

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; Mignucci-Giannoni *et al.* 1999; MacLeod *et al.* 2006). 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.

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; MacLeod *et al.* 2006). It is considered rare in Canadian waters (Houston 1990).

Gervais' 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and strandings have been reported from Cape Cod Bay to Florida, into the Caribbean and the Gulf of Mexico (NMFS unpublished data; Leatherwood *et al.* 1976; Mead 1989; MacLeod *et al.* 2006). This is the most common species of *Mesoplodon* to strand along the U.S. Atlantic coast. The northernmost stranding was on Cape Cod.

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; MacLeod *et al.* 2006). 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).

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; MacLeod *et al.* 2006). Furthermore, a single stranding occurred off the Florida west coast (Mead 1989). This species is considered rare in Canadian waters (Lien *et al.* 1990).

POPULATION SIZE

The total number of *Mesoplodon* spp. beaked whales off the eastern U.S. 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

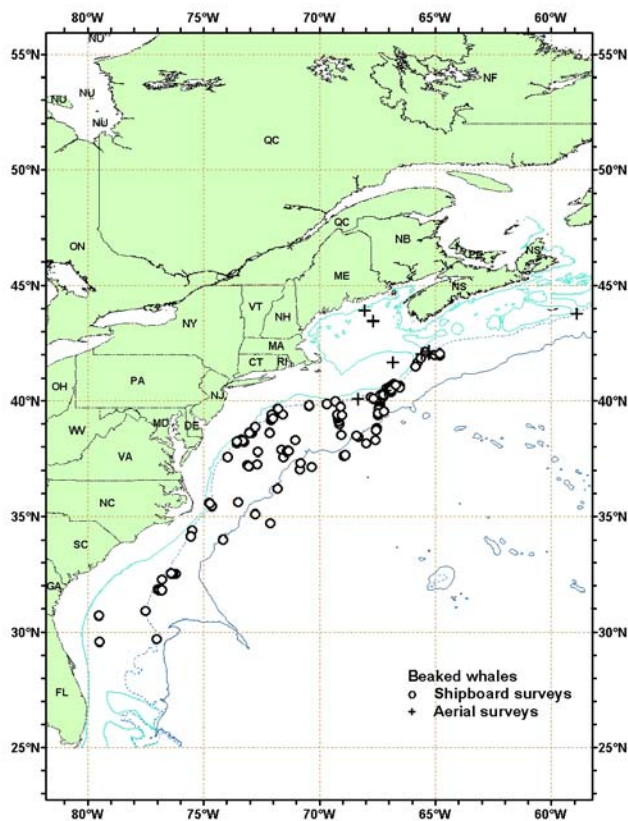


Figure 1: NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004 and 2006. Isobaths are the 100-m, 1000-m and 4000-m depth contours.

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=0.78), 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

An abundance estimate of 120 (CV=0.71) undifferentiated beaked whales was obtained 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 estimate of 442 (CV=0.51) undifferentiated beaked whales was obtained from an August 1990 shipboard line-transect sighting survey, conducted principally along the Gulf Stream north wall between Cape Hatteras and Georges Bank (NMFS 1990; Waring *et al.* 1992). An abundance of 262 (CV=0.99) undifferentiated beaked whales was estimated from a June and July 1991 shipboard line-transect sighting survey conducted primarily between the 200 and 2,000-m isobaths from Cape Hatteras to Georges Bank (Waring *et al.* 1992; Waring 1998). Abundance estimates of 370 (CV=0.65) and 612 (CV=0.73) undifferentiated beaked whales were obtained from line-transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11 aircraft (NMFS 1991). An abundance of 330 (CV=0.66) undifferentiated beaked whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000 m isobaths from the southern edge of Georges Bank, across the Northeast Channel, to the southeastern edge of the Scotian Shelf (NMFS 1993). An abundance of 99 (CV=0.64) undifferentiated beaked whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (NMFS 1994). An abundance of 1,519 (CV=0.69) undifferentiated beaked whales was estimated from a July to September 1995 sighting survey conducted by two ships and an airplane that covered waters from Virginia to the mouth of the Gulf of St. Lawrence (Palka 2006). An abundance estimate of 3,141 (CV=0.34) undifferentiated beaked whales was obtained from the sum of the estimate of 2,600 undifferentiated beaked whales (CV=0.40) from a line-transect sighting survey conducted during 6 July to 6 September 1998 by a ship and plane that surveyed 15,900 km of track line in waters north of Maryland (38°N) (Palka 2006), and the estimate of 541 (CV=0.55) undifferentiated beaked whales, obtained from a shipboard line-transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 4,163 km of track line in waters south of Maryland (38°N) (Mullin and Fulling 2003). 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.

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 June 12 to August 4, 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 > 50 m) between Florida and Maryland (27.5 and 38°N latitude) was conducted during June-August, 2004. The survey employed two independent visual teams searching with 25x 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	Georges Bank to Maine coast	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 *Mesoplodon* beaked whales.

Current Population Trend

There are insufficient data to determine 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 2,154. 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 *Mesoplodon* beaked whales.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 2002-2006 total average estimated annual mortality of beaked whales in fisheries in the U.S. Atlantic EEZ is 1.8 and is derived from four components: 1) average annual fishery bycatch of one animal (Table 2), 2) one stranded animal entangled in fishing gear, 3) two animals that were ship struck, and 4) one animal with ingested debris - see other mortality

text and Table 3.

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 2002-2006 in the U.S. fisheries listed below was 1 beaked whale (CV=1.0)(Table 2). Detailed fishery information is reported in Appendix III.

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 of bycatch mortality by species are 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 bycatch estimates (and CV) by ‘species’ are:

Year	Cuvier’s	Sowerby’s	True’s	<i>Mesoplodon spp.</i>
1994	1 (0.14)	3 (0.09)	0	0
1995	0	6 (0)	1 (0)	3 (0)
1996	0	9 (0.12)	2 (0.26)	2 (0.25)
1997	NA	NA	NA	NA
1998	0	2 (0)	2 (0)	7 (0)

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.

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 2004 - 2006. The estimated average combined mortality in 2002-2006 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			Observer Coverage	Observed Serious Injury	Observed Mortality	Estimated Serious Injury		Estimated Combined Mortality		Mean Annual Mortality
Pelagic Longline (excluding NED-E) ^b	02-06	87, 63, 60, 60, 63	Obs. Data Logbook	.04, .05, .09, .09, .06, .07	0, 1, 0, 0, 0	0, 0, 0, 0, 0	0, 5.3 ^c , 0, 0, 0	0, 0, 0, 0, 0	0, 5.3, 0, 0, 0	0, 1.0, 0, 0, 0	1(1.0)
TOTAL											1 (1.0)
^a	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).										
^b	2003 SI estimates were taken from Table 10 in Garrison and Richards (2004).										
^c	Number of vessels in the fishery are based on vessels reporting effort to the pelagic longline logbook.										

Other Mortality

From 1992 to 2001, a total of 63 beaked whales stranded along the U.S. Atlantic coast between Florida and Massachusetts (NMFS unpublished data). This includes: 35 (includes one tentative identification) Gervais' beaked whales (one 1997 animal had plastics in esophagus and stomach, and Sargassum in esophagus; 2 animals that stranded in September 1998 in South Carolina showed signs of fishery interactions; one Florida 2001 animal showed signs of acoustic or blunt trauma); 2 True's beaked whales; 5 Blainville's beaked whales; 1 Sowerby's beaked whale; 13 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, Canada between 1970 and 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 in North Atlantic marine environments have been associated with naval activities. 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 was 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. 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).

During 2002-2006, twenty-nine beaked whales stranded along the U.S. Atlantic coast and Puerto Rico (Table 3).

Table 3. Beaked whale (<i>Ziphius cavirostris</i> and <i>Mesoplodon</i> sp.) strandings along the U.S. Atlantic coast.						
State	2002	2003	2004	2005	2006	Total
Maine	<i>M. mirus</i> (1)	<i>M. bidens</i> (1) ^b				2
Massachusetts					<i>Ziphius</i> (1)	1
New Jersey				<i>Ziphius</i> (1)		1
Virginia	<i>M. Europaeus</i> (2) ^a	<i>M. mirus</i> (1) ^c				3
North Carolina	<i>M. Europaeus</i> (1) ^e	<i>M. europeus</i> (2)		<i>M. europeus</i> (2)		9
		<i>M. mirus</i> (1)	<i>M. densirostris</i> (1)	<i>M. densirostris</i> (1)	<i>M. densirostris</i> (1)	
South Carolina	<i>Ziphius</i> (1)	<i>Ziphius</i> (2)		<i>M. densirostris</i> (1)		4
Georgia			<i>M. bidens</i> (1)	<i>Ziphius</i> (1) ^e	<i>Ziphius</i> (1)	3
Florida	--	<i>Ziphius</i> (1)				4
		<i>M. europaeus</i> (1)	<i>M. europeus</i> (1)	<i>M. densirostris</i> (1)		
Puerto Rico	<i>M. densirostris</i> (1)		<i>M. densirostris</i> (1)			1
Total	6	9	4	7	3	29 ^d
^a Ship strike was the likely cause of death for one animal						
^b Boat strike was the likely cause of death						
^c Entanglement in fishing gear was the likely cause of death						
^d The cause of death for most of the stranded animals could not be determined.						
^e Plastic debris found in the stomach.						

STATUS OF STOCK

The status of *Mesoplodon* beaked whales relative to OSP in U.S. Atlantic EEZ is unknown. These species are not listed as threatened or endangered under the Endangered Species Act. 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 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. 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. University of Rhode Island Cetacean and Turtle Assessment Program. 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.
- 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.
- 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.
- 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.
- 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.
- Mullin, K. D. and G. L. Fulling 2003. Abundance of cetaceans in the southern U.S. North Atlantic Ocean during summer 1998. *Fish. Bull.* 101: 603-613.
- 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 1990. Cruise results, NOAA Ship CHAPMAN, Cruise No. 90-05. Marine Mammal Sighting Survey. National Marine Fisheries Service. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026. 5 pp.
- NMFS 1991. Northeast cetacean aerial survey and inter-platform study. National Marine Fisheries Service. NOAA-NMFS-SEFSC and NEFSC. 4 pp.
- NMFS 1993. Cruise results, NOAA ship DELAWARE II, Cruise No. DEL 93-06, Marine Mammal Survey. National Marine Fisheries Service. NOAA NMFS NEFSC, Woods Hole Laboratory, Woods Hole, MA 5 pp.
- NMFS 1994. Cruise results, NOAA ship RELENTLESS, Cruise No. RS 9402, Marine Mammal Survey/Warm Core Ring Study. National Marine Fisheries Service. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-102. 8 pp.
- 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
- 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. 1995. Abundance estimate of 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-Transsect 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. Reports of the International Whaling Commission. (Special Issue) 15.
- Simmonds, M. P. and L. F. Lopez-Jurado 1991. Whales and the military. Nature 351(6326): 448-448.
- 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. 1998. Results of the summer 1991 R/V Chapman marine mammal sighting survey. Northeast Fish. Sci. Cent. Ref. Doc. 98-09. 21 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.