

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

### STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of Cuvier's beaked whales is poorly known, and is based mainly on stranding records (Leatherwood *et al.* 1976). Strandings have been reported from Nova Scotia along the eastern U.S. coast south to Florida, around the Gulf of Mexico, and within the Caribbean (Leatherwood *et al.* 1976; CETAP 1982; Heyning 1989; Houston 1990; MacLeod *et al.* 2006). 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 U.S. coast (CETAP 1982; Waring *et al.* 1992; Waring *et al.* 2001; Hamazaki 2002; Palka 2006). Most sightings were in late spring or summer.

### POPULATION SIZE

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

However, several estimates of the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) from selected regions are available for select time periods (Barlow *et al.* 2006). Sightings are almost exclusively in the continental shelf edge and continental slope areas (Figure 1). The best abundance estimate for beaked whales is the sum of the estimates from the two 2004 U.S. Atlantic surveys, 3,513 (CV=0.63), where the estimate from the northern U.S. Atlantic is 2,839 (CV=0.578), and from the southern U.S. Atlantic is 674 (CV=0.36). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

### Earlier abundance estimates

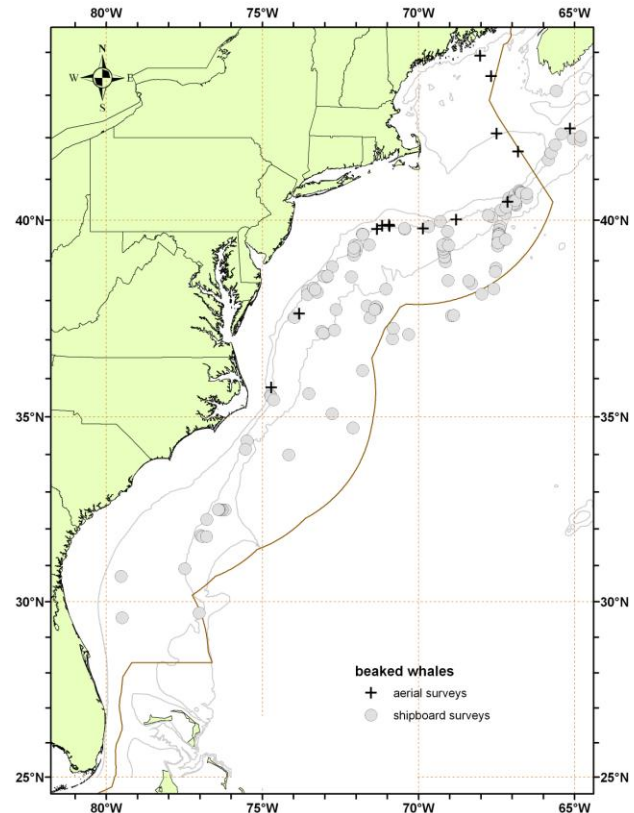
Please see Appendix IV for earlier abundance estimates. As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable, and should not be used for PBR determinations. Further, due to changes in survey methodology these data should not be used to make comparisons to more current estimates.

### Recent surveys and abundance estimates

An abundance estimate of 822 (CV=0.81) undifferentiated beaked whales was obtained from an aerial survey conducted in July and August 2002 which covered 7,465 km of trackline over waters from the 1000 m depth contour on the southern edge of Georges Bank to Maine (Table 1; Palka 2006). The value of  $g(0)$  used for this estimation was derived from the pooled data of 2002, 2004 and 2006 aerial survey data.

An abundance of 2,839 (CV=0.78) for beaked whales was estimated from a line-transect sighting survey conducted during 12 June to 4 August 2004 by a ship and plane that surveyed 10,761 km of track line in waters north of Maryland (38°N) to the Bay of Fundy (45°N) (Table 1; Palka 2006). Shipboard data were collected using the two independent team line-transect method and analyzed using the modified direct duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and  $g(0)$ , the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back line-transect method (Hiby 1999) and analyzed accounting for  $g(0)$  and biases due to school size and other potential covariates (Palka 2005).

A shipboard survey of the U.S. Atlantic outer continental shelf and continental slope (water depths  $\square > 50$  m) between



**Figure 1.** Distribution of beaked whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer 1998, 1999, 2002, 2004, 2006 and 2007. Isobaths are 100 m, 1,000 m, and 4000 m.

Florida and Maryland (27.5 and 38°N latitude) was conducted during June-August, 2004. The survey employed two independent visual teams searching with 25× bigeye binoculars. Survey effort was stratified to include increased effort along the continental shelf break and Gulf Stream front in the Mid-Atlantic. The survey included 5,659 km of trackline, and accomplished a total of 473 cetacean sightings. Sightings were most frequent in waters north of Cape Hatteras, North Carolina along the shelf break. Data were corrected for visibility bias  $g(0)$  and group-size bias and analyzed using line-transect distance analysis (Palka 1995; Buckland *et al.* 2001). The resulting abundance estimate for beaked whales between Florida and Maryland was 674 animals (CV =0.36).

An abundance estimate of 922 (CV=1.47) undifferentiated beaked whales was obtained from an aerial survey conducted in August 2006 which covered 10,676 km of trackline in the region from the 2000 m depth contour on the southern edge of Georges Bank to the upper Bay of Fundy and to the entrance of the Gulf of St. Lawrence (Table 1; Palka pers. comm.).

Although the 1990-2006 surveys did not sample exactly the same areas or encompass the entire beaked whale habitat, they did focus on segments of known or suspected high-use habitats off the northeastern U.S. coast. The collective 1990-2004 data suggest that, seasonally, at least several thousand beaked whales are occupying these waters, with 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 <i>Ziphius</i> and <i>Mesoplodon</i> spp. Month, year, and area covered during each abundance survey, and resulting abundance estimate ( $N_{best}$ ) and coefficient of variation (CV). |  |            |      |
|--|--|------------|------|
| Month/Year   | Area   | $N_{best}$ | CV   |
| Aug 2002   | S. Gulf of Maine to Maine                                      | 822        | 0.81 |
| Jun-Aug 2004   | Maryland to the Bay of Fundy                                   | 2,839      | 0.78 |
| Jun-Aug 2004   | Florida to Maryland  | 674        | 0.36 |
| Jun-Aug 2004   | Florida to Bay of Fundy (COMBINED)                             | 3,513      | 0.63 |
| Aug 2006   | S. Gulf of Maine to upper Bay of Fundy to Gulf of St. Lawrence | 922        | 1.47 |

### Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for undifferentiated beaked whales is 3,513 (CV=0.63). The minimum population estimate for the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 2,154. 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 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 is 6.1m 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 2,154. 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 0.4 because the CV for the fishery mortality estimate exceeds 0.8. PBR for all species in the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 17. It is not possible to determine the PBR for only Cuvier’s beaked whales.

**ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY**

The 2003-2007 total average estimated annual mortality of beaked whales in fisheries in the U.S. Atlantic EEZ was 1.0, derived from average annual fishery bycatch of one animal (Table 2).

**Fishery Information**

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

Total annual estimated average fishery-related mortality or serious injury of this stock in 2003-2007 in the U.S. fisheries listed below was 1 beaked whale (CV=1.0). Detailed fishery information is reported in Appendix III.

**Earlier Interactions**

There is no historical information available that documents incidental mortality of beaked whales in either U.S. or Canadian Atlantic coast fisheries (Read 1994). The only documented bycatch prior to 2003 of beaked whales is in the pelagic drift gillnet fishery (now prohibited). The bycatch 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 24 Sowerby’s, 4 True’s, 1 Cuvier’s and 17 undifferentiated beaked whales. Recent analyses of biological samples (genetics and morphological analysis) have been used to determine species identifications for some of the bycaught animals. Estimated bycatch mortality by species is available for the 1994-1998 period. Prior 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) and 12 in 1993 (0.16). The 1994-1998 estimates for Cuvier’s beaked whales are 1 in 1994 (0.14) and zero for the years 1995-1996 and 1998. There was no fishery during 1997. During July 1996, one beaked whale was entangled and released alive with “gear in/around a single body part”.

**Pelagic Longline**

One unidentified beaked whale was seriously injured in the U.S. Atlantic pelagic longline fishery in 2003. This interaction occurred in the Sargasso Sea fishing area. The estimated fishery-related combined mortality in 2003 was 5.3 beaked whales (CV=1.0). No serious injury or mortality interactions were reported prior to 2003 or in 2005-2007. The estimated average combined mortality in 2003-2007 was 1 beaked whale (CV=1.0; Table 2).

| Table 2. Summary of the incidental mortality of Beaked Whales ( <i>Ziphius cavirostris</i> and <i>Mesoplodon</i> 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 observed mortalities and serious injuries recorded by on-board observers, the estimated annual mortality and serious injury, the combined annual estimates of mortality and serious injury (Estimated Combined Mortality), the estimated CV of the combined estimates (Estimated CVs) and the mean of the combined estimates (CV in parentheses). |       |                      |                        |                         |                         |                    |                          |                     |                              |                 |                       |  |
|--|-------|----------------------|------------------------|-------------------------|-------------------------|--------------------|--------------------------|---------------------|------------------------------|-----------------|-----------------------|--|
| Fishery  | Years | Vessels <sup>c</sup> | Data Type <sup>a</sup> | Observer Coverage       | Observed Serious Injury | Observed Mortality | Estimated Serious Injury | Estimated Mortality | Estimated Combined Mortality | Estimated CVs   | Mean Annual Mortality |  |
| Pelagic Longline (excluding NED-E) <sup>b,c</sup>  | 03-07 | 63, 60, 60, 63, 62   | Obs. Data Logbook      | .09, .09, .06, .07, .08 | 1, 0, 0, 0, 0           | 0, 0, 0, 0, 0      | 5.3, 0, 0, 0, 0          | 0, 0, 0, 0, 0       | 5.3, 0, 0, 0, 0              | 1.0, 0, 0, 0, 0 | 1(1.0)                |  |

|              |  |         |
|--------------|--|---------|
| TOTAL        |  | 1 (1.0) |
| <sup>a</sup> | Observer data (Obs. Data) are used to measure bycatch rates and the data are collected within the Northeast Fisheries Observer Program. Mandatory logbook data were used to measure total effort for the longline fishery. These data are collected at the Southeast Fisheries Science Center (SEFSC). |         |
| <sup>b</sup> | 2003 SI estimates were taken from Table 10 in Garrison and Richards (2004).  |         |
| <sup>c</sup> | Number of vessels in the fishery are based on vessels reporting effort to the pelagic longline logbook.  |         |

### Other Mortality

From 1992 to 2002, a total of 69 beaked whales stranded along the U.S. Atlantic coast between Florida and Massachusetts (NMFS unpublished data). This includes: 38 (includes one tentative identification) Gervais' beaked whales (one 1997 animal and one 2002 animal had plastics in stomach; 2 animals that stranded in September 1998 in South Carolina showed signs of fishery interactions; one Florida 2001 animal showed signs of blunt trauma; one 2002 animal may have been involved in a ship strike); 3 True's beaked whales; 6 Blainville's beaked whales; 1 Sowerby's beaked whale; 14 Cuvier's beaked whales (one 1996 animal had propeller marks, and one 2000 animal had a longline hook in the lower jaw) and 7 unidentified animals.

One stranding of Sowerby's beaked whale was recorded on Sable Island between 1970-1998 (Lucas and Hooker 2000). The whale's body was marked by wounds made by the cookiecutter shark (*Isistius brasiliensis*), which has previously been observed on beaked whales (Lucas and Hooker 2000).

Also, several unusual mass strandings of beaked whales throughout their worldwide range have been associated with naval activities. During the mid- to late 1980's multiple mass strandings of Cuvier's beaked whales (4 to about 20 per event) and small numbers of Gervais' beaked whale and Blainville's beaked whale occurred in the Canary Islands (Simmonds and Lopez-Jurado 1991). Twelve Cuvier's beaked whales that live stranded and subsequently died in the Mediterranean Sea on 12-13 May 1996 were associated with low frequency acoustic sonar tests conducted by the North Atlantic Treaty Organization (Frantzis 1998). In March 2000, 14 beaked whales live stranded in the Bahamas; 6 beaked whales (5 Cuvier's and 1 Blainville's) died (Balcomb and Claridge 2001; NMFS 2001; Cox *et al.* 2006). Four Cuvier's, 2 Blainville's and 2 unidentified beaked whales were returned to sea. The fate of the animals returned to sea is unknown, since none of the whales have been resighted. Necropsies of 6 dead beaked whales revealed evidence of tissue trauma associated with an acoustic or impulse injury that caused the animals to strand. Subsequently, the animals died due to extreme physiologic stress associated with the physical stranding (i.e., hyperthermia, high endogenous catecholamine release) (Cox *et al.* 2006). Ocean Conservation Research has assembled a partial list of cetacean strandings, mostly beaked whales, that may have been associated with military-generated noise. (<http://ocr.org/research/impacts/military-associated-strandings.pdf>, accessed 21 Oct 2009).

During 2003-2007, nine Cuvier's beaked whales stranded along the U.S. Atlantic coast (Table 2). Two of these animals were classified as having signs of human interaction, however, as the cause of death of stranded animals is not being evaluated (interactions may be non-fatal or even post-mortem), these animals are not included in annual human-induced mortality estimates.

| State                       | 2003     | 2004     | 2005     | 2006     | 2007     | Total     |
|-----------------------------|----------|----------|----------|----------|----------|-----------|
| Massachusetts               |          |          |          | 1        |          | 1         |
| New Jersey                  |          |          | 1        |          |          | 1         |
| Georgia <sup>a</sup>        |          |          | 1        | 1        |          | 2         |
| South Carolina <sup>b</sup> | 2        |          |          |          | 1        | 3         |
| Florida                     | 1        |          |          |          | 2        | 3         |
| <b>Total</b>                | <b>3</b> | <b>0</b> | <b>2</b> | <b>2</b> | <b>3</b> | <b>10</b> |

a. Animal in Georgia in 2005 had plastic debris found in the stomach.  
b. Animal in South Carolina in 2007 displayed signs of having been involved in a boat collision.

## STATUS OF STOCK

The status of Cuvier's beaked whale relative to OSP in the U.S. Atlantic EEZ is unknown. This species is not listed as threatened or endangered under the Endangered Species Act. Although a species specific PBR cannot be determined, the permanent closure of the pelagic drift gillnet fishery has eliminated the principal known source of incidental fishery mortality. The total U.S. fishery mortality and serious injury for this group of species 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 average annual human-related mortality and serious injury does not exceed PBR.

## REFERENCES CITED

- Balcomb, K. C. I. and D. E. Claridge 2001. A mass stranding of cetaceans caused by naval sonar in the Bahamas. *Bahamas J. Sci.* 2: 2-12.
- Barlow, J., M. C. Ferguson, W. F. Perrin, L. Ballance, T. Gerrodette, G. Joyce, C. D. MacLeod, K. Mullin, D. L. Palka and G. Waring 2006. Abundance and densities of beaked and bottlenose whales (family *Ziphiidae*). *J. Cetacean Res. Manage.* 7: 263-270.
- 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 Tech. Memo. NMFS-OPR-6. 73 pp.
- Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers and L. Thomas 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press. 432 pp.
- CETAP 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf, final report, Cetacean and Turtle Assessment Program, University of Rhode Island. Washington, DC, Bureau of Land Management. #AA551-CT8-48: 576.
- Cox, T. M., T. J. Ragen, A. J. Read, E. Vos, R. W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G. D. Spain, A. Fernandez, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hilderbrand, D. Houser, T. Hullar, P. D. Jepson, D. Ketten, C. D. MacLeod, P. Miller, S. Moore, D. Moutain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead and L. Benner 2006. Understanding the impacts of anthropogenic sound on beaked whales. *J. Cetacean Res. Manage.* 7(3): 177-187.
- Frantzis, A. 1998. Does acoustic testing strand whales? *Nature* 392: 29.
- Garrison, L. P. and P. M. Richards 2004. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic pelagic longline fleet during 2003. NOAA Tech. Memo. NMFS-SEFSC-527. 57 pp.
- Hamazaki, T. 2002. Spatiotemporal prediction models of cetacean habitats in the mid-western North Atlantic Ocean (from Cape Hatteras, No. Carolina, USA to Nova Scotia, Canada). *Mar. Mamm. Sci.* 18(4): 920-939.
- 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.
- Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise. Pages 179-189 in: G.W. Garner, S.C. Amstrup, J.L. Laake *et al.*, (eds.) *Marine Mammal Survey and Assessment Methods.* Balkema, Rotterdam.
- Houston, J. 1990. Status of Blainville's beaked whale, *Mesoplodon densirostris*, in Canada. *Can. Field-Nat.* 104(1): 117-120.
- 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. 176 pp.
- Lucas, Z. N. and S. K. Hooker 2000. Cetacean strandings on Sable Island, Nova Scotia, 1970-1998. *Can. Field-Nat.* 114(1): 46-61.
- MacLeod, C., W. F. Perrin, R. Pitman, J. Barlow, L. Ballance, A. D'Amico, T. Gerrodette, G. Joyce, K. D. Mullin, D. L. Palka and G. T. Waring 2006. Known and inferred distributions of beaked whale species (Cetacea: *Ziphiidae*). *J. Cetacean Res. Manage.* 7(3): 271-286.
- Mead, J. G. 1984. Survey of reproductive data for the beaked whales (*Ziphiidae*). *Rep. Int. Whal. Comm. (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.
- Mitchell, E. D., (ed.), 1975. Review of the biology and fisheries for smaller cetaceans. Report of the meeting on smaller cetaceans. *Int. Whal. Comm. J. Fish. Res. Board Can* 32(7): 875-1240.

- NMFS 2001. Joint interim report on the Bahamas marine mammal stranding event of 15-16 March 2000 (December 2001). NOAA unpublished report 55 pp.  
[http://www.nmfs.noaa.gov/pr/pdfs/health/stranding\\_bahamas2000.pdf](http://www.nmfs.noaa.gov/pr/pdfs/health/stranding_bahamas2000.pdf)
- Palka, D. 1995. Abundance estimate of the Gulf of Maine harbor porpoise. Rep. Int. Whal. Comm. (Special Issue) 16: 27-50.
- Palka, D. L. 2005. Aerial surveys in the northwest Atlantic: estimation of  $g(0)$ . Proceedings of a Workshop on Estimation of  $g(0)$  in Line-Transect Surveys of Cetaceans, European Cetacean Society's 18th Annual Conference; Kolmården, Sweden; Mar. 28, 2004.
- Palka, D. L. 2006. Summer abundance estimates of cetaceans in US North Atlantic Navy Operating Areas. Northeast Fish. Sci. Cent. Ref. Doc. 06-03. 41 pp.  
<http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0603/crd0603.pdf>
- Palka, D. L. and P. S. Hammond 2001. Accounting for responsive movement in line transect estimates of abundance. Can. J. Fish. Aquat. Sci 58: 777-787.
- Read, A. J. 1994. Interactions between cetaceans and gillnet and trap fisheries in the northwest Atlantic. Pages 133-147 in: W.F. Perrin, G. P. Donovan and J. Barlow, (eds.) Gillnets and cetaceans. Rep. Int. Whal. Comm. (Special Issue) 15.
- Simmonds, M. P. and L. F. Lopez-Jurado 1991. Whales and the military. Nature 351(6326): 448-448.
- 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., C. P. Fairfield, C. M. Ruhsam and M. Sano 1992. Cetaceans associated with Gulf Stream Features off the Northeastern USA Shelf. ICES [Int. Counc. Explor. Sea] C.M. 1992/N:12.
- Waring, G. T., T. Hamazaki, D. Sheehan, G. Wood and S. Baker 2001. Characterization of beaked whale (*Ziphiidae*) and sperm whale (*Physeter macrocephalus*) summer habitat in shelf-edge and deeper waters off the northeast U.S. Mar. Mamm. Sci. 17(4): 703-717.

