BLAINVILLE'S BEAKED WHALE (*Mesoplodon densirostris*): 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, *M. 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. Thus, it is plausible the stock could actually contain multiple demographically independent populations that should themselves be stocks, because the current stock spans multiple eco-regions (Longhurst 1998; Spalding *et al.* 2007).

The distributions of *Mesoplodon* spp. in the northwest Atlantic are known principally from stranding records (Mead 1989; Nawojchik 1994; Mignucci-Giannoni *et al.* 1999; MacLeod *et al.* 2006; Jefferson *et al.* 2008). Off the U.S. Atlantic coast, beaked whale (*Mesoplodon* spp.) sightings have occurred principally along the shelf-edge and deeper oceanic waters (Figure 1; CETAP 1982; Waring *et al.* 1992; Tove 1995; Waring *et al.* 2001; Hamazaki 2002; Palka 2006). Most sightings were in late spring and summer, which corresponds to survey effort.

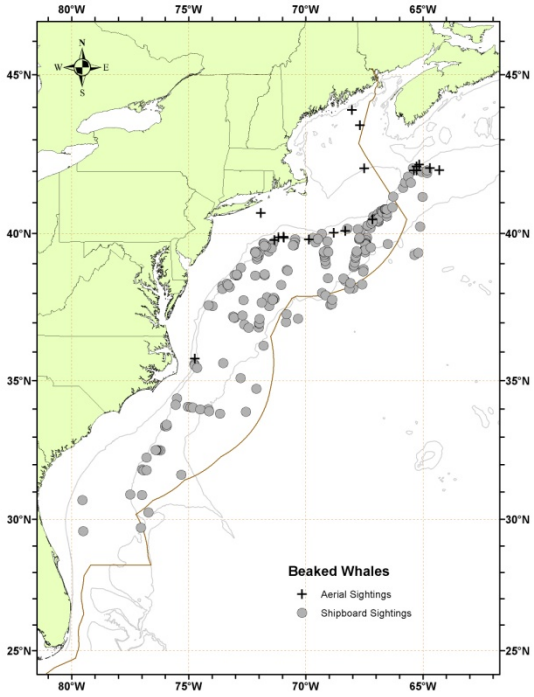

Figure 1. *Distribution of beaked whale (includes Ziphius and Mesoplodon spp.) sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, and 2007, 2008, 2010, and 2011. Isobaths are the 100-m, 1000-m and 4000-m depth contours.*

Blainville's beaked whales have been reported from southwestern Nova Scotia to Florida, and are believed to be widely but sparsely distributed (Leatherwood *et al.* 1976; Mead 1989; Nicolas *et al.* 1993; MacLeod *et al.* 2006; Jefferson *et al.* 2008). There are two records of strandings in Nova Scotia which probably represent strays from the Gulf Stream (Mead 1989). They are considered rare in Canadian waters (Houston 1990).

POPULATION SIZE

The total number of Blainville's beaked whales off the eastern U.S. and Canadian Atlantic coast is unknown, and seasonal abundance estimates are not available for this stock. 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) as well as two estimates of *Mesoplodon* spp. beaked whales alone. Sightings are almost exclusively in the continental shelf edge and continental slope areas (Figure 1). The best abundance estimate for *Mesoplodon* spp. beaked whales is the sum of the 2011 survey estimates – 7,092 (CV=0.54).

Earlier abundance estimates

Please see Appendix IV for a summary of abundance estimates, including earlier estimates and survey descriptions. Due to changes in survey methodology these historical data should not be used to make comparisons to more current estimates.

Recent surveys and abundance estimates

An abundance estimate of 922 (CV=1.47) undifferentiated beaked whales (*Ziphius* and *Mesoplodon* spp.) 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.).

An abundance estimate of 5,500 (CV=0.67) *Mesoplodon* spp. (not including *Ziphius*) beaked whales was generated from aerial and shipboard surveys conducted during June-August 2011 between central Virginia and the lower Bay of Fundy. The aerial portion covered 6,850 km of tracklines over waters north of New Jersey from the coastline to the 100-m depth contour through the U.S. and Canadian Gulf of Maine, and up to and including the lower Bay of Fundy. The shipboard portion covered 3,811 km of tracklines between central Virginia and Massachusetts in waters deeper than the 100-m depth contour out to beyond the U.S. EEZ. Both sighting platforms used a double-platform data collection procedure, which allows estimation of abundance corrected for perception bias of the detected species (Laake and Borchers 2004).

An abundance estimate of 1,570 (CV=0.65) *Mesoplodon* spp. (not including *Ziphius*) beaked whales was generated from a shipboard survey conducted concurrently (June–August 2011) in waters between central Virginia and central Florida. This shipboard survey included shelf-break and inner continental slope waters deeper than the 50-m depth contour within the U.S. EEZ. The survey employed two independent visual teams searching with 25× bigeye binoculars. A total of 4,445 km of tracklines were surveyed, yielding 290 cetacean sightings. The majority of sightings occurred along the continental shelf break with generally lower sighting rates over the continental slope. Estimation of the abundance was based on the independent observer approach assuming point independence (Laake and Borchers 2004) and calculated using the mark-recapture distance sampling option in the computer program Distance (version 6.0, release 2, Thomas *et al.* 2009).

Although the 1990-2011 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 1990-2011 data suggest that, seasonally, at least several thousand beaked whales are occupying these waters, with highest levels of abundance in the Georges Bank region. NMFS survey results suggest that beaked whale abundance may be highest in association with Gulf Stream and warm-core ring features (Waring *et al*. 2001, Hamazaki 2002).

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

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

Month/Year	Area	N_{best}	CV
Aug 2006[b]	S. Gulf of Maine to upper Bay of Fundy to Gulf of St. Lawrence	922	1.47
Jun-Aug 2011[a]	Central Virginia to lower Bay of Fundy	5,500	0.67
Jun-Aug 2011[a]	Central Florida to Central Virginia	1,592	0.67
Jun-Aug 2011[a]	Central Florida to lower Bay of Fundy (COMBINED)	7,092	0.54

[a] 2011estimates are for *Mesoplodon* spp. beaked whales alone.
[b] 2006 estimate includes *Mesoplodon* and *Ziphius.*

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 *Mesoplodon* spp. beaked whales (not including *Ziphius*) is 7,092 (CV=0.54). The minimum population estimate for *Mesoplodon* spp. beaked whales (not including *Ziphius*) is 4,632.

Current Population Trend

A trend analysis has not been conducted for this stock. The statistical power to detect a trend in abundance for this stock is poor due to the relatively imprecise abundance estimates and long survey interval. For example, the power to detect a precipitous decline in abundance (i.e., 50% decrease in 15 years) with estimates of low precision (e.g., CV > 0.30) remains below 80% (alpha = 0.30) unless surveys are conducted on an annual basis (Taylor *et al.*

2007).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. *Mesoplodon* spp. 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 *Mesoplodon* spp. beaked whales (not including *Ziphius*) is 4,632. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor, which accounts for endangered, depleted, or threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5. PBR for the western North Atlantic stock of *Mesoplodon* spp. beaked whales is 46.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 2007–2011 total average estimated annual mortality of Blainville's beaked whales in fisheries in the U.S. Atlantic EEZ is 0.2 based on one stranded animal likely killed in 2007 by fishery entanglement (Table 3).

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998; Andersen *et al*. 2008; NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*". Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

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.

Estimated annual average fishery-related mortality or serious injury of this stock in 2007–2011 in U.S. fisheries was 0.2.

Earlier Interactions

There is no historical information available that documents incidental mortality 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 (Northridge 1996). 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 analysis of biological samples (genetics and morphological analysis) has been used to determine species identifications for some of the bycaught animals. Estimates from the 1989 to 1993 period 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). Estimates of bycatch mortality by species are available for the 1994–1998 period. None of the animals were identified as Blainville's beaked whales. Estimated annual fishery-related mortality for unidentified *Mesoplodon* beaked whales during this period was 0 in 1994, 3 (0) in 1995, 2 (0.25) in 1996, and 7 (0) in 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".

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 the U.S.

Atlantic pelagic longline fishery in 2003 was 5.3 beaked whales (CV=1.0). No serious injury or mortality interactions have been reportedsince 2003.

Other Mortality

From 2007–2011, a total of 4 Blainville's beaked whales stranded along the U.S. Atlantic coast between Florida and Massachusetts (NMFS unpublished data). One animal in 2007 that stranded in South Carolina was classified as a fishery interaction.

Several unusual mass strandings of beaked whales throughout their worldwide range have been associated with naval activities (D'Amico *et al.* 2009; Filadelfo *et al.* 2009). During the mid- to late 1980s 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; D'Amico *et al.* 2009; Filadelfo *et al.* 2009). 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. Necropsy 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).

Fourteen beaked whales (mostly Cuvier's beaked whales but also including Gervais' and Blainville's beaked whales) stranded in the Canary Islands in 2002 (Cox *et al.* 2006, Fernandez *et al.* 2005; Martin *et al.* 2004). Gas bubble-associated lesions and fat embolism were found in necropsied animals from this event, leading researchers to link nitrogen supersaturation with sonar exposure (Fernandez *et al.* 2005).

Table 2. Blainville's beaked whale (*Mesoplodon densirostris*) strandings along the U.S. Atlantic coast.

State	2007	2008	2009	2010	2011	Total
North Carolina	1	1	0	0	0	**2**
South Carolina[a]	1	0	0	0	0	**1**
Florida	0	0	0	0	1	**1**
Total	**2**	**1**	**0**	**0**	**1**	**4**

a. Animal in South Carolina in 2007 is classified as a fishery interaction due to entanglement marks around its peduncle.

STATUS OF STOCK

Blainville's beaked whales are not listed as threatened or endangered under the Endangered Species ActT and the western North Atlantic stock of Blainville's beaked whale is not considered strategic under the Marine Mammal Protection Act. No habitat issues are known to be of concern for this species, but questions have been raised regarding potential effects of human-made sounds on deep-diving cetacean species such as Blainville's beaked whales (Richardson et al. 1995), There are insufficient data to determine the population size or trends, and, while a PBR value has been calculated for the *Mesoplodon* genus, PBR cannot be calculated for this species independently. The permanent closure of the pelagic drift gillnet fishery has eliminated the principal known source of incidental fishery mortality, and a single 2007 stranding record was the only fishery-related mortality and serious injury observed during the recent 5-year (2007-2011) period. Therefore, total U.S. fishery-related mortality and serious injury rate can be considered to be insignificant and approaching zero. The status of Blainville's beaked whales relative to OSP in U.S. Atlantic EEZ is unknown.

REFERENCES CITED

Andersen, M. S., K. A. Forney, T. V. N. Cole, T. Eagle, R. Angliss, K. Long, L. Barre, L. Van Atta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, and L. Engleby 2008. Differentiating serious and non-serious injury of marine mammals: Report of the serious injury technical workshop. NOAA Tech. Memo. NMFS-OPR-39.

Angliss, R.P. and D.P. DeMaster. 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations: Report of the serious injury workshop, 1-2 April 1997, Silver Spring, MD. NOAA Tech. Memo. NMFS-OPR-13. 48 pp.

Balcomb, K.C. III 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. Balance, 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. Mountain, 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.

D'Amico, A., R.C.Gisiner, D.R. Ketten, J.A Hammock, C. Johnson., P.L. Tyack and J. Mead. 2009. Beaked whale strandings and naval exercises. Aq. Mamm. 35(4) 452-472.

Fernandez, A., J.F. Edwards, F. Rodriguez, A.E. de los Monteros, P. Herraez, P. Castro, J.R. Jaber, V. Martin and M. Arbelo 2005. "Gas and Fat Embolic Syndrome" involving a mass stranding of beaked whales (Family *Ziphiidae*) exposed to anthropogenic sonar signals. Veterinary Pathology 42(4):446-457.

Filadelfo, R., J. Mintz, E. Michlovich, A. D'Amico, P.L Tyack and D.R. Ketten. 2009. Correlating military sonar use with beaked whale mass strandings: What do the historical data show? Aq. Mamm. 35(4) 435-444.

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.

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

Jefferson, T.A., Webber, M.A. and R.L. Pitman. 2008. Marine Mammals of the World. Elsevier, Amsterdam. 573 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. 176 pp.

Longhurst, A.R. 1998. Ecological geography of the sea, Second Edition., Elsevier Academic Press. 560 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.

Martín, V., A. Servidio and S. García 2004. Mass strandings of beaked whales in the Canary Islands. ECS Newsletter 42:33-6.

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.

Mignucci-Giannoni, A.A., B. Pinto-Rodríguez, M. Velasco-Escudero, R.A. Montoya-Ospina, N.M. Jiménez, M.A. Rodríguez-López, J.E.H. Williams and D.K. Odell 1999. Cetacean strandings in Puerto Rico and the Virgin Islands. J. Cetacean Res. Manage. 1: 191-198.

Nawojchik, R. 1994. First record of *Mesoplodon densirostris* (*Cetacea: Ziphiidae*) from Rhode Island. Mar. Mamm.

Sci. 10: 477-480.
Nicolas, J., A. Williams and G. Repucci 1993. Observations of beaked whales (*Mesoplodon sp.*) in the western North Atlantic Ocean. Proceedings of the Tenth Biennial Conference on the Biology of Marine Mammals.
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
NOAA. 2012. Federal Register 77:3233. National Policy for Distinguishing Serious From Non-Serious Injuries of Marine Mammals. Available from:http://www.nmfs.noaa.gov/op/pds/documents/02/238/02-238-01.pdf
Northridge, S. 1996. Estimation of cetacean mortality in the U.S. Atlantic swordfish and tuna driftnet and pair trawl fisheries. NMFS. 40ENNF500160**:** 21.
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.
Palka, D.L. 2012. Cetacean abundance estimates in US northwestern Atlantic Ocean waters from summer 2011 line transect survey. Northeast Fish. Sci. Cent. Ref. Doc. 12-29. 37 pp. http://www.nefsc.noaa.gov/nefsc/publications/crd/crd1229/
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.
Richardson, W.J., C.R. Greene Jr, C.I. Malme, and D.H.Thomson 1995 Marine Mammals and Noise, Academic Press, San Diego, CA. 576 pp.
Simmonds, M.P. and L.F. Lopez-Jurado 1991. Whales and the military. Nature: 351:448.
Spalding, M.D., H.E. Fox, G.R. Allen, N. Davidson, Z.A. Ferdaña, M. Finlayson, B.S. Halpern, M.A. Jorge, A. Lombana, S.A. Lourie, K.D. Martin, E. McManus, J. Molnar, C.A. Recchia and J. Robertson, 2007. Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. BioScience 57(7):573-583
Taylor, B.L., M. Martinez, T. Gerrodette, J. Barlow and Y.N. Hrovat. 2007. Lessons from monitoring trends in abundance in marine mammals. Mar. Mamm. Sci. 23(1): 157-175.
Tove, M. 1995. Live sighting of *Mesoplodon CF. M. Mirus*, True's Beaked Whale. Mar. Mamm. Sci. 11(1): 80-85.
Wade, P.R. and R.P. Angliss 1997. Guidelines for assessing marine mammal stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. 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.