (In press). Trends and patterns in mortality in Florida, 1974-1992. In: T.J. O'Shea, B.B. Ackerman, and H. F. Percival, editors. Population Biology of the Florida manatee (Trichechus manatus latirostris). National Biological Service, Biological Report.
Domning, D.P. and L.C. Hayek. 1986. Interspecific and intraspecific morphological variation in manatees (Sirenia: Trichechus). Marine Mammal Science 2:87-144.
Freeman, J. and H. Quintero. 1990. The distribution of West Indian manatees (Trichechus manatus) in Puerto Rico: 1988-1989. NTIS PB91-137240. Springfield, VA. 43 pp.
Lefebvre, L.W., T.J. O'Shea, G.B. Rathbun and R.C. Best. 1989. Distribution, status, and biogeography of the West Indian manatee. Biogeography of the West Indies, 1989: 567-610.
Marmontel, M. (In press). Age and reproductive parameter estimates in female Florida manatees. In: T.J. O'Shea, B.B. Ackerman, and H.F. Percival, eds. Population biology of the Florida manatee (Trichechus manatus latirostris). National Biological Service, Biological Report.
Mignucci Giannoni, A.A. 1989. Zoogeography of marine mammals in Puerto Rico and the Virgin Islands. Unpublished master's thesis, The University of Rhode Island, Kingston, RI.
Mignucci Giannoni, A.A. 1990. Manatee mortality in Puerto Rico: urgent need for assessment and preventive action. Whalewatcher, Journal of the American Cetacean Society, 24(1): 10-12.
Mignucci Giannoni, A.A., E.H. Williams, B. Pinto Rodríguez and R.A. Montoya Ospina. 1991. Marine mammal mortality assessment in the Caribbean and the established Caribbean Stranding Network. Presented at the Ninth Biennial Conference on the Biology of Marine Mammals, Chicago, IL, 7 December.
Mignucci Giannoni, A.A., B. Pinto-Rodriguez, R.A. Montoya-Ospina, D.P. Moore, and E.H. Williams. 1993. Stranding and mortality assessment of marine mammals in Puerto Rico and the Virgin Islands. Presented at the Tenth Biennial Conference on the Biology of Marine Mammals, Galveston, TX, 11-16 November.

National Marine Fisheries Service. 1992. Proposed Regime to Govern Interactions Between Marine Mammals and Commercial Fishing Operations. Silver Spring, MD. 96 pp.
Oland, J.P. 1994. Personal communication, July 19, 1994. From: James P. Oland, Supervisor, FWS Caribbean Field Office, Boqueron, PR. To: Robert O. Turner, Manatee Recovery Coordinator, FWS Jacksonville Field Office, Jacksonville, FL.
Rathbun, G.B., Carr, N., Carr, T., and C.A. Woods. 1985. The distribution of manatees and sea turtles in Puerto Rico, with emphasis on Roosevelt Roads Naval Station. NTIS PB 85-151847 AS. Springfield, VA. 83 pp.
U.S. Fish and Wildlife Service. 1986. Recovery plan for the Puerto Rico population of the West Indian manatee (Trichechus manatus manatus L.). Prepared by: G.B. Rathbun and E. Possardt for the U.S. Fish and Wildlife Service, Atlanta, GA. 28 pp.
U.S. Fish and Wildlife Service. 1992. Letter dated June 4, 1992, to the U.S. Army Corps of Engineers from the FWS Caribbean Field Office, Boqueron, PR.
Young, N.M., S. Iudicello, K. Evans, and D. Baur. 1993. The incidental capture of marine mammals in U.S. fisheries: problems and solutions. Center for Marine Conservation, Washington, D.C. 415 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 197881 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.

## 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 $70^{\circ}$ in the Davis Strait, along the east coast of Greenland to $77^{\circ}$ and from England to the west coast of Spitzbergen. It is largely a deepwater species and is very seldom found in waters less than $2,000 \mathrm{~m}$ 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.

## August 1997

## 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 ( $\mathrm{CV}=0.69$ ) 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 $(C I)=2,001-4,971$ ] 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 $\left(\mathrm{N}_{\text {best }}\right)$ and coefficient of variation (CV). Unk=unknown.

| Month/Year | Area | $\mathrm{N}_{\text {best }}$ | CV |
| :--- | :--- | ---: | ---: |
| spring 1978-82 | Cape Hatteras, NC <br> to Nova Scotia | 573 | 0.69 |
| 1980 's | E. Newfoundland <br> 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.

## 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 ( $>2,000 \mathrm{~m}$ ) 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 $(\mathrm{CV}=0.35)$.

## 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 $(\mathrm{CV}=0.35)($ 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 <br> Mortality ${ }^{4}$ | $\begin{gathered} \text { Estimated } \\ \text { CVs }^{4} \end{gathered}$ | Mean <br> Annual <br> Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 92-96 | $\begin{aligned} & 1994=12 \\ & 1995=11 \\ & 1996=10 \end{aligned}$ | Obs. Data Logbook | $\begin{gathered} .40, .42, \\ .87, .99 \\ .64 \end{gathered}$ | $\begin{gathered} 1,0,0,0 \\ 0 \end{gathered}$ | $\begin{gathered} 1.4,0.5,0 \\ 0^{5}, 0 \end{gathered}$ | $\begin{gathered} .31,1.0,0, \\ 0,0 \end{gathered}$ | $\begin{aligned} & 0.31 \\ & (.35) \end{aligned}$ |
| TOTAL |  |  |  |  |  |  |  | $\begin{aligned} & 0.31 \\ & (.35) \end{aligned}$ |

21994 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.

## 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 $82,000(\mathrm{SE}=12,636)$ 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 $\left(\mathrm{N}_{\text {min }}\right)$ and coefficient of variation (CV).

| Month/Year | Area | $\mathrm{N}_{\min }$ | 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 $\left(\mathrm{F}_{\mathrm{R}}\right)$ 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 $\mathrm{PBR}=24,000$ 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 $50^{\circ} \mathrm{N}$ ) 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 ( $\mathrm{CV}=0.96$; 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 $(C V=0.96)$. 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 <br> Mortality | Estimated <br> Mortality | $\begin{gathered} \text { Estimated } \\ \text { CVs } \end{gathered}$ | Mean <br> Annual Mortality |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| New England Multispecies Sink Gillnet | 92-96 | 349 | Obs. Data Weighout, Logbooks | $\begin{gathered} .07, .05 \\ .07, .05 \\ .04 \end{gathered}$ | $\begin{gathered} 0,0,0,1, \\ 0 \end{gathered}$ | $0,0,0,28,0$ | $\begin{gathered} 0,0,0, \\ .96,0 \end{gathered}$ | $\begin{gathered} 5.6 \\ (.96) \end{gathered}$ |
| TOTAL |  |  |  |  |  |  |  | $\begin{gathered} 5.6 \\ (.96) \end{gathered}$ |

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.

# SPERM WHALE (Physeter macrocephalus): Northern Gulf of Mexico Stock 

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Sperm whales are found throughout the world's oceans in deep waters from between about $60^{\circ} \mathrm{N}$ and $60^{\circ} \mathrm{S}$ latitudes (Leatherwood and Reeves 1983; Rice 1989). There has been speculation, based on year round occurrence of strandings, opportunistic sightings, and whaling catches, that sperm whales in the Gulf of Mexico may constitute a distinct stock (Schmidly 1981), but there is no information on stock differentiation. Seasonal aerial surveys confirm that sperm whales are present in the northern Gulf of Mexico in all seasons, but sightings are more common during the summer months (Mullin et al. 1991; Davis et al., in preparation).

## 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 1991-1994 springsummer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of sperm whales by survey year [coefficient of variation (CV) in parentheses] was 143 in 1991 (0.58), 931 in 1992 (0.48), 229 in 1993 (0.52), and 771 in 1994 (0.42) (Hansen et al. 1995). Survey effort-weighted estimated average abundance of sperm whales for all surveys combined was $530(\mathrm{CV}=0.31)$ (Hansen et al. 1995).


Figure 1. Distribution of sperm whale sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two ship surveys and are examples of typical ship survey transects. Isobaths are in 183 m (100 fm) intervals.

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate was calculated from the 1991-1994 average abundance estimate of 530 sperm whales $(C V=0.31)$ (Hansen et al. 1995) and is 411 sperm whales.

## Current Population Trend

No trend was discernable in the average annual abundance estimates. All of the log-normal $95 \%$ confidence intervals of the annual estimates overlap, indicating that the estimates were not significantly different at that level. The variation in abundance estimates may represent inter-annual variation in distribution, rather than a change in abundance.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was 0.10 because sperm whales are an endangered species. The resulting PBR for this stock is 0.8 sperm whales.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

A commercial fishery for sperm whales operated in the Gulf of Mexico during the late 1700's to the early 1900's, but the exact number of whales taken is not known (Townsend 1935).

The level of current, direct, human-caused mortality and serious injury of sperm whales in the northern Gulf of Mexico is unknown, but available information indicates there likely is little, if any, fisheries interaction with sperm whales in the northern Gulf of Mexico.

There were no documented strandings of sperm whales in the northern Gulf of Mexico during 1987-1994 which were 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 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.

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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury to sperm whales by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## Other Mortality

A total of nine sperm whale strandings were documented in the northern Gulf of Mexico during 1987-1994. One of the whales had deep, parallel cuts posterior to the dorsal ridge that were believed to be caused by the propeller of a large vessel. This trauma was assumed to be the proximate cause of this stranding.

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

Stock size is considered to be low relative to OSP and the species is therefore listed as endangered under the Endangered Species Act (ESA). There are insufficient data to determine population trends. The total level of humancaused mortality and serious injury is unknown, but it is believed to be insignificant; however, because this species is listed as endangered and there is presently no recovery plan in place, any fishery-related mortality would be unlawful. This is a strategic stock because the sperm whale is listed as an endangered species under the ESA.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris, and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the north-central and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, $9 \mathrm{pp} .+$ tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.
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.
Rice, D. W. 1989. Sperm whale, Physeter macrocephalus Linnaeus, 1758. Pages 177-233 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 4: river dolphins and the larger toothed whales. Academic Press, London, 442 pp.
Schmidly, D. J. 1981. Marine mammals of the southeastern United States and the Gulf of Mexico. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC, FWS/OBS-80/41, 165 pp.
Townsend, C. H. 1935. The distribution of certain whales as shown by logbook records of American whale ships. Zoologica 19: 1-50.

## BRYDE'S WHALE (Balaenoptera edeni): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Bryde's whales are considered the tropical and sub-tropical baleen whale of the world's oceans. In the western Atlantic, Bryde's whales are reported from off the southeastern United States and the southern West Indies to Cabo Frio, Brazil (Leatherwood and Reeves 1983). It is postulated that the Bryde's whales found in the Gulf of Mexico may represent a resident stock (Schmidly 1981; Leatherwood and Reeves 1983), but there is no information on stock differentiation. Most sightings of Bryde's whales have occurred during the spring-summer months (Hansen et al. 1995; Davis et al., in preparation), but strandings have occurred throughout the year (Jefferson et al. 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 1991-1994 springsummer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. The estimated abundance of Bryde's whales by survey year was 218 in 1991 (coefficient of variation, $\mathrm{CV}=$ 1.01) and zero in 1992, 1993, and 1994 (Hansen et al. 1995). Survey effort-weighted estimated average abundance of Bryde's whales for all surveys combined was $35(\mathrm{CV}=1.10)$ (Hansen et al. 1995) and was based on only three sightings, all of which occurred in 1991.


Figure 1. Distribution of Bryde's whale sightings (filled circles) and unidentified balaenopterid whales (unfilled circles) during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two ship surveys and are examples of typical ship survey transects. Isobaths are in 183 m (100 fm) intervals.

## Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the lognormal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate was based on the 1991-1994 average estimated abundance of Bryde's whales which was $35(C V=1.10)($ Hansen et al. 1995) and is 17 Bryde's whales.

## Current Population Trend

The abundance estimates decreased to zero for survey years 1992-1994 because Bryde's whales were not sighted during vessel surveys those years. This could be due to chance rather than to a decrease in population size and the result of a relatively small population size and low sampling intensity or it could be due to inter-annual variation in distribution.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. The resulting PBR for this stock is 0.2 Bryde's whales.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of Bryde's whales in the northern Gulf of Mexico is unknown, but available information indicates there is little fisheries interaction with Bryde's whales in the northern Gulf of Mexico. There was one report of a Bryde's whale entangled in line, but the line was removed and the animal released alive.

There were no documented strandings of Bryde's whales in the northern Gulf of Mexico during 1987-1994 which were 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 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.

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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about 5\% observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury to Bryde's whales by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## Other Mortality

No human-caused mortality has been reported for this stock.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the north-central and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National

Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Jefferson, T. A., S. Leatherwood, L. K. M. Shoda and R. L. Pitman. 1992. Marine mammals of the Gulf of Mexico: a field guide for aerial and shipboard observers. Texas A\&M University Printing Center, College Station, Texas, 92 pp .
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.
Schmidly, D. J. 1981. Marine mammals of the southeastern United States and the Gulf of Mexico. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC, FWS/OBS-80/41, 165 pp .

## CUVIER'S BEAKED WHALE (Ziphius cavirostris): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Cuvier's beaked whales are distributed throughout the world's oceans except for the polar regions (Leatherwood and Reeves 1983; Heyning 1989). Strandings have occurred in all months along the United States east coast (Schmidly 1981) and have been documented throughout the year in the Gulf of Mexico. Strandings of Cuvier's beaked whales along the west coast of North America, based on skull characteristics, are thought to represent members of a panmictic population (Mitchell 1968), but there is no information on stock differentiation in the Gulf of Mexico and nearby waters.

Beaked whales were seen in all seasons during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico (Davis et al., in preparation). Some of the aerial survey sightings may have included Curvier's beaked whale, but identification of beaked whale species from aerial surveys is problematic.

## 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 1991-1994 springsummer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. The estimated abundance [coefficient of variation (CV) in parentheses] by survey year was zero in 1991and 1992, 70 in 1993 (0.63), and 38 in 1994 (0.80) (Hansen et al. 1995). Survey effort-weighted estimated average abundance average abundance of Cuvier's beaked whales was $30(\mathrm{CV}=0.50)$ (Hansen et al. 1995). The estimated abundance of Curvier's beaked whales is probably low because only sightings of beaked whales which could be positively identified to species were used.

## Minimum Population Estimate

The minimum population estimate was based on


Figure 1. Distribution of Curvier's beaked whale sightings (filled circles) and unidentified beaked whale sightings (unfilled circles) during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical ship survey transects. Isobaths are in 183 m ( 100 fm ) intervals. average estimated abundance of
 population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 20 Cuvier's beaked whales.

## Current Population Trend

The abundance estimates were zero in 1991 and 1992, and then increased for 1993 and 1994. Cuvier's beaked whales were not sighted during the 1991 and 1992 vessel surveys. This could be due to chance given the small estimated population size and sampling intensity or inter-annual variation in distribution, rather than a change in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 0.2 Cuvier's beaked whales.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Cuvier's beaked whales were taken occasionally in a small, directed fishery for cetaceans that operated out of the Lesser Antilles (Caldwell and Caldwell 1971).

The actual level of past or current, direct, human-caused mortality of Cuvier's beaked whales in the northern Gulf of Mexico is unknown, but there have been no reports of fishery-related mortality or serious injury to beaked whales by U.S. fisheries in the Gulf of Mexico. Available information indicates there likely is little, if any, fisheries interaction with Cuvier's beaked whales in the northern Gulf of Mexico.

There were no documented strandings of Cuvier's beaked whales in the northern Gulf of Mexico during 19871994 which were 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 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.

Total 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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about 5\% observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury to Cuvier's or any beaked whales by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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. 1971. Beaked whales, Ziphius cavirostris, in the Bahamas. Florida Academy of Science Quarterly Journal. 34: 157-160.
Cramer, J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the north-central and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National

Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Heyning, J. E. 1989. Cuvier's beaked whale Ziphius cavirostris G. Cuvier, 1923. Pages 289-308 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales, Academic Press, London, 442 pp.
Jefferson, T. A., S. Leatherwood, L. K. M. Shoda and R. L. Pitman. 1992. Marine mammals of the Gulf of Mexico: a field guide for aerial and shipboard observers. Texas A\&M University Printing Center, College Station, 92 pp.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.
Schmidly, D. J. 1981. Marine mammals of the southeastern United States and the Gulf of Mexico. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC, FWS/OBS-80/41, 165 pp.

## BLAINVILLE'S BEAKED WHALE (Mesoplodon densirostris): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Only three species of Mesoplodon are known, from strandings and/or sightings, to occur in the Gulf of Mexico (Jefferson et al. 1992; Hansen et al. 1995). These are Blainville's beaked whale (M. densirostris), Gervais' beaked whale (M. europaeus), and Sowerby's beaked whale (M. bidens). The occurrence of Sowerby's beaked whale in the Gulf of Mexico is considered extralimital because there is only one known stranding of this species in the Gulf of Mexico (Bonde and O'Shea 1989) and because it normally occurs in northern temperate waters of the North Atlantic (Mead 1989).

Identification of Mesoplodon species at sea is problematic; therefore, nearly all sightings of these species are identified as beaked whales and may include sightings of Ziphius cavirostris that were not identified as such. Beaked whales were seen in all seasons during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico (Davis et al., in preparation).

Blainville's beaked whales appear to be widely but sparsely distributed in warm temperate and tropical waters of the world's oceans (Leatherwood et al. 1976; Leatherwood and Reeves 1983). Strandings have occurred along the northwestern Atlantic coast from Florida to Nova Scotia (Schmidly 1981), and there have been two documented strandings of this species in the northern Gulf of Mexico and one sighting (Jefferson et al. 1992; Hansen et al. 1995). There is no information on stock differentiation.

## POPULATION SIZE

Estimates of abundance of beaked whales 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Survey effort-weighted estimated average abundance of beaked whales not identified to species for all surveys combined was 117 (coefficient of variation, $\mathrm{CV}=$ 0.38) (Hansen et al. 1995). Estimated beaked whale abundance (CV in parentheses) by survey year was 129 in 1991 (0.78), 18 in 1992 (1.27), 53 in 1993 (0.78), and 287 in 1994 (0.48) (Hansen et al. 1995). These estimates may also include an unknown number of Cuvier's beaked whales (Ziphius cavirostris) and abundance of Blainville's beaked whale cannot be estimated due to uncertainty of species identification at sea.


Figure 1. Distribution of beaked whale sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m ( 100 fm ) intervals.

## Minimum Population Estimate

A minimum population estimate was not calculated because of uncertainty of species identification of sightings.

## Current Population Trend

The abundance estimates of beaked whales for 1991-1993 were lower than 1994, but there was considerable overlap of the log-normal $95 \%$ confidence intervals, which indicates the estimates were not significantly different at that
level. Any differences in abundance estimates could be due to chance given the small estimated population size and sampling intensity or a change in distribution, rather than a change in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was not calculated because the minimum population size cannot be calculated.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of beaked whales in the northern Gulf of Mexico is unknown, but there have been no documented reports of fishery-related mortality or serious injury to beaked whales by U.S. fisheries in the Gulf of Mexico. Available information indicates there likely is little, if any, fisheries interaction with beaked whales in the northern Gulf of Mexico.

There were no documented strandings of beaked whales in the northern Gulf of Mexico during 1987-1994 which were 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 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.

Although PBR cannot be calculated, the total known fishery-related mortality and serious injury for this stock is zero and, therefore, can be considered insignificant and approaching zero mortality and serious injury rate. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
Bonde, R. K. and T. J. O'Shea. 1989. Sowerby's beaked whale (Mesoplodon bidens) in the Gulf of Mexico. J. Mammal. 70: 447-449.
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.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the north-central and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National

Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Jefferson, T. A., S. Leatherwood, L. K. M. Shoda and R. L. Pitman. 1992. Marine mammals of the Gulf of Mexico: a field guide for aerial and shipboard observers. Texas A\&M University Printing Center, College Station, TX. 92 pp .
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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. NOAA Tech. Rep. NMFS CIRC-396, 176 pp.
Leatherwood, S. and R. R. Reeves. 1983. The Sierra Club handbook of whales and dolphins. Sierra Club Books, San Francisco, 302 pp.
Mead, J. G. 1989. Beaked whales of the genus Mesoplodon. Pages 349-430 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, London, 442 pp .

## GERVAIS' BEAKED WHALE (Mesoplodon europaeus): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Only three species of Mesoplodon are known, from strandings and/or sightings, to have occurred in the Gulf of Mexico (Jefferson et al. 1992; Hansen et al. 1995). These are Blainville's beaked whale (M. densirostris), Gervais' beaked whale (M. europaeus), and Sowerby's beaked whale (M. bidens). The occurrence of Sowerby's beaked whale in the Gulf of Mexico is considered extralimital because there is only one known stranding of this species in the Gulf of Mexico (Bonde and O'Shea 1989), and because it normally occurs in northern temperate waters of the North Atlantic (Mead 1989). Identification of Mesoplodon species at sea is problematic. Therefore, nearly all sightings of these species are identified as beaked whales and may include sightings of Ziphius cavirostris which were not identified as such. Beaked whales were seen in all seasons during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico (Davis et al., in preparation).

Strandings of Gervais' beaked whales have occurred along the northwestern Atlantic coast from Florida to New York (Mead 1989), and there have been at least ten documented strandings of this species in the Gulf of Mexico (Jefferson et al. 1992). There is no information on stock differentiation.

## POPULATION SIZE

Estimates of abundance of beaked whales 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Survey effort-weighted estimated average abundance of beaked whales not identified to species for all surveys combined was 117 (coefficient of variation, CV = 0.38) (Hansen et al. 1995). Estimated beaked whale abundance (CV in parentheses) by survey year was 129 in 1991 (0.78), 18 in 1992 (1.27), 53 in 1993 (0.78), and 287 in 1994 (0.48) (Hansen et al. 1995).

These estimates may also include an unknown number of Cuvier's beaked whales (Ziphius cavirostris) and abundance of Gervais' beaked whale cannot be estimated due to uncertainty of species identification at sea.


Figure 1. Distribution of beaked whale sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m ( 100 fm ) intervals.

## Minimum Population Estimate

A minimum population estimate could not be not calculated because of uncertainty of species identification of sightings.

## Current Population Trend

The abundance estimates of beaked whales for 1991-1993 were lower than 1994, but there was considerable overlap of the log-normal $95 \%$ confidence intervals, which indicates the estimates were not significantly different at that level. Any differences in abundance estimates could be due to chance given the small estimated population size and sampling intensity or a change in distribution, rather than a change in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was not calculated because the minimum population size cannot be calculated.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of beaked whales in the northern Gulf of Mexico is unknown, but there have been no documented reports of fishery-related mortality or serious injury to beaked whales by U.S. fisheries in the Gulf of Mexico. Available information indicates there likely is little, if any, fisheries interaction with beaked whales in the northern Gulf of Mexico.

There were no documented strandings of beaked whales in the northern Gulf of Mexico during 1987-1994 which were 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 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.

Although PBR cannot be calculated, the total known fishery-related mortality and serious injury for this stock is zero and, therefore, can be considered insignificant and approaching zero mortality and serious injury rate. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
Bonde, R. K. and T. J. O'Shea. 1989. Sowerby's beaked whale (Mesoplodon bidens) in the Gulf of Mexico. J. Mammal. 70: 447-449.
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.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the north-central and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.

Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Jefferson, T. A., S. Leatherwood, L. K. M. Shoda and R. L. Pitman. 1992. Marine mammals of the Gulf of Mexico: a field guide for aerial and shipboard observers. Texas A\&M University Printing Center, College Station, 92 pp.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. DISTANCE user's guide, V2.0. Colorado Cooperative Fish \& Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.
Mead, J. G. 1989. Beaked whales of the genus Mesoplodon. Pages 349-430 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, London, 442 pp .

## BOTTLENOSE DOLPHIN (Tursiops truncatus): Gulf of Mexico Outer Continental Shelf Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The Gulf of Mexico Outer Continental Shelf (OCS) bottlenose dolphin stock is assumed to consist of the shallow, warm water bottlenose dolphin ecotype hypothesized by Hersh and Duffield (1990) inhabiting waters over the U.S. OCS in the northern Gulf of Mexico from approximately 9 km seaward of the 18 m isobath to approximately 9 km seaward of the 183 m isobath and from the U.S.-Mexican border to the Florida Keys. The stock range may extend into Mexican and Cuban territorial waters; however, there are no available estimates of either abundance or mortality from those countries. As a working hypothesis, the bottlenose dolphins inhabiting the $0-18 \mathrm{~m}$ depth stratum are believed to constitute coastal stocks in the western, northern, and eastern U.S. Gulf of Mexico separate from the OCS stock; however, the OCS stock may overlap with coastal stocks in some areas and may be genetically indistinguishable from those stocks. The OCS stock may be combined with some or all of the coastal stocks when additional data become available.

In addition, the aerial surveys from which the current abundance estimates were derived overlapped the outer continental shelf edge which is believed to be inhabited by the OCS edge and continental slope stock (Fig. 1). This stock is believed to consist of the deep, cold water ecotype described by Hersh and Duffield for the Atlantic (1990). It is not currently possible to differentiate the two ecotypes visually during aerial surveys.

## POPULATION SIZE

Preliminary estimates of abundance were derived using distance sampling analysis (Buckland et al. 1993) and the computer program DISTANCE (Laake et al. 1993) with sighting data collected during Gulf of Mexico regional aerial line-transect surveys in September-October 1992 and 1993 (Blaylock and Hoggard 1994) and 1994 (NMFS unpublished data). Transects providing systematic coverage of the area and assumed to be randomly placed with respect to bottlenose dolphin distribution extended orthogonally from approximately 9 km past the 18 m isobath to approximately 9 km past the 183 m isobath. Approximately $3.3 \%$ of the total area was visually sampled. Preliminary analyses provided a bottlenose dolphin abundance estimate of 50,247 dolphins with coefficient of variation $(C V)=0.18$. The survey area overlapped with a portion of the area occupied by the OCS edge and continental slope stock which was assumed to occur in waters over the OCS edge and beyond to the seaward limits of the U.S. Exclusive Economic Zone. This would tend to inflate the abundance estimate, but it is not currently possible to estimate the amount of potential bias.


Figure 1. Sightings of U.S. Gulf of Mexico outer continental shelf (OCS) bottlenose dolphin stock during GOMEX regional aerial surveys (filled circles). Bottlenose dolphin sightings along the OCS edge and continental slope during NOAA Ship Oregon II surveys (unfilled circles), shown for comparison, are believed to be a separate stock. The straight lines show transects during two ship surveys and are examples of typical ship survey transects. Isobaths are in 183 m (100 fm) intervals.

## Minimum Population Estimate

The minimum population estimate was based on the abundance estimate of 50,247 dolphins ( $\mathrm{CV}=0.18$ ). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distribution as specified by NMFS (Anon. 1994). The minimum population estimate is 43,233 bottlenose dolphins.

## Current Population Trend

The data are insufficient to determine population trends. Aerial surveys conducted during autumn 1983 and 1985 by the Southeast Fisheries Science Center (SEFSC) produced an abundance estimate of 31,519 bottlenose dolphins $(C V=0.08)$ for this stock (Scott et al. 1989). This population thus appears to have increased from earlier estimated levels; however, a valid statistical comparison of the historical and present estimated population sizes is not presently possible because of the preliminary nature of the recent population size estimate and the possible biases caused by overlap of the survey area with the OCS edge and continental slope stock.

## 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 (Reilly and Barlow 1986).

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) was specified as the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because of the stock's status relative to its OSP level is unknown. PBR for this stock is 432 bottlenose dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

There are no observed cases of human-caused mortality and serious injury in this stock; however, based on an observed non-lethal take in U.S. Atlantic waters in 1993 in the pelagic longline fishery, this stock may be subject to incidental take resulting in serious injury or mortality. Fishery interactions have been reported to occur between bottlenose dolphins and the longline swordfish/tuna fishery in the Gulf of Mexico (SEFSC unpublished logbook data) and annual fishery-related mortality and serious injury to bottlenose dolphins is estimated to be 2.8 per year ( $\mathrm{CV}=0.74$ ) during 1992-1993. This could include bottlenose dolphins from the outer continental shelf edge and continental slope stock.

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 determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fishery Information

Annual fishing effort for the shrimp trawl fishery in the U.S. Gulf of Mexico OCS during 1988-1993 averaged approximately 2.58 million hours of tows $(C V=0.07)$ (NMFS unpublished data). This fishery was monitored by NMFS observers in 1992 and 1993, but less than $1 \%$ of the fishing effort was observed (NMFS unpublished data). There have been no reports of incidental mortality or injury associated with the shrimp trawl fishery in this area.

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about 5\% observer coverage, in terms of trips observed, since 1992. 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. The following estimates were based on observed takes across the Atlantic longline swordfish/tuna fishery (which includes the Gulf of Mexico). All observed takes were used because the species occurs generally throughout the area of the fishery, but observed takes were infrequent in any given region of the fishery. There were no lethal takes of bottlenose dolphins observed or reported in 1992 and 1993, and only one non-lethal take was reported in 1993, which is assumed to have caused serious injury. The estimated level of fishery-related mortality and serious injury for the entire fishery, including waters outside of the Gulf of Mexico, in 1993 was 16 bottlenose dolphins $(C V=0.19)$. No take was observed in the Gulf of Mexico, but interactions between bottlenose dolphins and this fishery in the Gulf of Mexico have been reported under the Marine Mammal Protection Act Interim Exemption Program (NMFS 1993).

Given the fact that fishery interactions have been reported to occur between bottlenose dolphins and the longline swordfish/tuna fishery in the Gulf of Mexico, a probable level of fishery-related mortality and serious injury rate can be
estimated. Under the assumption that the probability of an incidental take is proportional to fishing effort (number of sets), the estimated level of incidental mortality and serious injury partitioned to include only the Gulf of Mexico stock would be 5.5 bottlenose dolphins in $1993(\mathrm{CV}=0.19)$. Average annual fishery-related mortality and serious injury during 1992-1993 would be 2.8 bottlenose dolphins ( $\mathrm{CV}=0.74$ ). This estimate could include dolphins from the OCS edge and continental slope stock.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration in the Gulf of Mexico.

A trawl fishery for butterfish was monitored by NMFS observers for a short period in the 1980's with no records of incidental take of marine mammals (Burn and Scott 1988; NMFS unpublished data), although an experimental set by NMFS resulted in the death of two bottlenose dolphins (Burn and Scott 1988). There are no other data available.

## Other Human-Related Mortality or Serious Injury

The use of explosives to remove oil rigs in the portions of the OCS in the western Gulf of Mexico has the potential to cause serious injury or mortality to marine mammals. These activities have been closely monitored by NMFS observers since 1987 (Gitschlag and Hale, in press) and Gitschlag and Herczeg (in press) described the monitoring activities that occurred in 1992. There have been no reports of either serious injury or mortality to bottlenose dolphins (NMFS unpublished data).

## STATUS OF STOCK

The status of this stock relative to OSP is not known and the population trend cannot be determined due to insufficient data. This species is not listed as threatened or endangered under the Endangered Species Act. This is not a strategic stock because fishery-related mortality and serious injury does not exceed PBR.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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.
Burn, D. And G. P. Scott. 1988. Synopsis of available information on marine mammal-fisheries interactions in the southeastern United States: preliminary report. NMFS/SEFC, Miami Laboratory, Coastal resources Division, Contribution ML-CRG-87/88-26, 37 pp.
Gitschlag, G. R. and J. K. Hale. In press. Susceptibility of sea turtles to underwater explosives at offshore energy structure removals. Submitted to N. E. Gulf Science.
Gitschlag, G. R. and B. A. Herczeg. In press. Sea turtle observations at explosive removals of energy structures. Submitted to Mar. Fish. Rev.
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 (editors), The bottlenose dolphin, Academic Press, San Diego, 653 pp.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. DISTANCE user's guide, V2.0. Colorado Cooperative Fish \& Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.
Northridge, S. In review. 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.
Reilly, S. B. and J. Barlow. 1986. Rates of increase in dolphin population size. Fish. Bull., U.S. 84(3): 527-533.

# BOTTLENOSE DOLPHIN (Tursiops truncatus): Gulf of Mexico Continental Shelf Edge and Continental Slope Stock 

## STOCK DEFINITION AND GEOGRAPHIC RANGE

This bottlenose dolphin stock is defined as the stock which occupies the outer edge of the U.S. Gulf of Mexico Outer Continental Shelf (OCS) and waters over the continental slope within the U.S. Exclusive Economic Zone (EEZ), from the latitude and longitude of the U.S. EEZ off the U.S.-Mexico border to the latitude of the U.S. EEZ south of Key West, Florida. Close observation by experienced NMFS observers from shipboard surveys conducted throughout much of its range (Fig. 1) indicates that most of the dolphins sighted during ship-based surveys over the continental shelf edge and continental slope were the relatively large and robust dolphins assumed to be of the deep water ecotype hypothesized by Hersh and Duffield (1990). These dolphins were reported to be larger and darker in color than bottlenose dolphins seen over the continental shelf closer to shore (NMFS unpublished data). This stock's range may extend into Mexican and Cuban waters; however, there are no estimates available for bottlenose dolphin abundance or mortality from those countries.

## POPULATION SIZE

Preliminary estimates of abundance were derived using distance sampling analysis (Buckland et al. 1993) and the computer program DISTANCE (Laake et al. 1993) with sighting data collected during shipboard line-transect surveys conducted during the spring of 1992-1994 (Fig. 1). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Average bottlenose dolphin abundance over six surveys was estimated at 5,618 dolphins with coefficient of variation $(\mathrm{CV})=0.26$. In this analysis, it was assumed that all of the bottlenose dolphins sighted during the ship-based surveys were of this stock. The survey area overlapped in some areas with the OCS stock which was assumed to occur from approximately 9 km seaward of the 18 m isobath to approximately 9 km seaward of the 183 m isobath; however, the amount of overlap is considered


Figure 1. Distribution of sightings of bottlenose dolphins during NOAA Ship Oregon II marine mammal surveys in the Gulf of Mexico outer continental shelf (OCS) edge and continental slope waters (filled circles). Sightings of the OCS bottlenose dolphin stock made during GOMEX regional aerial surveys (unfilled circles) are shown for comparison. The bottlenose dolphin on the OCS are believed to be a separate stock. The straight lines show transects during two ship surveys and are examples of typical ship survey transects. Isobaths are in 183 m (100 fm) intervals. insignificant and its effect on the abundance estimate is not known.

## Minimum Population Estimate

The minimum population estimate was based on the average bottlenose dolphin abundance estimate of 5,618 bottlenose dolphins ( $\mathrm{CV}=0.26$ ). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distribution as specified by NMFS (Anon. 1994). The minimum population estimate is 4,530 bottlenose dolphins.

## Current Population Trend

The data are insufficient to determine population trends.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates for this stock are unknown. The maximum net productivity rate for purposes of this assessment, was assumed to be 0.04 . 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 (Reilly and Barlow, 1986).

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) has been specified as the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP). The recovery factor was 0.50 because of the stock's unknown status relative to OSP. PBR for this stock is 45 bottlenose dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

There are no observed cases of human-caused mortality and serious injury in this stock; however, based on an observed non-lethal take in U.S. Atlantic waters in 1993 in the pelagic longline fishery, this stock may be subject to incidental take resulting in serious injury or mortality. Fishery interactions have been reported to occur between bottlenose dolphins and the longline swordfish/tuna fishery in the Gulf of Mexico [Southeast Fisheries Science Center (SEFSC) unpublished logbook data] and annual fishery-related mortality and serious injury to bottlenose dolphins is estimated to be 2.8 per year $(C V=0.74)$ during 1992-1993. This estimate could include bottlenose dolphins from the OCS stock.

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 determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fishery Interaction

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. 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. The following estimates were based on observed takes across the Atlantic longline swordfish/tuna fishery (which includes the Gulf of Mexico). All observed takes were used because the species occurs generally throughout the area of the fishery, but observed takes were infrequent in any given region of the fishery. There were no lethal takes of bottlenose dolphins observed or reported in 1992 and 1993, and only one non-lethal take was reported in 1993, which is assumed to have caused serious injury. The estimated level of fishery-related mortality and serious injury for the entire fishery, including waters outside of the Gulf of Mexico, in 1993 was 16 bottlenose dolphins $(C V=0.19)$. No take was observed in the Gulf of Mexico, but there are logbook reports of interactions between bottlenose dolphins and this fishery (SEFSC unpublished logbook data).

Given the fact that fishery interactions have been reported to occur between bottlenose dolphins and the longline swordfish/tuna fishery in the Gulf of Mexico, a probable level of fishery-related mortality and serious injury rate can be estimated. Under the assumption that the probability of an incidental take is proportional to fishing effort (number of sets), the estimated level of incidental mortality and serious injury partitioned to include only the Gulf of Mexico stock would be 5.5 bottlenose dolphins in $1993(\mathrm{CV}=0.19)$. Average annual fishery-related mortality and serious injury during 1992-1993 would be 2.8 bottlenose dolphins ( $\mathrm{CV}=0.74$ ). This estimate could include dolphins from the OCS stock.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

A trawl fishery for butterfish was monitored by NMFS observers for a short period in the 1980's with no records of incidental take of marine mammals (Burn and Scott 1988; NMFS unpublished data), although an experimental NMFS set resulted in the death of two bottlenose dolphins (Burn and Scott 1988). There are no other data available.

## Other Mortality

No direct or indirect human-caused mortality has been reported for this stock.

## STATUS OF STOCK

The status of this stock relative to OSP is not known and the population trend cannot be determined due to insufficient data. This species is not listed as threatened or endangered under the Endangered Species Act. This is not a strategic stock because fishery-related mortality or serious injury does not exceed PBR.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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.
Burn, D. And G. P. Scott. 1988. Synopsis of available information on marine mammal-fisheries interactions in the southeastern United States: preliminary report. NMFS/SEFC, Miami Laboratory, Coastal resources Division, Contribution ML-CRG-87/88-26, 37 pp.
Cramer, J. 1994. Large pelagic logbook newsletter-1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 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 (editors), The bottlenose dolphin, Academic Press, San Diego, 653 pp.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. DISTANCE user's guide, V2.0. Colorado Cooperative Fish \& Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.
Northridge, S. In review. 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.
Reilly, S. B. and J. Barlow. 1986. Rates of increase in dolphin population size. Fish. Bull., U.S. 84(3): 527-533.

## BOTTLENOSE DOLPHIN (Tursiops truncatus): Western Gulf of Mexico Coastal Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The western Gulf of Mexico coastal bottlenose dolphin stock has been defined for management purposes as the bottlenose dolphins inhabiting the nearshore coastal waters in the U.S. Gulf of Mexico from the Texas border to the Mississippi River mouth, from shore or presumed bay boundaries to 9.3 km seaward of the 18.3 m isobath (Fig. 1). As a working hypothesis, it is assumed that the dolphins occupying habitats with dissimilar climactic, coastal, and oceanographic characteristics might be restricted in their movements between habitats and, thus, constitute separate stocks. The western coastal area is characterized by an arid to temperate climate, sand beaches, and low fresh water input. The northern coastal stock area which is characterized by a temperate climate, barrier islands, sand beaches, coastal marshes and marsh islands, and has a relatively high level of fresh water input from rivers and streams. The eastern coastal stock area is temperate to subtropical in climate, is bordered by a mixture of coastal marshes, sand beaches, marsh and mangrove islands, and has an intermediate level of freshwater input.

The stock occurs trans-boundary with Mexico; however, there is no information available for abundance estimation, nor for estimating fishery-related mortality in Mexican waters. The ratio of DDE to DDT was extraordinarily high in tissues of one bottlenose dolphin stranded on the Texas coast (Varanasi et al. 1992), suggesting recent exposure to DDT which is still in use in Mexico.

The Mississippi
River outflow may


Figure 1. Sightings of coastal bottlenose dolphins during GOMEX aerial surveys of the Gulf of Mexico in 1992-1994. Western Gulf of Mexico coastal bottlenose dolphin stock is shown with filled circles. Isobaths are in 183 m ( 100 fm ) intervals. constitute an effective ecological barrier to stock migration at the eastern boundary. This assumption has not been tested and interbreeding may, in fact, occur between this and the northern coastal stock at this boundary; therefore, the definition of this stock may be revised and the stock may be incorporated with the northern coastal stock when more data become available. There are data which suggest that there is considerable alongshore movement by some members of the western coastal stock (NMFS unpublished data), but the extent of this movement is unknown.

Some of this stock may co-occur with the resident bay, sound, and estuarine stocks, and breeding may occur among these stocks. For instance, two bottlenose dolphins previously seen in the South Padre Island area in Texas were seen in Matagorda Bay, 285 km north, in May 1992 and May 1993 (Lynn 1995). These sightings suggest that some bay stocks dolphins occasionally traverse the coastal stock area.

Portions of this stock may co-occur with the U.S. Gulf of Mexico outer continental shelf (OCS) stock. The seaward boundary for this stock corresponds to aerial survey strata (NMFS unpublished data) and thus, represents a management boundary rather than an ecological boundary. Anecdotal evidence suggests that both the coastal and OCS stocks consist of the shallow, warm water ecotype described by Hersh and Duffield (1990). Data are not currently available to determine genetically if the two stocks should be separated or, if so, where; and interbreeding may occur at the boundary interface.

## POPULATION SIZE

Preliminary abundance estimates were derived using distance sampling analysis (Buckland et al. 1993) and the computer program DISTANCE (Laake et al. 1993) with sighting data collected during aerial linetransect surveys in September-October 1992 (Blaylock and Hoggard 1994). Sampling transects extended orthogonally from shore out to approximately 9 km past the 18 m isobath. The 1992 coastal survey area extended from the U.S. -Mexican border to the Mississippi River mouth. Systematic transects were placed randomly with respect to bottlenose dolphin distribution and provided approximately $5 \%$ visual coverage of the survey area. Bottlenose dolphin abundance was estimated to be 3,499 dolphins ( $\mathrm{CV}=0.21$ ) (Blaylock and Hoggard 1994).

## Minimum Population Estimate

The minimum population estimate was based on the 1992 abundance estimate of 3,499 bottlenose dolphins $(C V=0.21)$ (Blaylock and Hoggard 1994). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normally distributed abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The minimum population estimate is 2,938 bottlenose dolphins.

## Current Population Trend

Aerial surveys of this area conducted by NMFS in autumn 1983 resulted in an estimated bottlenose dolphin abundance of $4,718(C V=0.10)$. The data are not sufficient to conduct a statistical trend analysis, but the current population size estimate is significantly lower than the 1983 estimate (Student's t-test, $\mathrm{P}<0.001$ ) and suggests a decline in stock abundance.

This stock was subject to higher than usual mortality levels in 1990, 1992, and 1993-94, and the incidence of bottlenose dolphin strandings along the Texas coast in those years was significantly higher than the 1984-94 mean stranding rate (Southeast U.S. Marine Mammal Stranding Network unpublished data). Some of these mortalities may have been related to accumulation of anthropogenic hydrocarbon contaminants. A recent study indicated an inverse relationship between hydrocarbon contaminant levels and certain bacterial and viral antigen titers in bottlenose dolphins from Matagorda Bay, Texas (Reif et al., in review).

## 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 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 0.5 because this stock is of unknown status, because of an undetermined level of fishery-related mortality, and because of the recent occurrence of three anomalous mortality events. PBR for this stock is 29 dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of direct human-caused mortality in this stock is unknown. An annual mean of $13(\mathrm{CV}=$ 0.46 ) bottlenose dolphins stranded on the Texas coast during the period 1988-1993, showing signs of fishery interactions such as net entanglement, mutilation, gunshot wounds, etc. (Southeast U.S. Marine Mammal Stranding Network unpublished data). This was $10.3 \%$ of the total bottlenose dolphin strandings reported for this area. There were 283 reported bottlenose dolphin strandings in Texas (1994), of these 7 (2\%) showed signs of human interaction. Three had evidence of fishery entanglement, one of which was found in a shrimp trawl, three were mutilated and one was shot. In 1995 the total number of reported bottlenose dolphins in Texas for 1995 was 110 and 3 (3\%) were human interactions. One was found in a shrimp trawl. The total bottlenose
dolphin strandings from January through August 31, 1996 was 175 and 1 ( $0.5 \%$ ) had evidence of human interaction (entanglement).

There are a number of difficulties associated with the interpretation of stranding data. It is possible that some or all of the stranded dolphins may have been from a bay, sound or estuarine stock; however, the proportion of the stranded dolphins belonging to another stock cannot be determined because of the difficulty of determining from where the stranded carcass originated. 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.

## Fisheries Information

Annual fishing effort for the shrimp trawl fishery in the western Gulf of Mexico coastal stock area during 1988-1993 averaged approximately 0.35 million hours of tows ( $\mathrm{CV}=0.16$ ) (NMFS unpublished data). This fishery was monitored by NMFS observers in 1992 and 1993, but less than $1 \%$ of the fishing effort was observed (NMFS unpublished data). There have been no reports of incidental mortality or injury in the western Gulf of Mexico coastal bottlenose dolphin stock associated with the shrimp trawl fishery in this area.

The menhaden purse seine fishery targets the Gulf menhaden, Brevoortia patronus, in Gulf of Mexico coastal waters approximately $3-18 \mathrm{~m}$ in depth (NMFS 1991). Seventy-five menhaden vessels operate within 1.6 km of shore from Apalachicola, Florida to Freeport, Texas, from April-October. Lethal takes of bottlenose dolphins reported by the menhaden fishery during the period 1982-1988 ranged between 0-4 dolphins annually (NMFS unpublished data).

Gillnets are not used in Texas, and gillnets over $46 \mathrm{~m}^{3}$ in area will not be allowed in Florida past July 1995, but fixed and runaround gillnets are currently in use in Louisiana, Mississippi, and Alabama. These fisheries, for the most part, operate year around. They are state-controlled and licensed, and vary widely in intensity and target species. No marine mammal mortalities associated with gillnet fisheries have been reported in these states, but stranding data suggest that gillnet and marine mammal interaction does occur, causing mortality and serious injury.

The fishery for blue crabs operates in estuarine areas throughout the Gulf coast employing traps attached to a buoy with rope. Bottlenose dolphins have been reported stranded in Mississippi with polypropylene rope around their flukes indicating the possibility of entanglement with crab pot lines (NMFS 1991); however, this fishery has not been monitored by observers.

Two bottlenose dolphins were entangled and died in a scientific research net fishery for sea turtles in Sabine Pass in 1993 (A. Landry, Texas A\&M University, report to Texas Marine Mammal Stranding Network, August 1993). The nets used in this Endangered Species Act (ESA) permitted research activity were two 4.9 m deep x 91.5 m in length stationary entanglement nets adjacent to each other. They were fished in shallow water (0.9-2.5 m depth), monitored continuously throughout the day, and removed at night.

## Other Mortality

The coast adjacent to the nearshore habitat occupied by this stock varies from agricultural to industrial and, in some places, such as Galveston Island, is dense in human population. Concentrations of chlorinated hydrocarbons and metals were relatively low in most of the bottlenose dolphins examined in conjunction with an anomalous mortality event in Texas bays in 1990; however, some had concentrations at levels of possible toxicological concern (Varanasi et al. 1992). Agricultural runoff following periods of high rainfall in 1992 was implicated in a high level of bottlenose dolphin mortalities in Matagorda Bay, which is adjacent to the western coastal stock area (NMFS unpublished data). A recent study of hydrocarbon contaminant levels was conducted in conjunction with a health assessment study of 35 live-captured bottlenose dolphins in Matagorda Bay which adjoins the coastal stock area. Alpha-HCB, p,p,DDE, and PCB concentrations were inversely related to the magnitude of the serum antibody titer to Erysipelas spp. and Staphylococcus spp. bacteria (Reif et al., in review.). A similar and more pronounced trend was seen in relationship to the pseudorabies virus; however, since pseudorabies virus is not known to infect bottlenose dolphins, the significance of this finding is not clear. Concentrations of contaminants were higher in dolphins having evidence of exposure to the cetacean morbillivirus. The reason for the difference in the relationship between antibody titers to bacteria and pseudorabies and antibody titers to cetacean morbillivirus is not understood.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown. A population trend analysis is not available due to insufficient information. This species is not listed as threatened or endangered under the ESA. The occurrence of three anomalous mortality events among bottlenose dolphins along the Texas coast since 1990 (NMFS unpublished data) is cause for concern and the available evidence suggests that bottlenose dolphin stocks in the northern and western portion of the U.S. Gulf of Mexico may have experienced a morbillivirus epidemic in 1993 (Lipscomb 1993); however, the effects of these events on stock abundance has yet to be determined. 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 known level of fishery-related mortality or serious injury does not exceed 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.
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.
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 (editors), 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.
Lipscomb, T. P. 1993. Some answers to questions about morbillivirus. Pages 4-5 in R. A. Blaylock, B. Mase, and D. K. Odell (editors), Strandings - Newsletter of the Southeast U.S. Marine Mammal Stranding Network, Vol. 2 No. 3, Southeast Fisheries Science Center, Miami Laboratory, Miami, Florida, 8 pp.
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.
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.
Varanasi, U., K. L. Tilbury, D. W. Brown, M. M. Krahn, C. A. Wigren, R. C. Clark, and S-L. Chan. 1992. Pages 56-86 in L. J. Hansen (editor), Report on investigation of 1990 Gulf of Mexico bottlenose dolphin strandings, Southeast Fisheries Science Center Contribution MIA-92/93-21, 219 pp.
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 .

## BOTTLENOSE DOLPHIN (Tursiops truncatus): Northern Gulf of Mexico Coastal Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The northern Gulf of Mexico coastal bottlenose dolphin stock has been defined for management purposes as those bottlenose dolphins occupying the nearshore coastal waters in the U.S. Gulf of Mexico from the Mississippi River mouth to approximately $84^{\circ} \mathrm{W}$ longitude, from shore, barrier islands, or presumed bay boundaries to 9.3 km seaward of the 18.3 m isobath (Fig. 1). As a working hypothesis, it is assumed that the dolphins occupying habitats with dissimilar climactic, coastal, and oceanographic characteristics might be restricted in their movements between habitats and, thus, constitute separate stocks. The northern coastal stock area is characterized by a temperate climate, barrier islands, sand beaches, coastal marshes and marsh islands, and has a relatively high level of fresh water input from rivers and streams. It is bordered on the east by an extensive area of coastal marsh and marsh islands typical of Florida's Apalachee Bay. The western coastal area is characterized by an arid to temperate climate, sand beaches, and low fresh water input. The eastern coastal stock area is temperate to subtropical in climate, is bordered by a mixture of coastal marshes, sand beaches, marsh and mangrove islands, and has an intermediate level of freshwater input.

The definition of this stock may be changed and it may be incorporated with other Gulf of Mexico stocks when more data become available. Seasonal changes in bottlenose dolphin abundance in Mississippi Sound (NMFS unpublished data) suggests that there is interchange with at least that portion of the Gulf of Mexico bay and sound stocks; however, its extent and significance is not


Figure 1. Sightings of coastal bottlenose dolphins during GOMEX aerial surveys of the Gulf of Mexico in 1992-1994. Northern Gulf of Mexico coastal bottlenose dolphin stock is shown with filled circles. Isobaths are in $183 \mathrm{~m}(100$ fm) intervals. presently known. Portions of this stock may co-occur with the U.S. Gulf of Mexico outer continental shelf (OCS) stock. The seaward boundary for this stock corresponds to aerial survey strata (NMFS unpublished data) and thus, represents a management boundary rather than an ecological boundary. Anecdotal evidence suggests that both the coastal and OCS stocks consist of the shallow, warm water ecotype described by Hersh and Duffield (1990). Data are not currently available to determine genetically if the stocks should be separated or, if so, where; and interbreeding may occur at the boundary interface.

## POPULATION SIZE

Preliminary estimates of abundance were derived using distance sampling analysis (Buckland et al.1993) and the computer program DISTANCE (Laake et al. 1993) with sighting data collected during aerial line-transect surveys in September-October 1993 (Blaylock and Hoggard 1994). Systematic sampling transects, placed randomly with respect to the bottlenose dolphin distribution, extended orthogonally from shore out to approximately 9 km past the 18 m isobath. The area surveyed extended from the Mississippi River mouth to approximately $84^{\circ} \mathrm{W}$ Longitude, and approximately $5 \%$ of the total area was visually searched. Bottlenose dolphin abundance was estimated to be 4,191 dolphins with coefficient of variation $(\mathrm{CV})=0.21$ (Blaylock and Hoggard 1994).

## Minimum Population Estimate

The minimum population estimate was based on the 1993 abundance estimate of 4,191 dolphins (CV $=0.21$ ) (Blaylock and Hoggard 1994). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normally distributed abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The minimum population estimate is 3,518 bottlenose dolphins.

## Current Population Trend

Aerial surveys of this area conducted partly in autumn 1983 and partly in autumn 1985, by NMFS resulted in an estimated bottlenose dolphin abundance of $1,319(\mathrm{CV}=0.10)$. The data are not sufficient to conduct a statistical trend analysis, but the current population size estimate is significantly higher than the 198385 estimate (Student's t-test, $\mathrm{P}<0.005$ ).

## 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 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 0.5 because this stock is of unknown status, because the stock apparently sustains some unknown level of fishery-related mortality, and because of the unknown effects of the 1993 mortality event. PBR for this stock is 35 dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of direct human-caused mortality in this stock is unknown. An annual average of ten bottlenose dolphins $(\mathrm{CV}=0.41)$ stranded on the coast of Louisiana, Mississippi, or Alabama during the period 1988-1993, showing signs of fishery interactions such as net entanglement, mutilation, gunshot wounds, etc. (Southeast U.S. Marine Mammal Stranding Network unpublished data). This was $8.2 \%$ of the total bottlenose dolphin strandings reported for this area. In 1994, the Stranding Network reported a total of 92 bottlenose dolphins in Mississippi, Louisiana and Alabama, four (4\%) were reported as showing signs of human interaction. One was a boat strike, one entangled in fishing gear and 2 had gun shot wounds. There were 78 strandings reported in 1995 in the northern Gulf and 10 ( $12 \%$ ) had evidence of human interaction; 6 were entanglements ( 2 were found wrapped in a square gillnet), two mutilations and 2 had gunshot wounds. A total of 120 bottlenose dolphin strandings was reported from January through August 31, 1996, and four (3\%) of these were reported as human interactions ( 2 net entanglements, 1 boat strike and one mutilation).

There are a number of difficulties associated with the interpretation of stranding data. It is possible that some or all of the stranded dolphins may have been from a bay, sound or estuarine stock; however, the proportion of the stranded dolphins belonging to another stock cannot be determined because of the difficulty of determining from where the stranded carcass originated. 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.

## Fisheries Information

Annual fishing effort for the shrimp trawl fishery in the northern Gulf of Mexico coastal stock area during 1988-1993 averaged approximately 2.17 million hours of tows $(C V=0.13)(N M F S ~ u n p u b l i s h e d ~ d a t a) . ~$ This fishery was monitored by NMFS observers in 1992 and 1993, but less than $1 \%$ of the fishing effort was observed (NMFS unpublished data). There have been no reports of incidental mortality or injury in the northern Gulf of Mexico coastal bottlenose dolphin stock associated with the shrimp trawl fishery in this area.

The menhaden purse seine fishery targets the Gulf menhaden, Brevoortia patronus, in Gulf of Mexico coastal waters approximately 3-18 m in depth (NMFS 1991). Seventy-five menhaden vessels operate within 1.6 km of shore from Apalachicola, Florida to Freeport, Texas, from April-October. Lethal takes of bottlenose dolphins reported by the menhaden fishery during the period 1982-1988 ranged between 0-4 dolphins annually (NMFS unpublished data).

Other clupeid purse seiners opportunistically target Spanish sardine, thread herring, ladyfish, cigarfish, and blue runners. Single boat purse seiners, fishing for sardines and herrings, operate in coastal waters between the Mississippi River delta and Pascagoula, Mississippi and in the Florida panhandle between Pensacola and Apalachicola. It is estimated that ten vessels participate in this fishery between May-October. There are no estimates of dolphin mortality associated with this fishery.

Gillnets are not used in Texas, and gillnets over $46 \mathrm{~m}^{3}$ in area will not be allowed in Florida past July 1995, but fixed and runaround gillnets are currently in use in Louisiana, Mississippi, and Alabama. These fisheries, for the most part, operate year around. They are state-controlled and licensed, and vary widely in intensity and target species. No marine mammal mortalities associated with gillnet fisheries have been reported in these states, but stranding data suggest that gillnet and marine mammal interaction does occur, causing mortality and serious injury.

The fishery for blue crabs operates in estuarine areas throughout the Gulf coast employing traps attached to a buoy with rope. Bottlenose dolphins have been reported stranded in Mississippi with polypropylene rope around their flukes indicating the possibility of entanglement with crab pot lines (NMFS 1991); however, this fishery has not been monitored by observers.

## Other Mortality

The nearshore habitat occupied by this stock is adjacent to areas of high human population. Two stranded dolphins from the northern Gulf coastal area (one from Mississippi and one from Alabama) had the highest levels of DDT derivatives of any of the bottlenose dolphin liver samples analyzed in conjunction with the 1990 mortality investigation conducted by NMFS (Varanasi et al. 1992). The significance of these findings are unclear, but there is some evidence that increased exposure to anthropogenic compounds may reduce immune function in bottlenose dolphins. A recent study found the magnitude of the serum antibody titer to Erysipelas spp. and Staphylococcus spp. bacteria in bottlenose dolphins was inversely related to $\alpha-\mathrm{HCB}$, p,p,DDE, and PCB's concentrations (Reif et al., in review).

This stock was subject to a high incidence of mortality in 1993, which was suspected to have been the result of a morbillivirus epidemic. The effect of this mortality event on the stock cannot be determined, in part, because the mortality may have also affected the bay, sound and estuarine stock and the stock identity of the stranded animals could not be determined. The increase in mortalities began in the Florida panhandle area and moved westward during that period (NMFS unpublished data). Concentrations of contaminants were found to be higher in dolphins having evidence of exposure to the cetacean morbillivirus (Reif et al., in review). The reason for the relationship between cetacean morbillivirus antibody titers and high contaminant levels is not understood and the effect of the epidemic on this stock has not been determined.

## STATUS OF STOCK

The status of this stock relative to OSP is not known and population trends cannot be determined due to insufficient data. This 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 unknown, but considering the evidence from stranding data, it may not be 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 known level of fishery-related mortality or serious injury does not exceed 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..
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.
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 (editors), 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.
Lipscomb, T. P. 1993. Some answers to questions about morbillivirus. Pages 4-5 in R. A. Blaylock, B. Mase, and D. K. Odell (editors), Strandings - Newsletter of the Southeast U.S. Marine Mammal Stranding Network, Vol. 2 No. 3, Southeast Fisheries Science Center, Miami Laboratory, Miami, Florida, 8 pp.
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.
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.
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 .

## BOTTLENOSE DOLPHIN (Tursiops truncatus): Eastern Gulf of Mexico Coastal Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The eastern Gulf of Mexico coastal bottlenose dolphin stock has been defined for management purposes as the bottlenose dolphins occupying the area which extends from approximately $84^{\circ} \mathrm{W}$ Longitude to Key West, Florida, from shore, barrier islands, or presumed bay boundaries to 9.3 km seaward of the 18.3 m isobath (Fig. 1). As a working hypothesis, it is assumed that the dolphins occupying habitats with dissimilar climactic, coastal, and oceanographic characteristics might be restricted in their movements between habitats and, thus, constitute separate stocks. The eastern coastal stock area is temperate to subtropical in climate, is bordered by a mixture of coastal marshes, sand beaches, marsh and mangrove islands, and has an intermediate level of freshwater input. It is bordered on the north by an extensive area of coastal marsh and marsh islands typical of Florida's Apalachee Bay. The western coastal area is characterized by an arid to temperate climate, sand beaches, and low fresh water input. The northern coastal stock


Figure 1. Sightings of coastal bottlenose dolphins during GOMEX aerial surveys of the Gulf of Mexico in 1992-1994. Eastern Gulf of Mexico coastal bottlenose dolphin stock is shown with filled circles. Isobaths are in $183 \mathrm{~m}(100$ fm) intervals. area is characterized by a temperate climate, barrier islands, sand beaches, coastal marshes and marsh islands, and has a relatively high level of fresh water input from rivers and streams.

Portions of this stock may co-occur with the U.S. Gulf of Mexico outer continental shelf (OCS) stock. The seaward boundary for this stock corresponds to aerial survey strata (NMFS unpublished data) and thus, represents a management boundary rather than an ecological boundary. Anecdotal evidence suggests that both the coastal and OCS stocks consist of the shallow, warm water ecotype described by Hersh and Duffield (1990). Data are not currently available to determine genetically if the two stocks should be separated or, if so, where; and interbreeding may occur at the boundary interface.

## POPULATION SIZE

Preliminary estimates of abundance were derived using distance sampling analysis (Buckland et al. 1993) and the computer program DISTANCE (Laake et al. 1993) with sighting data collected during aerial linetransect surveys conducted during autumn 1994 (NMFS unpublished data). Systematic sampling transects, placed randomly with respect to the bottlenose dolphin distribution, extended orthogonally from shore out to approximately 9 km past the 18 m isobath. Approximately $5 \%$ of the total survey area was visually searched. Bottlenose dolphin abundance was estimated to be 9,912 dolphins with coefficient of variation $(\mathrm{CV})=0.12$.

## Minimum Population Estimate

The minimum population estimate was based on the 1994 abundance estimate of 9,912 ( $\mathrm{CV}=0.12$ ) (NMFS unpublished data). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normally distributed abundance estimate. This is equivalent to the 20 th percentile
of the log-normal distribution as specified by Wade and Angliss (1997). The minimum population estimate is 8,963 bottlenose dolphins.

## Current Population Trend

Aerial surveys of this area conducted by NMFS in autumn 1985, resulted in an estimated bottlenose dolphin abundance of $4,711(\mathrm{CV}=0.05)$. The data are not sufficient to conduct a statistical trend analysis, but the current population size estimate is significantly higher than the 1985 estimate (Student's t-test, $\mathrm{P}<0.0005$ ).

## 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 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 0.5 because this stock is of unknown status. PBR for this stock is 90 dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of direct human-caused mortality in this stock is unknown. An annual mean of eight bottlenose dolphins $(C V=0.41)$ stranded on the Florida Gulf coast during the period 1988-1993, showing signs of fishery interactions such as net entanglement, mutilation, gunshot wounds, etc. (Southeast U.S. Marine Mammal Stranding Network unpublished data). This was $8.9 \%$ of the total bottlenose dolphin strandings reported for this area. Morgan and Patton (1990) reported that $12.9 \%$ of 116 cetaceans examined by Mote Marine Laboratory's marine mammal stranding response program on the west coast of Florida between 1984 and 1990 exhibited evidence of human-caused mortality or serious injury. The stranding networks reported a total of 62 bottlenose dolphin strandings in 1994 with only one reported human interaction. Eighty-three strandings were reported in 1995 and 2 had evidence of human interactions. One was found entangled in a gillnet, and one was a boat strike. The network reported 111 bottlenose dolphins from January through August 31, 1996. Three showed signs of human interaction (one entanglement-gillnet, one boat strike and one mutilation).

There are a number of difficulties associated with the interpretation of stranding data. It is possible that some or all of the stranded dolphins may have been from a bay, sound or estuarine stock; however, the proportion of the stranded dolphins belonging to another stock cannot be determined because of the difficulty of determining from where the stranded carcass originated. 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.

## Fisheries Information

Annual fishing effort for the shrimp trawl fishery in the eastern Gulf of Mexico coastal stock area during 1988-1993 averaged approximately 0.102 million hours of tows $(C V=0.30)$ (NMFS unpublished data). This fishery was monitored by NMFS observers in 1992 and 1993, but less than $1 \%$ of the fishing effort was observed (NMFS unpublished data). There was one report in 1992 of an incidental mortality in the eastern Gulf of Mexico coastal bottlenose dolphin stock which was associated with the shrimp trawl fishery in this area.

Gillnets are not used in Texas, and gillnets over $46 \mathrm{~m}^{3}$ in area will not be allowed in Florida past July 1995, but fixed and runaround gillnets are currently in use in Louisiana, Mississippi, and Alabama. These
fisheries, for the most part, operate year around. They are state-controlled and licensed, and vary widely in intensity and target species. No marine mammal mortalities associated with gillnet fisheries have been reported in these states, but stranding data suggest that gillnet and marine mammal interaction does occur, causing mortality and serious injury. A coastal gillnet fishery for menhaden was reported to have taken one bottlenose dolphin in 1991 (NMFS unpublished data). There are no effort data available for this fishery.

The menhaden purse seine fishery targets the Gulf menhaden, Brevoortia patronus, in Gulf of Mexico coastal waters approximately $3-18 \mathrm{~m}$ in depth (NMFS 1991). Seventy-five menhaden vessels operate within 1.6 km of shore from Apalachicola, Florida to Freeport, Texas, from April-October. Lethal takes of bottlenose dolphins reported by the menhaden fishery during the period 1982-1988 ranged between 0-4 dolphins annually (NMFS unpublished data).

Other clupeid purse seiners opportunistically target Spanish sardine, thread herring, ladyfish, cigarfish, and blue runners. There are no effort data available for this fishery and there are no estimates of dolphin mortality associated with this fishery.

A fishery for blue crabs operates in estuarine areas throughout the Gulf coast employing traps attached to a buoy with rope. Bottlenose dolphins have been reported stranded in other coastal locations in the Gulf of Mexico with polypropylene rope around their flukes indicating the possibility of entanglement with crab pot lines (NMFS 1991); however, this fishery has not been monitored by observers.

## Other Mortality

The nearshore habitat occupied by this stock is adjacent to areas of high human population and in some areas of Florida, such as the Tampa Bay area, is highly industrialized. PCB concentrations in three stranded dolphins sampled from this stock ranged from $16-46 \mu \mathrm{~g} / \mathrm{g}$ wet weight. Concentrations of $\alpha-\mathrm{HCB}, \mathrm{p}, \mathrm{p}, \mathrm{DDE}$, and PCB's were inversely related to the magnitude of the serum antibody titer to Erysipelas spp. and Staphylococcus spp. bacteria in a study of bottlenose dolphins in Texas (Reif et al., in review). A similar and more pronounced trend was seen in relationship to the pseudorabies virus; however, since pseudorabies virus is not known to infect bottlenose dolphins, the significance of this finding is not clear. Concentrations of contaminants were higher in dolphins having evidence of exposure to the cetacean morbillivirus. The reason for the difference in the relationship between antibody titers to bacteria and pseudorabies and antibody titers to cetacean morbillivirus is not understood.

## STATUS OF STOCK

The status of this stock relative to OSP is not known and population trends cannot be determined due to insufficient data. This species is not listed as threatened or endangered under the Endangered Species Act. 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 to be insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because the known level of fishery-related mortality or serious injury does not exceed 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.
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.
Morgan, M. A. and G. W. Patton. 199 0. Human dolphin interactions on the west coast of Florida: Documentation from MML's marine mammal response program. MML Technical Report \#191, 9 pp.
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.

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 .

## ATLANTIC SPOTTED DOLPHIN (Stenella frontalis): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The Atlantic spotted dolphin is endemic to the Atlantic Ocean in warm temperate to tropical waters (Perrin et al. 1987, 1994). Sightings of this species are concentrated along the continental shelf edge and also occur over the continental shelf in the northern Gulf of Mexico [Fritts et al. 1983; Mullin et al. 1991; Southeast Fisheries Science Center (SEFSC) unpublished data], but they have been reported as occurring around oceanic islands and far offshore in other areas (Perrin et al. 1994). The island and offshore animals may be a different stock than those occurring on the continental shelf (Perrin et al. 1994). Atlantic spotted dolphins were seen in all seasons during seasonal recent GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation). Atlantic spotted dolphins were seen in 1992 during regional aerial surveys conducted in the autumn of 1992-1994 over the U.S. continental shelf [see Blaylock and Hoggard (1994) for a description of the areas surveyed in 1992-1993]. These surveys were designed to estimate abundance of bottlenose dolphins and spotted dolphin abundance was not estimated. It has been suggested that there may be a seasonal movement of this species onto the continental shelf in the spring, but data supporting this hypothesis are limited (Caldwell and Caldwell 1966; Fritts et al. 1983).

## 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of Atlantic spotted dolphins [coefficient of variation (CV) in parentheses] by survey year was zero in 1991, 4,527 in 1992 (0.65), 4,618 in 1993 (0.62), and 2,186 in 1994 (0.85) (Hansen et al. 1995). Survey effortweighted estimated average abundance of Atlantic spotted dolphins for all surveys combined was $3,213(\mathrm{CV}=0.44)$


Figure 1. Distribution of Atlantic spotted dolphin sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994 (filled circles) and during GOMEX regional aerial surveys during 1992-1994 (unfilled circles). The straight lines show transects during two ship surveys and are examples of typical ship survey transects. Isobaths are in 183 m (100 fm) intervals. (Hansen et al. 1995). This is probably an underestimate and should be considered a partial stock estimate because the continental shelf areas were not generally covered by either the vessel or GulfCet aerial surveys.

## Minimum Population Estimate

The minimum population size was estimated using the average abundance estimate of Atlantic spotted dolphins for all surveys combined which was $3,213(C V=0.44)$ (Hansen et al. 1995). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 2,255 Atlantic spotted dolphins.

## Current Population Trend

No trend was identified in the annual abundance estimates. There were no sightings of this stock during 1991. The lack of sightings during 1991 may have been due to less sampling that year along the continental shelf edge where sightings of this species were concentrated. The difference in abundance estimates during 1992-1994 were not significant using the criteria of no overlap of log-normal $95 \%$ confidence intervals.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. The resulting PBR, based on the partial estimate, for this stock is 23 dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of Atlantic spotted dolphins in the northern Gulf of Mexico is unknown; however, interactions between spotted dolphins and fisheries have been observed in the northern Gulf of Mexico.

There were two documented strandings of Atlantic spotted dolphins in the northern Gulf of Mexico during 1987-1994 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 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.

Total estimated average annual fishing-related mortality and serious injury of spotted dolphins (both species) is 1.5 spotted dolphins annually ( $\mathrm{CV}=0.33$ ). Observed fishery-related mortality and serious injury for spotted dolphins is less than $10 \%$ of PBR and can be considered insignificant and approaching zero mortality and serious injury rate for this stock. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were two observed incidental takes and releases of spotted dolphins in the Gulf of Mexico during 1994, but no observed lethal takes of Atlantic spotted dolphins by this fishery in the Gulf of Mexico.

Estimates of fishery-related mortality and serious injury were based on a generalized linear model (Poisson error assumption) fit to the available observed incidental take for the entire Atlantic longline swordfish/tuna fishery (which includes the Gulf of Mexico) (SEFSC, unpublished data). Takes observed
throughout the range of this fishery were used because the species occurs generally throughout the area of the fishery, but observed takes were infrequent in any given region. Either spotted dolphin species may have been involved in the observed fishery-related mortality and serious injury incidents, but because of the difficulty of species identification by fishery observers, they cannot currently be separated. Estimated mortality and serious injury to spotted dolphins attributable to the longline fishery for the entire fishery (including waters outside of the Gulf of Mexico) for 1993 was $16(C V=0.19)$. Estimated fishery-related mortality and serious injury for the Gulf of Mexico, based on proportionality of fishing effort (number of sets) in 1993 was 4.4 spotted dolphins. Estimated average annual fishing-related mortality and serious injury of spotted dolphins attributable to this fishery during 1991-1993 was 1.5 annually ( $\mathrm{CV}=0.33$ ).

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of humancaused mortality and serious injury is unknown, but it is believed to be low relative to PBR; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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.
Caldwell, D. K. and M. C. Caldwell. 1966. Observations on the distribution, coloration, behavior and audible sound production of the spotted dolphin, Stenella plagiodon (Cope). Los Angeles County Museum Contribution to Science, 104:1-28.
Cramer, J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Fritts, T. H., A. B. Irvine, R. D. Jennings, L. A. Collum, W. Hoffman and M. A. McGehee. 1983. Turtles, birds, and mammals in the northern Gulf of Mexico and nearby Atlantic waters. U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D. C., FWS/OBS-82/65, 455 pp.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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, 108 pp.
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 spp. Mar. Mam. Sci. 3(2):99-170.

Perrin, W. F., D. K. Caldwell and M. C. Caldwell. 1994. Atlantic spotted dolphin Stenella frontalis (G. Cuvier, 1829). Pages 173-190 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London, 416 pp .

## PANTROPICAL SPOTTED DOLPHIN (Stenella attenuata): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

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 occurred over the deeper waters of the northern Gulf of Mexico, and rarely over the continental shelf or continental shelf edge [Mullin et al. 1991; Southeast Fisheries Science Center (SEFSC) unpublished data]. Pantropical spotted dolphins were seen in all seasons during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation). 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 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of pantropical spotted dolphins by survey year [coefficient of variation (CV) in parentheses] was 19,767 in 1991 (0.45), 15,280 in 1992 (0.36), 29,414 in 1993 (0.29), and 71,847 in


Figure 1. Distribution of pantropical spotted dolphin sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m ( 100 fm ) intervals. 1994 (0.31) (Hansen et al. 1995). Survey effort-weighted estimated average abundance of pantropical spotted dolphins for all surveys combined was $31,320(\mathrm{CV}=0.20)$ (Hansen et al. 1995).

## Minimum Population Estimate

The minimum population size was estimated from the average estimated abundance of pantropical
 the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 26,510 pantropical spotted dolphins.

## Current Population Trend

The 1994 abundance estimate was larger than the estimates for 1991-1993. The 1992 and 1994 estimates were significantly different using the criteria of no overlap of log-normal $95 \%$ confidence intervals, but differences within 1991-1993 estimates and differences between 1991, 1993, and 1994 were not significant. The observed differences in abundance estimates may have been caused by inter-annual variation in distribution patterns and spatial sampling, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. The resulting PBR for this stock is 265 animals.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of pantropical spotted dolphins in the northern Gulf of Mexico is unknown; however, interactions between spotted dolphins and fisheries have been observed in the northern Gulf of Mexico.

There was one documented stranding of a pantropical spotted dolphin in the northern Gulf of Mexico during 1987-1994 which was 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 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.

Total estimated average annual fishing-related mortality and serious injury of spotted dolphins (both species) is 1.5 spotted dolphins annually ( $\mathrm{CV}=0.33$ ). Observed fishery-related mortality and serious injury for spotted dolphins is less than $10 \%$ of PBR and can be considered insignificant and approaching zero mortality and serious injury rate for this stock. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were two observed incidental takes and releases of spotted dolphins in the Gulf of Mexico during 1994, but no observed lethal takes of Atlantic spotted dolphins by this fishery in the Gulf of Mexico.

Estimates of fishery-related mortality and serious injury were based on a generalized linear model (Poisson error assumption) fit to the available observed incidental take for the entire Atlantic longline swordfish/tuna fishery (which includes the Gulf of Mexico) (SEFSC, unpublished data). Takes observed throughout the range of this fishery were used because the species occurs generally throughout the area of the fishery, but observed takes were infrequent in any given region. Either spotted dolphin species may have been involved in the observed fishery-related mortality and serious injury incidents, but because of the difficulty of species identification by fishery observers, they cannot currently be separated. Estimated mortality and serious injury to spotted dolphins attributable to the longline fishery for the entire fishery (including waters outside of the Gulf of Mexico) for 1993 was $16(\mathrm{CV}=0.19)$. Estimated fishery-related mortality and serious injury for
the Gulf of Mexico, based on proportionality of fishing effort (number of sets) in 1993 was 4.4 spotted dolphins. Estimated average annual fishing-related mortality and serious injury of spotted dolphins attributable to this fishery during 1991-1993 was 1.5 annually ( $\mathrm{CV}=0.33$ ).

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of humancaused mortality and serious injury is unknown, but it is believed to be insignificant relative to PBR; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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, 108 pp.
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 spp. Mar. Mam. Sci. 3(2): 99-170.
Perrin, W. F. and A. A. Hohn. 1994. Pantropical spotted dolphin Stenella attenuata. Pages 71-98 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London, 416 pp.

## STRIPED DOLPHIN (Stenella coeruleoalba): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The striped dolphin is distributed worldwide in tropical to warm temperate oceanic waters (Leatherwood and Reeves 1983; Perrin et al. 1994). Sightings of these animals in the northern Gulf of Mexico occur primarily over the deeper waters off the continental shelf [Mullin et al. 1991; Southeast Fisheries Science Center (SEFSC) unpublished data]. Striped dolphins were seen in fall, winter, and spring during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation). 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of striped dolphins by survey year [coefficient of variation (CV) in parentheses] was 3,483 in 1991 (0.76), 2,574 in 1992 (0.52), 4, 160 in 1993 (0.63), and 8,147


Figure 1. Distribution of striped dolphin sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in $183 \mathrm{~m}(100 \mathrm{fm})$ intervals. in 1994 (0.60) (Hansen et al. 1995). Survey effort-weighted estimated average abundance of striped dolphins for all surveys combined was $4,858(C V=0.44)($ Hansen et al. 1995).

## Minimum Population Estimate

The minimum population size was estimated from the average estimate abundance which was 4,858 striped dolphins $(C V=0.44)$ (Hansen et al. 1995). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 3,409 striped dolphins.

## Current Population Trend

The abundance estimates for 1991-1993 were less than the 1994 estimate. The abundance estimates were not significantly different using the criteria of no overlap of log-normal $95 \%$ confidence intervals. The apparent differences in abundance estimates may have been caused by small sample sizes; only 29 observations of herds of striped dolphins were used in the distance sampling analysis. The differences in the estimates may also have been caused by inter-annual variation in distribution patterns and spatial sampling, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 34 striped dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of striped dolphins in the northern Gulf of Mexico is unknown. Available information indicates there likely is little, if any, fisheries interaction with striped dolphins in the northern Gulf of Mexico. There have been no logbook reports of fishery-related mortality or serious injury and no fishery-related mortality or serious injury has been observed.

There were no documented strandings of striped dolphins in the northern Gulf of Mexico during 19871994 which were 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.

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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury to striped dolphins by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of humancaused mortality and serious injury is unknown, but it is believed to be insignificant relative to PBR; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, $9 \mathrm{pp} .+$ tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.
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, 108 pp.
Perrin, W. F., C. E. Wilson and F. I. Archer II. 1994. Striped dolphin Stenella coeruleoalba (Meyen, 1833). Pages 129-159 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London, 416 pp.

## SPINNER DOLPHIN (Stenella longirostris): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The spinner dolphin is distributed worldwide in tropical to warm temperate waters in the world's oceans (Leatherwood and Reeves 1983; Perrin and Gilpatrick 1994). Sightings of these animals in the northern Gulf of Mexico occur primarily over the deeper waters off the continental shelf [Southeast Fisheries Science Center (SEFSC) unpublished data]. Spinner dolphins were seen in winter, spring and summer during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation). Different geographic stocks have been identified in the Pacific based on morphological characteristics (Perrin and Gilpatrick 1994); however, 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of spinner dolphins by survey year [coefficient of variation (CV) in parentheses] was zero in 1991, 2,593 in 1992 (0.63), 2,336 in 1993 (0.62), and 15,995 in 1994 (0.67) (Hansen et


Figure 1. Distribution of spinner dolphin sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m ( 100 fm ) intervals. al. 1995). Survey effort-weighted estimated average abundance of spinner dolphins for all surveys combined was 6,316 (CV = 0.43) (Hansen et al. 1995).

## Minimum Population Estimate

The minimum population size was estimated from the average estimate abundance which was 6,316 spinner dolphins $(\mathrm{CV}=0.43)$ (Hansen et al. 1995). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 4,465 spinner dolphins.

## Current Population Trend

The abundance estimates for 1992 and 1993 were approximately the same and the 1994 estimate was considerably larger; however, the estimates were not significantly different using the criteria of no overlap of log-normal $95 \%$ confidence intervals. The apparent differences in abundance estimates may have been caused by less sampling effort during 1991 (Hansen et al. 1995), or by inter-annual variation in distribution patterns or spatial sampling patterns, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates for this stock are not known; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 45 spinner dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of spinner dolphins in the northern Gulf of Mexico is unknown. Available information indicates there likely is little, if any, fisheries interaction with spinner dolphins in the northern Gulf of Mexico. There have been no logbook reports of fishery-related mortality or serious injury and no fishery-related mortality or serious injury has been observed.

There were no documented strandings of spinner dolphins in the northern Gulf of Mexico during 19871994 which were 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.

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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury of spinner dolphins by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of human-
caused mortality and serious injury is unknown, but it is believed to be insignificant relative to PBR; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report, OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, $9 \mathrm{pp}+$ tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.
Perrin, W. F. and J. W. Gilpatrick, Jr. 1994. Spinner dolphin Stenella longirostris (Gray, 1828). Pages 99-128 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London, 416 pp.

## ROUGH-TOOTHED DOLPHIN (Steno bredanensis): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The rough-toothed dolphin is distributed worldwide in tropical to warm temperate waters (Leatherwood and Reeves 1983; Miyazaki and Perrin 1994). Sightings of these animals in the northern Gulf of Mexico occur primarily over the deeper waters off the continental shelf [Southeast Fisheries Science Center (SEFSC) unpublished data]. Rough-toothed dolphins were seen in all seasons during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation). 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the
U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of rough-toothed dolphins by survey year [coefficient of variation (CV) in parentheses] was 545 in 1991 (1.15), 758 in 1992 (0.58), 1,192 in 1993 (0.48),


Figure 1. Distribution of rough-toothed dolphin sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m ( 100 fm ) intervals. and 527 in 1994 (0.86) (Hansen et al. 1995). Survey effort-weighted estimated average abundance of rough-toothed dolphins for all surveys combined was $852(\mathrm{CV}=0.31)$ (Hansen et al. 1995).

## Minimum Population Estimate

The minimum population size was estimated from the average estimate abundance which was 852 rough-toothed dolphins $(\mathrm{CV}=0.31)$ (Hansen et al. 1995). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 660 rough-toothed dolphins.

## Current Population Trend

The 1993 abundance estimate was greater than the 1991, 1993, and 1994 estimates; however, the abundance estimates were not significantly different using the criteria of no overlap of log-normal $95 \%$
confidence intervals. The apparent differences in abundance estimates may have been caused by small sample sizes (Hansen et al. 1995) or by inter-annual variation in distribution patterns or spatial sampling patterns, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. The resulting PBR for this stock is 6.6 rough-toothed dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of rough-toothed dolphins in the northern Gulf of Mexico is unknown. Available information indicates there likely is little, if any, fisheries interaction with rough-toothed dolphins in the northern Gulf of Mexico. There have been no logbook reports of fisheryrelated mortality or serious injury and no fishery-related mortality or serious injury has been observed.

There were no documented strandings of rough-toothed dolphins in the northern Gulf of Mexico during 1987-1994 which were 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 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.

Total 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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury of roughtoothed dolphins by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of humancaused mortality and serious injury is unknown, but it is believed to be insignificant relative to PBR; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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. Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, $9 \mathrm{pp} .+$ tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.
Miyazaki, N. and W. F. Perrin. 1994. Rough-toothed dolphin Steno bredanensis (Lesson, 1828). Pages 1-21 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London, 416 pp.

## CLYMENE DOLPHIN (Stenella clymene): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The Clymene dolphin is endemic to tropical and sub-tropical waters of the Atlantic (Leatherwood and Reeves 1983; Perrin and Mead 1994). Sightings of these animals in the northern Gulf of Mexico occur primarily over the deeper waters off the continental shelf (Mullin et al. 1994). Clymene dolphins were seen in the winter, spring and summer during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation). 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of Clymene dolphins by survey year [coefficient of variation (CV) in parentheses] was 1,936 in 1991 (0.69), 3,390 in 1992 (0.48), 6,486 in 1993 (0.46), and 12,255


Figure 1. Distribution of clymene dolphin sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m ( 100 fm ) intervals. in 1994 (0.62) (Hansen et al. 1995). Survey effort-weighted estimated average abundance of Clymene dolphins for all surveys combined was 5,571 (CV $=0.37)($ Hansen et al. 1995 $)$.

## Minimum Population Estimate

The minimum population size was estimated from the average estimate abundance which was 5,571 Clymene dolphins ( $\mathrm{CV}=0.37$ ) (Hansen et al. 1995). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 4,120 Clymene dolphins.

## Current Population Trend

The abundance estimates showed an increasing trend during 1991-1994; however, the estimates were not significantly different using the criteria of no overlap of log-normal $95 \%$ confidence intervals. The apparent differences in abundance estimates may have been caused by small sample sizes (Hansen et al. 1995) or by
inter-annual variation in distribution patterns or spatial sampling patterns, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 41 Clymene dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of Clymene dolphins in the northern Gulf of Mexico is unknown. Available information indicates there likely is little, if any, fisheries interaction with Clymene dolphins in the northern Gulf of Mexico. There have been no logbook reports of fishery-related mortality or serious injury and no fishery-related mortality or serious injury has been observed.

There were no documented strandings of Clymene dolphins in the northern Gulf of Mexico during 1987-1994 which were 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 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.

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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury to Clymene dolphins by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of humancaused mortality and serious injury is unknown, but it is believed to be insignificant relative to PBR; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.
Mullin, K. D., L V. Higgins, T. A. Jefferson, and L. J. Hansen. 1994. Sightings of the Clymene dolphin (Stenella clymene) in the Gulf of Mexico. Mar. Mam. Sci. 10(4): 464-470.
Perrin, W. F. and J. G. Mead. 1994. Clymene dolphin Stenella clymene (Gray, 1846). Pages 161-171 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London, 416 pp.

## FRASER'S DOLPHIN (Lagenodelphis hosei): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Fraser's dolphin is distributed worldwide in tropical waters (Perrin et al. 1994). Sightings of these animals in the northern Gulf of Mexico occur primarily over the deeper waters off the continental shelf (Leatherwood et al. 1993). Fraser's dolphins have been observed recently in the northern Gulf of Mexico during the spring, summer, and fall (Leatherwood et al. 1993), and also were seen in the winter during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation). 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of Fraser's dolphins by survey year [coefficient of variation (CV) in parentheses] was zero in 1991, 443 in 1992 (0.92), and zero in 1993 and 1994 (Hansen et al.


Figure 1. Distribution of Fraser's dolphin sightings during NOAA Ship Oregon II surveys during 1991-1994 (filled circle) and during GulfCet seasonal aerial surveys (unfilled circles). The straight lines show transects during two ship surveys and are examples of typical survey transects. Isobaths are in 183 m (100 fm) intervals. 1995). Survey effortweighted estimated average abundance of Fraser's dolphins for all vessel surveys combined was $127(\mathrm{CV}=0.90)$ (Hansen et al. 1995).

## Minimum Population Estimate

The minimum population size was estimated from the average estimate abundance which was 127 Fraser's dolphins ( $\mathrm{CV}=0.90$ ) (Hansen et al. 1995). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 66 Fraser's dolphins.

## Current Population Trend

No trend was identified in the annual abundance estimates. There were no observations of Fraser's dolphins during 1991 and 1993 vessel surveys, and the 1992 estimate is based on only one observation (Hansen et al. 1995); however, five other sightings of Fraser's dolphins were documented in the northern Gulf of Mexico during other surveys in 1992, 1993 and 1994 (Leatherwood et al. 1993, SEFSC unpublished data). The
apparent differences in abundance estimates may have been caused by low sampling intensity relative to population size (Hansen et al. 1995) or by inter-annual variation in distribution patterns or spatial sampling patterns, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 0.7 Fraser's dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of Fraser's dolphins in the northern Gulf of Mexico is unknown. Available information indicates there likely is little, if any, fisheries interaction with Fraser's dolphins in the northern Gulf of Mexico. There have been no logbook reports of fishery-related mortality or serious injury and no fishery-related mortality or serious injury has been observed.

There were no documented strandings of Fraser's dolphins in the northern Gulf of Mexico during 19871994 which were 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 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.

Available information indicates there likely is little, if any, fisheries interaction with Fraser's dolphins in the northern Gulf of Mexico. 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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury of Fraser's dolphins by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of humancaused mortality and serious injury is unknown, but it is believed to be insignificant relative to PBR; therefore this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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. Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, $9 \mathrm{pp} .+$ tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. DISTANCE user's guide, V2.0. Colorado Cooperative Fish \& Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.
Leatherwood, S., T. A. Jefferson, J. C. Norris, W. E. Stevens, L. J. Hansen, and K. D. Mullin. 1993. Occurrence and sounds of Fraser's dolphin in the Gulf of Mexico. The Texas Journal of Science, 45(4):349-354.
Perrin, W. F., S. Leatherwood and A. Collet. 1994. Fraser's dolphin Lagenodelphis hosei (Fraser 1956). Pages 225-240 in S. H. Ridgway and R. Harrison (editors), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London, 416 pp.

## KILLER WHALE (Orcinus orca): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The killer whale is distributed worldwide from tropical to polar regions (Leatherwood and Reeves 1983). Sightings of these animals in the northern Gulf of Mexico occur primarily over the deeper waters off the continental shelf [Southeast Fisheries Science Center (SEFSC) unpublished data]. Killer whales were seen only in the summer during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation) and in the late spring during vessel surveys (SEFSC unpublished data). Different stocks have been identified in the northeastern Pacific based on morphological, behavioral, and genetic characteristics (Bigg et al. 1990; Hoelzel 1991). There is no information on stock differentiation for the Atlantic population, although an analysis of vocalizations of killer whales from Iceland and Norway indicated that stocks from these areas may represent different stocks (Moore et al. 1988).

## 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated killer whale abundance by survey year [coefficient of variation (CV) in parentheses] was zero in 1991, 138 in 1992 (0.96), 641 in 1993
(0.50), and 193 in 1994


Figure 1. Distribution of killer whale sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m ( 100 fm ) intervals.
(1.12) (Hansen et al. 1995). Survey effort-
weighted estimated average abundance of killer whales for all surveys combined was 277 ( $\mathrm{CV}=0.42$ ) (Hansen et al. 1995).

## Minimum Population Estimate

The minimum population size was estimated from the average estimate abundance which was 277 killer whales $(C V=0.42)$ (Hansen et al. 1995). The minimum population estimate is the lower limit of the twotailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 197 killer whales.

## Current Population Trend

The abundance estimates were highest during 1993; however, there were no observations of this species during 1991, and the 1992-1994 estimates were not significantly different using the criteria of no overlap of log-normal $95 \%$ confidence intervals. The apparent differences in abundance estimates may have been caused by lower sampling effort during 1991, and by low sampling intensity relative to population size (Hansen et al. 1995) or by inter-annual variation in distribution patterns or spatial sampling patterns, rather than changes in population size. Preliminary analysis of existing photo-identification data shows that some individual whales have been seen during more than one survey (SEFSC unpublished data).

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates for this stock are not known; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 2.0 killer whales.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of killer whales in the northern Gulf of Mexico is unknown. Available information indicates there likely is little, if any, fisheries interaction with killer whales in the northern Gulf of Mexico. There have been no logbook reports of fishery-related mortality or serious injury and no fishery-related mortality or serious injury has been observed.

There were no documented strandings of killer whales in the northern Gulf of Mexico during 19871994 which were 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 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.

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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury of killer whales by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of humancaused mortality and serious injury is unknown, but it is believed to be insignificant relative to PBR; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
Bigg, M. A., P. F. Olesiuk, G. M. Ellis, J. K. B. Ford and K. C. Balcomb. 1990. Social organization and genealogy of resident killer whales (Orcinus orca) in the coastal waters of British Columbia and Washington State. Pages 383-405 in P. S. Hammond, S. A. Mizroch and G. P. Donovan (editors), Individual recognition of cetaceans: Use of photoidentification and other techniques to estimate population parameters, Rep. Int. Whal. Commn., Special Issue 12, Cambridge, 440 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.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Hoelzel, A. R. 1991. Analysis of regional mitochondrial DNA variation in the killer whale; implications for conservation. Pages 225-233 in A. R. Hoelzel (editor), Genetic ecology of whales and dolphins, Rep. Int. Whal. Commn. Special Issue 13, Cambridge, 311 pp.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.
Moore, S. E., J. K. Francine, A. E. Bowles and K. B. Ford. 1988. Analysis of calls of killer whales, Orcinus orca, from Iceland and Norway. Rit. Fiskideild. 11:225-250.

## FALSE KILLER WHALE (Pseudorca crassidens): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The false killer whale is distributed worldwide throughout warm temperate and tropical oceans (Leatherwood and Reeves 1983). Sightings of this species in the northern Gulf of Mexico occur primarily over the deeper waters off the continental shelf [Southeast Fisheries Science Center (SEFSC) unpublished data]. False killer whales were seen only in the summer during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation) and in the late spring during vessel surveys (NMFS unpublished data). 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of false killer whales by survey year [coefficient of variation (CV) in parentheses] was 661 in 1991 (0.88), 196 in 1992 (1.00), 77 in 1993 (1.08), and 744 in 1994 (1.14) (Hansen et al.


Figure 1. Distribution of false killer whale sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994 (filled circles) and during GulfCet seasonal aerial surveys (filled circles). The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m ( 100 fm ) intervals. 1995). Survey effortweighted estimated average abundance of false killer whales for all surveys combined was $381(\mathrm{CV}=0.62)$ (Hansen et al. 1995).

## Minimum Population Estimate

The minimum population size was estimated from the average estimate abundance which was 381 false killer whales $(C V=0.62)$ (Hansen et al. 1995). The minimum population estimate is the lower limit of the twotailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 236 false killer whales.

## Current Population Trend

No trend was identified in the annual abundance estimates, and the differences in the abundance estimates were not significant using the criteria of no overlap of log-normal $95 \%$ confidence intervals. The apparent differences in abundance estimates may have been caused by lower sampling effort during 1991, by
low sampling intensity relative to population size (Hansen et al. 1995), or by inter-annual variation in distribution patterns or spatial sampling patterns, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 2.4 false killer whales.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of false killer whales in the northern Gulf of Mexico is unknown. Available information indicates there likely is little, if any, fisheries interaction with false killer whales in the northern Gulf of Mexico. There have been no logbook reports of fishery-related mortality or serious injury and no fishery-related mortality or serious injury has been observed.

There were no documented strandings of false killer whales in the northern Gulf of Mexico during 1987-1994 which were 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 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.

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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury of false killer whales by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of humancaused mortality and serious injury is unknown, but it is believed to be insignificant relative to PBR; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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. Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, $9 \mathrm{pp} .+$ tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.

## PYGMY KILLER WHALE (Feresa attenuata): Northern Gulf of Mexico 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 [Southeast Fisheries Science Center (SEFSC) unpublished data]. Pygmy killer whales and melon-headed whales (Peponocephala electra) are difficult to distinguish and sightings of either species are often categorized as pygmy killer/melon-headed whales. Sightings of this category were documented in all seasons during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation). 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 19911994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of pygmy killer whales by survey year [coefficient of variation (CV) in parentheses] was 2,347 in (0.81), 356 in 1992 (0.73), 153 in 1993 (1.13), and zero in 1994 (Hansen et al. 1995).


Figure 1. Distribution of pygmy killer whale sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m (100 fm) intervals. Survey effort-weighted estimated average abundance of pygmy killer whales for all surveys combined was $518(\mathrm{CV}=0.81)$ (Hansen et al. 1995).

## Minimum Population Estimate

The minimum population size was estimated from the average estimated abundance which was 518 pygmy killer whales $(\mathrm{CV}=0.81)$ (Hansen et al. 1995). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 285 pygmy killer whales.

## Current Population Trend

A declining trend was identified in the annual abundance estimates; however, the 1991-1993 abundance estimates were not significantly different using the criteria of no overlap of log-normal $95 \%$ confidence intervals. There were no observations of this species during the 1994 survey. The apparent differences in abundance estimates may have been caused by lower sampling effort during 1991, by low sampling intensity relative to population size (Hansen et al. 1995), or by inter-annual variation in distribution patterns or spatial sampling patterns, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 2.8 pygmy killer whales.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

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

There were no documented strandings of pygmy killer whales in the northern Gulf of Mexico during 1987-1994 which were 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 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.

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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury of pygmy killer whales by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of humancaused mortality and serious injury is unknown, but it is believed to be insignificant relative to PBR; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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. 1971. The pygmy killer whale, Feresa attenuata, in the western Atlantic, with a summary of world records. J. Mamm. 52:206-209.
Cramer, J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp. Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. DISTANCE user's guide, V2.0. Colorado Cooperative Fish \& Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.
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 (editors), Handbook of marine mammals, Vol. 5: The first book of dolphins. Academic Press, London, 416 pp.

# MELON-HEADED WHALE (Peponocephala electra): Northern Gulf of Mexico Stock 

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The melon-headed whale appears to be distributed worldwide in tropical to sub-tropical waters (Perryman et al. 1994). Sightings of these animals in the northern Gulf of Mexico occur primarily over the deeper waters off the continental shelf (Mullin et al. 1994). Melon-headed whales and pygmy killer whales (Feresa attenuata) are difficult to distinguish and sightings of either species are often categorized as pygmy killer/melon-headed whales. Sightings of this category were documented in all seasons during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation). There is no information on stock differentiation for the Atlantic population.

## POPULATION SIZE

Seasonal aerial survey data were insufficient for estimating abundance. 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 1991-1994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig.1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic
Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of melon-headed whales by survey year [coefficient of variation (CV) in parentheses] was zero in 1991, 3,174 in 1992 (0.54), 827 in 1993 (0.70) and 10,586 in 1994 (0.48) (Hansen et al. 1995). The


Figure 1. Distribution of melon-headed whale sightings during NOAA Ship Oregon II marine mammal surveys in 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m ( 100 fm ) depth intervals. survey effort-weighted estimated average abundance of melon-headed whales for all surveys combined was 3,965 (CV=0.39) (Hansen et al. 1995).

## Minimum Population Estimate

The minimum population size was estimated from the average abundance estimate which was 3,965
 confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 2,888 melon-headed whales.

## Current Population Trend

No trend was identified in the annual abundance estimates; however, the 1994 estimate was more than ten times larger than the 1993 estimate and the difference was significant using the criteria of no overlap of log-
normal $95 \%$ confidence intervals. No melon-headed whales were sighted during 1991, and the differences between the 1992 and 1993 estimates and between the 1993 and 1994 estimates were not significant. The apparent differences in abundance estimates may have been caused by lower sampling effort during 1991, and by low sampling intensity relative to population size (Hansen et al. 1995), or by inter-annual variation in distribution patterns or spatial sampling patterns, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 29 melon-headed whales.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

There has historically been some take of this species in small cetacean fisheries in the Caribbean (Caldwell et al. 1976); however, the level of past or current, direct, human-caused mortality of melon-headed whales in the northern Gulf of Mexico is unknown. Available information indicates there likely is little, if any, fisheries interaction with melon-headed whales in the northern Gulf of Mexico. There have been no logbook reports of fishery-related mortality or serious injury and no fishery-related mortality or serious injury has been observed.

There were no documented strandings of melon-headed whales in the northern Gulf of Mexico during 1987-1994 which were 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 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.

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. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. There were no reports of mortality or serious injury to melonheaded whales by this fishery.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown. This species is not listed under the Endangered Species Act. There are insufficient data to determine population trends. The total level of fishery-related mortality and serious injury is unknown, but it is believed to be insignificant relative to PBR; therefore, this is not a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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., M. C. Caldwell and R. V. Walker. 1976. First records for Fraser's dolphin (Lagenodelphis hosei) in the Atlantic and the melon-headed whale (Peponocephala electra) in the western Atlantic. Cetology 25: 1-4.
Cramer, J. 1994. Large pelagic logbook newsletter - 1993. NOAA Tech. Mem. NMFS-SEFSC-352, 19 pp. Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. DISTANCE user's guide, V2.0. Colorado Cooperative Fish \& Wildlife Research Unit, Colorado State University, Ft. Collins, Colorado, 72 pp.

Mullin, K. D., T. A. Jefferson, L. J. Hansen and W. Hoggard. 1994. First sightings of melon-headed whales (Peponocephala electra) in the Gulf of Mexico. Mar. Mam. Sci. 10(3): 342-348.

## RISSO'S DOLPHIN (Grampus griseus): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Risso's dolphin is distributed worldwide in tropical to warm temperate waters (Leatherwood and Reeves 1983). Sightings of these animals in the northern Gulf of Mexico occur primarily along the continental shelf and continental slope (Mullin et al. 1991; Southeast Fisheries Science Center, SEFSC, unpublished data). Risso's dolphin were seen in all seasons during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation) and in the late spring during vessel surveys (SEFSC, unpublished data). There is no information on stock differentiation for the Atlantic population.

## POPULATION SIZE

Seasonal aerial survey data were insufficient for abundance estimation. 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 1991-1994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig.1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range and these data were not used for abundance estimation. Estimated abundance of Risso's dolphins by survey year [coefficient of variation (CV) in


Figure 1. Distribution of Risso's dolphin sightings during NOAA Ship Oregon II marine mammal surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in $183 \mathrm{~m}(100 \mathrm{fm})$ intervals. parentheses] was 667 in 1991 (0.95), 2,325 in 1992 (0.34), 1,408 in 1993 (0.41), and 6,332 in 1994 (0.45) (Hansen et al. 1995). Survey effort-weighted average abundance of Risso's dolphins estimated for all surveys combined was $2,749(\mathrm{CV}=$ 0.27) (Hansen et al. 1995).

## Minimum Population Estimate

The minimum population size was estimated from the average abundance estimate which was 2,749 Risso's dolphins ( $\mathrm{CV}=0.27$ ) (Hansen et al. 1995). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 2,199 Risso's dolphins.

## Current Population Trend

No trend was identified in the annual abundance estimates. The 1994 abundance estimate was greater than the other annual estimates, but no annual estimates differed significantly using the criteria of no overlap of log-normal $95 \%$ confidence intervals. The apparent differences in abundance estimates may have been
caused by lower sampling effort during 1991 (Hansen et al. 1995) or by inter-annual variation in distribution patterns or spatial sampling patterns, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates for this stock are not known; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 22 Risso's dolphins.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of Risso's dolphins in the northern Gulf of Mexico is unknown. This species has been taken in the U.S. longline swordfish/tuna fishery in the northern Gulf of Mexico and in the U.S. Atlantic (Lee et al. 1994). Estimated average annual fishery-related mortality and serious injury attributable to the longline swordfish/tuna fishery in the Gulf of Mexico during 1992-1993 was 19 Risso's dolphins annually ( $\mathrm{CV}=0.20$ ).

There were no documented strandings of Risso' dolphins in the northern Gulf of Mexico during 19871994 which were 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 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.

The total estimated fishery-related mortality and serious injury for this stock is not less than $10 \%$ of the calculated PBR and, therefore, cannot be considered insignificant and approaching zero mortality and serious injury rate. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Interactions between the U.S. longline swordfish/tuna fishery and Risso' dolphins have been documented in the northern Gulf of Mexico (Lee et al. 1994). Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in 1991, 4,850 sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery has been monitored with about $5 \%$ observer coverage, in terms of trips observed, since 1992. One Risso's dolphin was observed taken and released alive during 1992; the extent of injury to the animal was unknown (SEFSC, unpublished data). One lethal take of a Risso's dolphin by the fishery was observed in the Gulf of Mexico during 1993 (SEFSC, unpublished data). Annual fishery-related mortality and incidental injury was estimated using a generalized linear model (Poisson error assumption) fit to the available observed incidental take data for the entire fishery and partitioned on the fishery effort (number of sets) in the Gulf of Mexico. Estimated total mortality and serious injury to Risso's dolphins (CV in parentheses) in the Gulf of Mexico in 1992 was 24 (0.19), and in 1993 it was 13 (0.20). Estimated average annual fishery-related mortality and serious injury attributable to the longline swordfish/tuna fishery in the Gulf of Mexico during 1992-1993 was 19 Risso's dolphins annually ( $\mathrm{CV}=0.20$ ).

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown. This species is not listed under the Endangered Species Act and there are insufficient data to determine population trends. This is not a strategic stock because fishery-related mortality and serious injury does not exceed PBR; however, fishery-related mortality and serious injury is very close to PBR and requires close monitoring.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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. Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, $9 \mathrm{pp} .+$ tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.
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 .

## SHORT-FINNED PILOT WHALE (Globicephala macrorhynchus): Northern Gulf of Mexico Stock

## STOCK DEFINITION AND GEOGRAPHIC RANGE

The short-finned pilot whale is distributed worldwide in tropical to warm temperate waters (Leatherwood and Reeves 1983). Sightings of these animals in the northern Gulf of Mexico occur primarily along the continental shelf and continental slope [Mullin et al. 1991; Southeast Fisheries Science Center (SEFSC) unpublished data]. Short-finned pilot whales were seen in all seasons during recent seasonal GulfCet aerial surveys of the northern Gulf of Mexico during 1993-1995 (Davis et al., in preparation). There is no information on stock differentiation for the Atlantic population.

## POPULATION SIZE

Abundance was estimated using distance sampling analysis (Buckland et al. 1993) and the computer program DISTANCE (Laake et al. 1993) with sighting data collected during 1991-1994 spring-summer, visual sampling, line-transect vessel surveys of the northern Gulf of Mexico (Hansen et al. 1995) (Fig. 1), which includes data collected as part of the GulfCet program (Davis et al., in preparation). These surveys were conducted throughout the area from approximately the 200 m isobath along the U.S. coast to the seaward extent of the U.S. Exclusive Economic Zone. The seasonal GulfCet aerial surveys included only a small portion of the stock range, so those data were not used for abundance estimation. Estimated abundance of shortfinned pilot whales by survey year [coefficient of variation (CV) in parentheses] was zero in 1991, 909 in 1992 (0.62), 103 in 1993


Figure 1. Distribution of short-finned pilot whale sightings during NOAA Ship Oregon II surveys during 1991-1994. The straight lines show transects during two surveys and are examples of typical survey transects. Isobaths are in 183 m ( 100 fm ) intervals. (1.20), and 240 in 1994 (1.03) (Hansen et al. 1995). Survey effort-weighted estimated average abundance of short-finned pilot whales for all surveys combined was $353(\mathrm{CV}=0.89)(H a n s e n ~ e t ~ a l . ~ 1995) . ~$

## Minimum Population Estimate

The minimum population size was estimated from the average abundance estimate which was 353 pilot whales ( $\mathrm{CV}=0.89$ ) (Hansen et al. 1995). The minimum population estimate is the lower limit of the two-tailed $60 \%$ confidence interval of the log-normal distributed average abundance estimate, which is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by NMFS (Anon. 1994). The minimum population estimate is 186 pilot whales.

## Current Population Trend

The annual abundance estimates were not significantly different using the criteria of no overlap of lognormal $95 \%$ confidence intervals. The variation in abundance estimates that was observed may have been caused by lower sampling effort during 1991, by low sampling intensity relative to population size (Hansen et
al. 1995), or by inter-annual variation in distribution patterns or spatial sampling patterns, rather than changes in population size.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for this stock; therefore, the default maximum net productivity rate of 0.04 (Anon. 1994) was used for purposes of this assessment.

## POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal level (PBR) was specified as the product of the minimum population size, one half the maximum net productivity rate, and a recovery factor for endangered, threatened, or depleted stocks, or stocks of unknown status relative to optimum sustainable population (OSP) (Anon. 1994). The recovery factor was set at 0.50 because the status of the stock relative to OSP is unknown. PBR for this stock is 1.9 short-finned pilot whales.

## ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The level of past or current, direct, human-caused mortality of short-finned pilot whales in the northern Gulf of Mexico is unknown. This species has been taken in the U.S. longline swordfish/tuna fishery in U.S. Atlantic waters (Lee et al. 1994) and there is a logbook report of a fishery-related mortality or serious injury in the northern Gulf of Mexico (NMFS unpublished data); however, fishery-related mortality or serious injury has not been observed. Total known fishery-related mortality or serious injury is estimated to be 0.3 shortfinned pilot whales per year based upon the logbook report.

There were no documented strandings of short-finned pilot whales in the northern Gulf of Mexico during 1987-1994 which were 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 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.

The total known fishery-related mortality and serious injury for this stock is greater than $10 \%$ of the calculated PBR and, therefore, cannot be considered insignificant and approaching zero mortality and serious injury rate. This determination cannot be made for specific fisheries until the implementing regulations for Section 118 of the MMPA have been reviewed by the public and finalized.

## Fisheries Information

Pelagic swordfish, tunas, and billfish are the targets of the longline fishery operating in the U.S. Gulf of Mexico. Interactions between the U.S. longline swordfish/tuna fishery and short-finned pilot whales have been reported in the northern Gulf of Mexico (SEFSC, unpublished logbook data), but have not been observed by NMFS fishery observers. Total longline effort for the Gulf of Mexico pelagic fishery, including OCS edge, continental slope, and Mexican territorial waters, based on mandatory logbook reporting, was 4,400 sets in $1991,4,850$ sets in 1992, and 3,260 sets in 1993 (Cramer 1994). This fishery was been monitored with about $5 \%$ observer coverage in both the Atlantic Ocean and the Gulf of Mexico, in terms of trips observed, in 19921993. There was one logbook report of a fishery-related injury of a pilot whale in the northern Gulf of Mexico in 1991, but no fishery interactions were observed during 1992-1993. Total known fishery-related mortality or serious injury is estimated to be 0.3 short-finned pilot whales per year based upon the logbook report.

Pair trawl fishing gear has the potential to capture marine mammals, but there have been no reports of mortality or serious injury to marine mammals in the Gulf of Mexico. This fishery has not been observed by NMFS observers, and there are no other data available as to the extent of this fishery in the Gulf of Mexico. It is assumed that it is very limited in scope and duration.

## STATUS OF STOCK

The status of this stock relative to OSP is unknown and there are insufficient data to determine population trends. This species is not listed under the Endangered Species Act. The total level of estimated fishery-related mortality and serious injury is unknown, but because there is a record of a fishery-related mortality or serious injury and because of the extremely low estimated stock size, this is a strategic stock.

## REFERENCES

Anon. 1994. Report of the PBR (Potential Biological Removal) workshop. June 27-29, 1994. NOAA, NMFS Southwest Fisheries Science Center, La Jolla, California, 13 pp. + Appendices.
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.
Davis, R., G. Scott, B. Würsig, W. Evans, G. Fargion, L. Hansen, K. Mullin, N. May, T. Leming, B. Mate, J. Norris and T. Jefferson. In preparation. Distribution and abundance of marine mammals in the northcentral and western Gulf of Mexico: Final Report. OCS Study \#MMS 94-0003. Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.
Hansen, L. J., K. D. Mullin and C. L. Roden. 1995. Estimates of cetacean abundance in the northern Gulf of Mexico from vessel surveys. Southeast Fisheries Science Center, Miami Laboratory, Contribution No. MIA-94/95-25, 9 pp. + tables and figures.
Laake, J. L., S. T. Buckland, D. R. Anderson, and K. P. Burnham. 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.

## INDEX


Blainville's beaked whale . . . . . . . . . . . . . . . 72, 236
blue runners . . . . . . . . . . . . . . . . . . . . . . . . 254, 258
blue whale . . . . . . . . . . . . . . . . . . . . . . . . . 4, 42-34
Bonsecour Bay . . . . . . . . . . . . . . . . . . . . . . . . . . 185
bottlenose dolphin . . . 3, 4, 137-151, 183-191, 198, 202, 242, 244, 245, 247-258, 262
Brevortia tyrannus . . . . . . . . . . . . . . . . . . . . . . 147
Bryde's whale . . . . . . . . . . . . . . . . . . . . . . . 230, 231
Calcasieu Lake . . . . . . . . . . . . . . . . . . . . . . . . . . . 185
Canada ... 9, 26, 29, 30, 32, 33, 40, 44, 45, 50, 55, $58,59,65,72,79,86,87,89,90,96,98$, $104,106,108,115,117,118,134,135$, 152, 157, 159-161, 163, 164, 166, 168, 170-174, 176-179, 181, 211, 222-226
Canadian East Coast . . . . . . . . . . . . 4, 35-37, 43, 44
Canadian fisheries . . . . . . . . . . . . 40, 104, 154, 157
Cape Cod Bay . . . . . . . . . . 6, 9, 11, 22, 43, 44, 67
Cape Hatteras . . . . 9, 18, 19, 25, 29, 30, 35, 38, 39,
$48,52,54,55,57,58,60,62,63,68,70$,
$74,76,77,81,82,84-86,92,94-96,98$, $101,104,110,112-115,119,121,122$, $125,127,128,131,133,137,139,143-$ $146,148,149,156,167,173,178,211-$ $213,215,216,219,220,224$
Chesapeake Bay 119,160 chlorinated hydrocarbons . . . . . . . 91, 149, 189, 250 cigarfish . . . . . . . . . . . . . . . . . . . . . . . . . . . . 254, 258 Clearwater Harbor . . . . . . . . . . . . . . . . . . . . . . . . 185 clymene dolphin . . . . . . . . . . . . . . . . . . . . . 276, 278
coastal gillnet . . . 39, 42, 78, 87, 96, 102, 103, 114, $116,121,127,147,149,154,156,160$, $168,178,179,224,258$
cod traps . . $9,17,40,87,98,168,169,174,179$, 217, 224
common dolphin . . . . . 2, 110-115, 117, 169, 198
Compano Bay . . . . . . . . . . . . . . . . . . . . . . . . . 185
Connecticut . . . . . . . 39, 103, 147, 156, 161, 225
contaminants . . . . 89, 90, 144, 149, 151, 152, 165, 190, 249-251, 254, 255, 258
Crystal Bay . . . . . . . . . . . . . . . . . . . . . . . . . . . 185
Cystophora cristata . . . . . . . . . 181, 222, 225, 226
DDE . . . . . . . . . . . . . . . . . . . . . . 248, 250, 254, 258
DDT 89, 248, 254
Delaware . . $14,20,39,45,52,54,58,65,72,79$, $84,89,94,106,107,117,146,156,161$,

215
Delphinus delphis . . . . . . . . . . . . . . 110, 116-118
drift gillnet . . 9, 18, 19, 23, 37, 38, 41, 45, 48-50, $52,57-59,62-65,70,71,73,76-79,84$, $85,88,90,94,97,99,102-105,107,112$, 113, 116, 118, 121-124, 127-129, 133-135, $139,141,142,154,156,159,163,178$, 211, 213, 215, 220, 221, 224
dwarf sperm whale . $3,4,47,49,50,53,192,193$, 196
East Bay . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 185
ecotype .... 49, 53, 137, 143, 146, 193, 196, 242, 245, 248, 252, 256
entanglement . 7-10, 17, 18, 20, 23, 27, 30, 37, 39, 40, 42-44, 52, 94, 106, 148-151, 160, 167, $170,175,187,190,193,196,200,201$, 204, 212, 228, 231, 234, 237, 240, 249, 250, 253, 254, 257, 258, 261, 265, 268, 271, 274, 277, 280, 283, 286, 289, 292, 295, 298
epidemic . . . . . . . . . . . . . . . . . . . . . . 189, 251, 254
Erysipelas spp. . . . . . . . . . . . . . . . . . 250, 254, 258
estuaries . . . . . . . . . . . . . 143, 144, 183-185, 187
Eubalaena glacialis . . . . . . . . . . . . . . . . . 5, 12, 13
false killer whale .............................. . . 285
Feresa attenuata . . . . . . . 212, 213, 288, 290, 291
fin whale . . . . . . . . . . . . . . . . . viii, 3, 25-28, 31, 33
foreign fishing . . . $30,40,76,84,87,89,93,98$, $103,104,112,121,127,133,138,157$, 216
Fraser's dolphin . . . . . . . . . . . . . . . . . . . . . . . . 279
Georges Bank . . . 5, 10, 15, 18, 20, 23, 29, 36, 38, $39,48,54-58,60,61,63,67-70,74-76$, $81-83,85,86,94,100,101,104,108,110$, $111,113,119,121,125,127,131,133$, 137, 139, 156, 214, 218, 220
Georgia . . . . 5, 9, 27, 144, 147, 148, 170, 203, 204
Gervais' beaked whale 239
gillnet . . 4, 9, 10, 13, 18, 19, 21, 23, 37-43, 45, 46, 48-50, 52, 57-59, 62-66, 70, 71, 73, 76-79, $84,85,87,88,90,94,96-99,102-105$, 107-109, 113, 114, 116, 118, 121-124, 127-129, 133-135, 139, 141, 142, 147-149, 151, 154-157, 159, 160, 162-165, 167-171, 174-176, 178-182, 188, 210, 211, 213, 215, 217-221, 224-226, 250, 253, 254, 257, 258
Globicephala macrorhynchus . . . . . . . . . . 92, 297
Globicephala melas 81, 84, 90, 92, 94
Grampus griseus 74, 78, 79, 294
gray seal . . . . . . . . . . . . . . . . . . . . . . . . . 2, 170-176
Great South Channel . . . 5, 7, 9, 11, 12, 20, 21, 29,
85, 86, 94
Greenland . . . . 5, 14, 32, 35, 57, 87, 98, 100, 104, $152,153,166,168,174,177,214,216$, 222
groundfish ... 9, 10, 17, 40, 87, 98, 104, 154, 156, $157,159,167-169,174,179,217,224$
Gulf of Maine . . . . . . . . 1, 2, 5, 9, 10, 14-18, 22, 23, $25-29,31,34,36,37,39,45,50,53,55$, $59,61,65,68,72,74,75,79,81,82,90$, 99-102, 104, 108, 110, 111, 114, 118, 120, $124-126,129,132,135,142,152-156$, $162-165,167,168,170,174,176,178$, $181,210,216,218,224,225$
Gulf of Mexico . . . . . . . 1, 4, 5, 13, 32, 35, 47, 59, $60,67,77,78,85,86,88,92,95,97,99$, $110,113,119,122,125,127-129,131$, $135,137,139,145,150,183-197,202$, 203, 207, 211-213, 219, 221, 227-248, 250-252, 254-258, 260-299
Gulf Stream . . 26, 28, 36, 54-56, 59-61, 66-69, 73-$75,80-82,91,92,101,110,111,118-120$, $124,125,131,132,135,143,145,221$
Gullivan Bay . . . . . . . . . . . . . . . . . . . . . . . . . . 185 gunshot wounds . . . . . . . . . 149, 187, 249, 253, 257
Halichoerus grypus . . . . . . . . . 170, 172, 175, 176
harbor porpoise . . 2, 28, 45, 50, 53, 59, 65, 72, 79, $90,99,107,108,118,124,129,135,142$, $152-160,162-165,168,170,174,176$,

179, 181, 224, 225
harbor seal . . . . . . . . . . . . . . . 2, 163, 166-171, 176
harp seal . . . . . . . . . . . . . . . . . . . . . . . . . 2, 177-181
health assessment . . . . . . . . . . . . 149, 150, 189, 250
herring weirs . . . 9, 40, 157-160, 164, 168, 169, 174
hooded seal . . . . . . . . . . . . . . . . . . . . . . . 2, 222-226
humpback whale . . . . . . . . . . . . . 1, 3, 14-19, 22-24
Hyperoodon ampullatus . . . . . . . . . . . . . . . 214, 215
Indian/Banana River . . . . . . . . . . . . . . . . . . 137, 143
Key West . . . . . . . . . . . . . . . . . . . . . . . 185, 245, 256
killer whale . . 3, 199, 210-213, 282, 284, 285, 288, 290
Kogia breviceps . . . 49-51, 53, 192, 193, 195, 196
Kogia simus ... 47, 49, 50, 53, 192, 193, 195, 196
ladyfish . . . . . . . . . . . . . . . . . . . . . . . . . . . 254, 258
Lagenorhynchus acutus . . . . . . 100, 105, 108, 118
Long Island . . . . . . . . . . . . . . . . . . 39, 59, 144, 166
longline fishery . . . $37,76,77,85,88,93,95,97$, $113,122,123,127,128,134,139,193$, 196, 228, 231, 234, 237, 240, 243, 246, 261, 262, 265, 268, 271, 274, 277, 280, 283, 286, 289, 292, 295, 298
long-finned pilot whale . . $1,81,82,84,87,89,90$,
92, 94, 98
mackerel $\ldots . .15,21,76,84,86,88,89,93,96-98$, 102-105, 112-116, 138-140, 167
Maine . . . . . . 1, 2, 5, 9, 10, 14-20, 22, 23, 25-29, $31,34,36-40,45,50,53,55,57-59,61$, $65,68,72,74,75,79,81,82,89,90,99-$ $102,104,106,108,110,111,114,118$, $120,124-126,129,132,135,142,152-$ 157, 160-178, 180-182, 184, 210, 216,
$218,222,224,225$
mark-recapture . . . . . . . . 15, 16, 23, 54, 177, 181
Maryland . . 13, 23, 47, 49, 51, 55, 56, 61, 68, 69, $75,82,83,92,106,111,120,126,132$, 137, 138, 148, 160, 161, 175
Massachusetts . . 1, 5, 9, 11, 13, 15, 17, 22, 25, 28, $33,44,46,49,58,59,64,66,71,73,79$, 89-91, 98, 99, 106, 108, 109, 117, 118, $134,136,142,148,154,155,160,161$, $163-165,168,170-172,175,176,180$, $182,210,225,226$
matrilines . 5
Megaptera novaeangliae . . .... 14, 19, 22-24, 33
melon-headed whale . . . . . . . . . . . . . . . . 291, 293
menhaden . . . . . . . . . . . . . 147, 187, 250, 254, 258
Mesoplodon bidens . . . . . . . . . . . . . 72, 237, 240
Mesoplodon densirostris . . . . . . . . . . . . . 72, 236
Mesoplodon europaeus . . . . . . . . . . . . . . . . . 239
Mesoplodon mirus . . . . . . . . . . . . . . . . . . . . . . . 67
metals . . . . . . . . . . . . . . . . . . . . . . . . 152, 189, 250
minke whale . . . . . . . . . . . . . . . . 4, 35-41, 44, 45
morbillivirus . . . 189, 190, 250, 251, 254, 255, 258
mutilation . . . . . . . . 141, 160, 187, 249, 253, 257
net entanglement . . . . . . . . . . 9, 17, 249, 253, 257
New England . 5, 9, 14, 15, 22, 25, 30, 35, 39, 42, $45,46,54,67,77,86,95,104,106-109$, $114,119,131,133,140,147,157,162$, 163, 165-178, 180-182, 210, 211, 213, $215,216,222,224-226$

New Jersey . . . . . 22, 39, 52, 81, 98, 143-145, 147, $152,156,160,161,166,170,171,177$, 180
New York . . $27,34,39,52,58,59,65,72,79,87$, $89,96,103,104,108,114,117,123,129$, $135,141,152,156,157,160-162,166$, 168, 170-172, 175, 179-181, 191, 215,

225, 239
North Carolina . . 14, 19, 21, 22, 27, 29, 35, 39, 49, $52,55,60,68,74,81,87,92,96,98,100$, $101,103,110,114,117,119,123,125$, $129,131,143,147-152,156,160-162$, $164,168,170,179,180,212,216,219$, 225
Orcinus orca . . . . . . . . . . . . . . . 210, 211, 282, 284 pair trawl $\ldots .9,18,23,45,50,52,57,59,62,65$, $73,76-79,84,85,88-90,94,95,97-99$, 107, 108, 113, 116-118, 121, 123, 124, 127-129, 133, 135, 139, 140, 142, 163, $164,178,193,196,211,213,215,220$, 221, 224, 228, 231, 234, 237, 240, 244, 246, 247, 262, 266, 268, 271, 274, 277,

280, 283, 286, 289, 292, 295, 298
pantropical spotted dolphin . . . . 2, 119, 125, 126, 128, 129, 264-266
PCBs . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 89, 152
Peponocephala electra . . . . . . . . . . . . 288, 291, 293
Perdido Bay . . . . . . . . . . . . . . . . . . . . . . . . . . 185
Phoca groenlandica . . . . . . . . . . 177, 180, 181, 226
Phoca vitulina . . . . . . . . . . . . . . 166, 169-171, 176
Phocoena phocoena . . . . . . . . . . 152, 159, 163-165
photo-identification . . 6, 7, 33, 144, 145, 151, 184,
191, 283
Physeter macrocephalus . . . 22, 54, 58, 59, 227, 229
Pine Sound . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 185
Plymouth . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6
polychlorinated biphenyls . . . . . . . . . . . . . . . . . 89
population growth rate . . . . . . . . . . . . 6, 7, 16, 154
pseudorabies virus . . . . . . . . . . . . . . . . . . . 250, 258
Pseudorca crassidens . . . . . . . . . . . . . . . . . . . . . 285
pygmy killer whale . . . . . . . . . 3, 212, 213, 288, 290
pygmy sperm whale $\ldots .3,4,50-53,193,195,196$
Redfish Bay . . . . . . . . . . . . . . . . . . . . . . . . . . . 185
right whale . . . . . . . . . . . . . . . . . . . . . 3, 5, 8-13, 29
Risso's dolphin . . . . . . . . . . . . . . . . 74-78, 202, 294
Sabine Lake . . . . . . . . . . . . . . . . . . . . . . . . . . . . 185
salmon gillnets . . . . . . . . . . . . 40, 87, 98, 168, 174
Scotian Shelf . . 5, 15, 29, 36, 54-56, 59-61, 68, 69,
$74,75,82,83,101,110,111,117,135$,
137, 142, 176
sei whale . . . . . . . . . . . . . . . . . . . . . . . . . . 3, 38-31
ship strikes . . . . . . 4, 8, 10, 17, 19, 22, 37, 43, 58
short-finned pilot whale ... 81, 84, 89, 92-94, 98, 297
sink gillnet . $4,38,45,52,57,62,70,76,84,88$, $94,97,102,103,105,107,108,113,114$, $116,121,127,133,139,147,148,154$, $155,157,159,163,168-170,174-176$, $178,180,181,210,211,213,215,220$,

224, 225
South Carolina . . 64, 71, 77, 86, 89, 95, 114, 122, $128,139,144,147,148,151,170,204$, 219
Sowerby's beaked whale . . . . 236, 237, 239, 240
sperm whale . . 3, 4, 47, 49-59, 192, 193, 195, 196,
227-229
spinner dolphin . . . . . . 2, 201, 219-221, 270, 272
squid $\ldots . .76,84,86-90,93,94,96,97,102-105$, 112-116, 138-140, 183, 201
St. Andrew Bay . . . . . . . . . . . . . . . . . . . . . . . . 185
St. Joseph Bay . . . . . . . . . . . . . . . . . . . . . . . . . . 185
Staphylococcus spp. . . . . . . . . . . . . . 250, 254, 258
Stellwagen Bank . . . . . . . . . . . . 15, 20, 29, 38, 168
Stenella attenuata . . . . . . . . . . . . 125, 129, 264, 266
Stenella clymene . . . . . . . . . . . . . . . . . 110, 276, 278
Stenella frontalis . . . . . . . . . . . 119, 125, 260, 263
Stenella longirostris . . . . . . . . . 219, 220, 270, 272
Strait of Belle Isle . . . . . . . . . . . . . . . . . . . . . . 6, 32
striped dolphin . . . . . . . . . . 2, 131-133, 267, 269
swordfish . . $18,23,38,45,48,50,58,59,63,65$, $70,73,76,79,85,90,94,99,103,108$, $113,118,121,124,127,129,133,135$, $139,142,156,164,193,196,221,228$, 231, 234, 237, 240, 243, 244, 246, 247, 261, 262, 265, 268, 271, 274, 277, 280, 283, 286, 289, 292, 295, 298
Ten Thousand Islands . . . . . . . . . . . . . . . . . . . . . 185
TerreBonne Bay . . . . . . . . . . . . . . . . . . . . . . . . 185
thread herring . . . . . . . . . . . . . . . . . . . . . . 254, 258
Trichechus manatus latirostris . . . . . 203, 205-208
Trichechus manatus manatus . . . . . . 203, 207, 209
Trinity Bay . . . . . . . . . . . . . . . . . . . . . . . . . . . . 185
tunas . . $77,85,95,113,140,193,196,228,231$, 234, 237, 240, 243, 246, 261, 265, 268, 271, 274, 277, 280, 283, 286, 289, 292,

295, 298
Vermillion Bay . . . . . . . . . . . . . . . . . . . . . . . . . 185
West Bay . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 185
West Cote Blanche Bay . . . . . . . . . . . . . . . . . . . 185
Whitewater Bay . . . . . . . . . . . . . . . . . . . . . . . . 185
white-beaked dolphin . . . . . . . . . . . . . . 2, 216-218
white-sided dolphin . . . 2, 100, 102-105, 108, 218
Ziphius cavirostris . 60, 64, 65, 71, 233, 235, 236,
239


[^0]:    ${ }^{\text {aRobins, C.R. (chair); Bailey, R.M.; Bond, C.E.; Brooker, J.R.; Lachner, E.A.; Lea, R.N.; Scott, W.B. 1991. Common and scientific names of fishes }}$ from the United States and Canada. 5th ed. Amer. Fish. Soc. Spec. Publ. 20; 183 p.
    ${ }^{\text {bTurgeon, D.D. (chair); Quinn, J.F., Jr.; Bogan, A.E.; Coan, E.V.; Hochberg, F.G.; Lyons, W.G.; Mikkelsen, P.M.; Neves, R.J.; Roper, C.F.E.; }}$ Rosenberg, G.; Roth, B.; Scheltema, A.; Thompson, F.G.; Vecchione, M.; Williams, J.D. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: mollusks. 2nd ed. Amer. Fish. Soc. Spec. Publ. 26; 526 p.
    ${ }^{\text {cWilliams, A.B. (chair); Abele, L.G.; Felder, D.L.; Hobbs, H.H., Jr.; Manning, R.B.; McLaughlin, P.A.; Pérez Farfante, I. 1989. Common and }}$ scientific names of aquatic invertebrates from the United States and Canada: decapod crustaceans. Amer. Fish. Soc. Spec. Publ. 17; 77 p.
    ${ }^{d}$ Rice, D.W. 1998. Marine mammals of the world: systematics and distribution. Soc. Mar. Mammal. Spec. Publ. 4; 231 p.

[^1]:    Figure 1. Distribution of pilot whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer in 1990-1998. Isobaths are at 100 m and $1,000 \mathrm{~m}$.

[^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 for the pelagic drift gillnet and longline fishery, and these data are collected at the Southeast Fisheries Science Center (SEFSC).
    2 Observer coverage of the mid-Atlantic coastal sink gillnet fishery is measured in tons of fish landed.
    Observer coverage for the pelagic drift gillnet, pair trawl and longline fishery are in terms of sets. The trawl fisheries are measured in trips.
    3 1994, 1995 and 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 0.84 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.
    5 Annual mortality estimates include seriously injured and released alive animals.
    ${ }^{6}$ The fishery did not operate in 1997; the average annual mortality is based on the number of years (4; 1994, 1995, 1996, and 1998) that the fishery operated.
    7 Observer coverage for the Atlantic bottom trawl fishery in 1995 is based on only January to May data.
    8 In 1997 and 1998 the observed pilot whales were taken from the Illex squid otter trawl subfishery.
    ${ }^{9}$ Mortality estimates were taken from Yeung (1999a,b) and exclude the Gulf of Mexico.

