

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). Off the U.S. Atlantic coast, beaked whale (*Mesoplodon* spp.) sightings have occurred principally along the shelf-edge and deeper oceanic waters (CETAP, 1982; Waring *et al.* 1992; Tove 1995; Waring *et al.* 2001; Palka *et al.* unpublished manuscript; Figure 1). 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). 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from Cape Cod Bay to Florida, into the Caribbean and the Gulf of Mexico (Leatherwood *et al.* 1976; Mead 1989; NMFS unpublished data). 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). 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). 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 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 (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 (NMFS 1990; Waring *et al.* 1992). An abundance of 262 (CV=0.99)

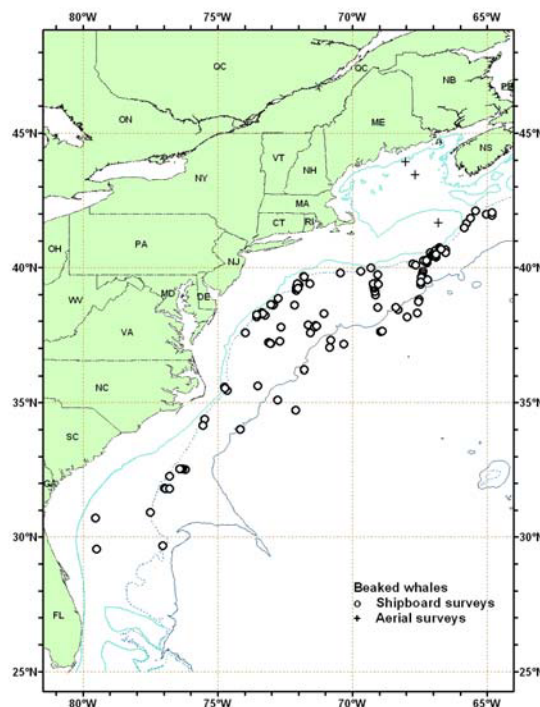


Figure 1. Distribution of beaked whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summer 1998, 1999, and 2004. Isobaths are at 100 m, 1,000 m, and 4,000 m.

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). Abundances of 370 (CV=0.65) and 612 (CV=0.73) undifferentiated beaked whales were estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (NMFS 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 (CV=0.66) undifferentiated beaked whales was estimated from a June and July 1993 shipboard line transect sighting survey conducted principally between the 200 and 2,000m isobaths from the southern edge of Georges Bank, across the Northeast Channel to the southeastern edge of the Scotian Shelf (NMFS 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *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 99 (CV=0.64) undifferentiated beaked whales was estimated from an August 1994 shipboard line transect survey conducted within a Gulf Stream warm-core ring located in continental slope waters southeast of Georges Bank (Table 1; NMFS 1994). Data were collected by two alternating teams that searched with 25x150 binoculars and an independent observer who searched by naked eye from a separate platform on the bow. Data were analyzed using DISTANCE (Buckland *et al.* 1993). 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 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 *et al.* unpublished manuscript). Total track line length was 32,600km. The ships covered waters between the 50 and 1000 fathom isobaths, 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 isobath, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom isobath. Data collection and analysis methods used were described in Palka (1995).

An abundance of 2,600 (CV=0.40) 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 15,900km of track line in waters north of Maryland (38°N) (Figure 1; Palka *et al.* unpublished manuscript). 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 541 (CV=0.55) for undifferentiated beaked whales was estimated from a shipboard line transect sighting survey conducted between 8 July and 17 August 1998 that surveyed 4,163km of track line in waters south of Maryland (38°N) (Figure 1; Mullin and Fulling 2003). This estimate is a recalculation of the same data reported in previous SARs. For more details see Mullin and Fulling (2003). Abundance estimates were made using the program DISTANCE (Buckland *et al.* 1993) where school size bias and ship attraction were accounted for.

The best 1998 abundance estimate for undifferentiated beaked whales is the sum of the estimates from the two U.S. Atlantic surveys, 3,141 (CV=0.34), where the estimate from the northern U.S. Atlantic is 2,600 (CV=0.40) and from the southern U.S. Atlantic is 541 (CV=0.55). This joint estimate is considered best because together these two surveys have the most complete coverage of the species' habitat.

An abundance of 2,211 (CV=0.58) 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) (Figure 1; Palka unpublished). 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 (Figure 1; Palka unpublished).

A shipboard survey of the U.S. Atlantic outer continental shelf and continental slope (water depths > 50m) 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 50x 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 there were a total of 473 cetacean sightings. Sightings were most frequent in waters North of Cape Hatteras, North Carolina along the shelf break. Data were analyzed to correct for visibility bias ($g(0)$) and group-size bias employing line transect distance analysis and the direct duplicate estimator (Palka, 1995; Buckland *et al.*, 2001). The resulting abundance estimate for beaked whales between Florida and Maryland was 674 (CV =0.36).

The best 2004 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.

Although the 1990-2004 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
Jul-Sep 1998	Maryland to Gulf of St. Lawrence	2,600	0.40
Jul-Aug 1998	Florida to Maryland	541	0.55
Jul-Sep 1998	Gulf of St. Lawrence to Florida (COMBINED)	3,141	0.34
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

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 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 3m, length at sexual maturity 6.1m for females, and 5.5m 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 0.5 because this stock is of unknown status. PBR for all species in the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 22. It is not possible to determine the PBR for only *Mesoplodon* beaked whales.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 1999-2003 total average estimated annual mortality of beaked whales in fisheries in the U.S. Atlantic EEZ was 1.0 and is derived from three components: 1) two stranded animals were entangled in fishing gear, 2) two animals were ship struck, and 3) one stranded animal died from acoustic or blunt trauma - see other mortality text and (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.

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 sink gillnet, Mid-Atlantic coastal gillnet, or North Atlantic bottom trawl fisheries by NMFS sea samplers. 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 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) have 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 estimates by 'species' are:

Year	Cuvier's	Sowerby's	True's	<i>Mesoplodon</i> spp.
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.

Other Mortality

From 1992-2000, a total of 53 beaked whales stranded along the U.S. 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; 2 animals that stranded in September 1998 in South Carolina showed signs of fishery interactions); 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 4 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 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; Evans and England 2001; Cox *et al.*, in review). 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.*, in review).

During 2001-2003, twenty-four beaked whales stranded along the U.S. Atlantic coast (Table 2).

Table 2. Beaked whale (<i>Ziphius cavirostris</i> and <i>Mesoplodon</i> sp.) strandings along the U.S. Atlantic coast.				
State	2001	2002	2003	Total
Maine	0	<i>M. mirus</i> (1)	<i>M. bidens</i> (1) ^c	2
Massachusetts	0	--	0	0
Virginia	0	<i>M. Europaeus</i> (2) ^b	<i>M. mirus</i> (1) ^d	3
North Carolina	<i>M. europaeus</i> (1) Mesoplodon sp. (3)	Unid. (1)	<i>M. europaeus</i> (2); <i>Mesoplodon</i> sp. (1)	9
South Carolina	<i>M. europaeus</i> (2)	<i>Ziphius</i> (1)	<i>Ziphius</i> (2)	5
Florida	<i>M. europaeus</i> (4) ^a	--	<i>Ziphius</i> (1); <i>M. europaeus</i> (1)	5
Total	10	5	9	24 ^e
^a Acoustic or blunt trauma was the assigned cause of mortality for one animal stranded in Broward County in Sept. ^b Ship strike was the likely cause of death for one animal ^c Boat strike was the likely cause of death ^d Entanglement in fishing gear was the likely cause of death ^e The cause of death for most of the stranded animals could not be determined.				

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 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 a strategic stock because of uncertainty regarding stock size and evidence of human induced mortality and serious injury associated with acoustic activities.

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