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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). Stock structure in the western 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; NMFS unpubl. data). Most sightings were in late spring or summer. Based on sighting data, this species is a rare inhabitant of waters off the northeast U.S. coast (CETAP 1982).

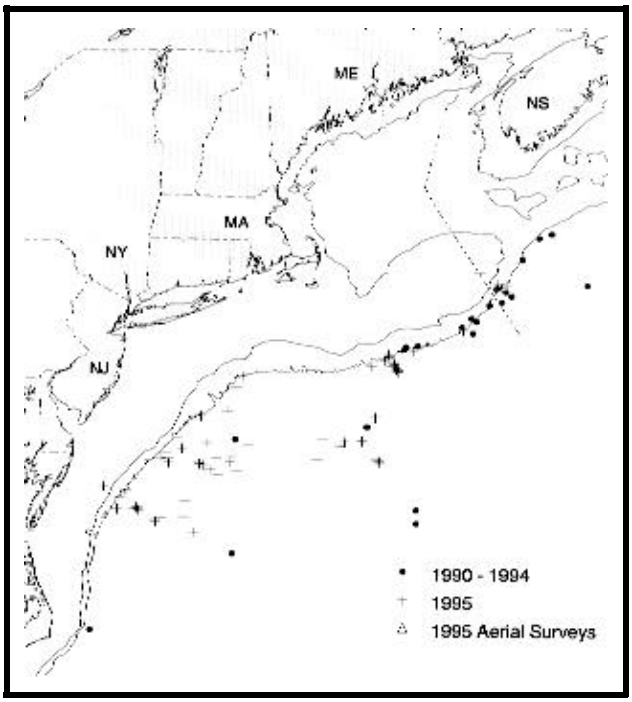

Figure 1. *Distribution of beaked whale sightings from NEFSC shipboard and aerial surveys during the summer in 1990-1995. Isobaths are at 100 m and 1,000 m.*

POPULATION SIZE

The total number of Cuvier's beaked whales off the eastern U.S. coast is unknown. However, seven estimates of the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) are available from select regions of the habitat during summer 1978-82, August 1990, June-July 1991, August-September 1991, June-July 1993, August 1994, and July to September 1995 (Table 1; Figure 1).

A population size of 120 undifferentiated beaked whales (CV=0.71) was estimated from an aerial survey program conducted from 1978 to 1982 on the continental shelf and shelf edge waters between Cape Hatteras, North Carolina and Nova Scotia (Table 1; CETAP 1982). The estimate is based on summer data because the greatest proportion of the population off the northeast U.S. coast appeared in the study area during this season. This estimate does not include corrections for dive-time or g(0), the probability of detecting an animal group on the track line. This estimate may not reflect the current true population size because of its high degree of uncertainty (e.g., large CV), its old age, and it was estimated just after cessation of extensive foreign fishing operations in the region.

A population size of 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 (Table 1; Waring *et al.* 1992). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size 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 2,000m isobaths from Cape Hatteras to Georges Bank (Table 1; Waring *et al.* 1992; Waring 1998). Data were collected by one team that searched by naked eye and analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but no corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size of 370 (CV=0.65) and 612 (CV=0.73) undifferentiated beaked whales was estimated from line transect aerial surveys conducted from August to September 1991 using the Twin Otter and AT-11, respectively (Table

1; Anon. 1991). The study area included that covered in the CETAP study plus several additional continental slope survey blocks. Due to weather and logistical constraints, several survey blocks south and east of Georges Bank were not surveyed. The data were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993), where the CV was estimated using the bootstrap option. The abundance estimates do not include g(0) and were not pooled over platforms because the inter-platform calibration analysis has not been conducted.

A population size 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 (Table 1; Anon. 1993). Data were collected by two alternating teams that searched with 25x150 binoculars and were analyzed using DISTANCE (Buckland *et al.* 1993; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size 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; Anon. 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; Laake *et al.* 1993). Estimates include school size-bias, if applicable, but do not include corrections for g(0) or dive-time. Variability was estimated using bootstrap resampling techniques.

A population size 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 (Table 1; NMFS unpubl. data). Total track line length of this survey was 32,600 km (17,600 nmi). The ships covered waters between the 50 and 1000 fathom contour lines, the northern edge of the Gulf Stream, and the northern Gulf of Maine/Bay of Fundy region. The airplane covered waters in the Mid-Atlantic from the coastline to the 50 fathom contour line, the southern Gulf of Maine, and shelf waters off Nova Scotia from the coastline to the 1000 fathom contour line. Shipboard data were collected using a two independent sighting team procedure and were analyzed using the product integral method (Palka 1995) and DISTANCE (Buckland *et al.* 1993). Shipboard estimates were corrected for g(0) and, if applicable, also for school size-bias. Standard aerial sighting procedures with two bubble windows and one belly window observer were used during the aerial survey. An estimate of g(0) was not made for the aerial portion of the survey. Estimates do not include corrections for dive-time. Variability was estimated using bootstrap resampling techniques. Because the number of beaked whale sightings in each strata were extremely low (3 to 10), and their sightability and behavior preclude pooling with other cetaceans, the abundance estimates are based on small sample sizes. Therefore, the above abundance estimates should be viewed with caution.

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.

The best available current abundance estimate for the undifferentiated complex of beaked whales is 1,519 (CV=0.69) as estimated from the July to September 1995 line transect survey (NMFS unpubl. data) because this survey provided the most complete coverage of the known habitat.

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

Month/Year	Area	N_{best}	CV
summer 1978-82	Cape Hatteras, NC to Nova Scotia	120	0.71
Aug 1990	Gulf Stream	442	0.51
Jun-Jul 1991	Cape Hatteras, NC to Georges Bank, shelf edge only	262	0.99
Aug-Sep 1991	Cape Hatteras, NC to Nova Scotia	370 and 612*	0.65 and 0.73*
Jun-Jul 1993	Georges Bank to Scotian shelf, shelf edge only	330	0.66
Aug 1994	warm-core ring SE of Georges Bank	99	0.64
Jul-Sep 1995	Virginia to Gulf of St. Lawrence	1,519	0.69

* from data collected on the Twin Otter and AT-11, respectively.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the 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 1,519 (CV=0.69). The minimum population estimate for the undifferentiated complex of beaked whales (*Ziphius* and *Mesoplodon* spp.) is 895 (CV=0.69). It is not possible to determine the minimum population estimate of only Cuvier's beaked whales.

Current Population Trend

There are insufficient data to determine the population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity include: length at birth is 2 to 3 m, length at sexual maturity 6.1 m for females, and 5.5 m for males, maximum age for females were 30 growth layer groups (GLG's) and for males was 36 GLG's, which may be annual layers (Mitchell 1975; Mead 1984; Houston 1990).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al*. 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a "recovery" factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for the undifferentiated complex of beaked whales is 895 (CV=0.69). 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 8.9. It is not possible to determine the PBR for only Cuvier's beaked whales.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 1992-1996 total average estimated annual fishery-related mortality of beaked whales in the U.S. EEZ was 9.7 (CV = 0.07).

Fishery Information

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

Current data on incidental takes in U.S. fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and since that year several fisheries have been covered by the program. In 1986, NMFS established a mandatory self-reported fishery information system for large pelagic fisheries. Data files are maintained at Southeast Fisheries Science Center (SEFSC). In late 1992 and in 1993 the SEFSC provided observer coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and currently provides observer coverage of vessels fishing south of Cape Hatteras.

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

By-catch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in the pelagic longline, pelagic pair trawl, New England multispecies sink gillnet, mid-Atlantic coastal sink gillnet, or North Atlantic bottom trawl observed fisheries.

Pelagic Drift Gillnet

The estimated total number of hauls in the pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995, and 1996 were 233, 243, 232, 197, 164, and 143, respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. Since 1994, between 10-12 vessels have participated in the fishery (Table 2). Observer coverage, expressed as percent of sets observed, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, and 64% in 1996. Effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the pelagic drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total by-catch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Estimates of total annual by-catch for 1994 and 1995 were estimated from the sum of the observed caught and the product of the average bycatch per haul and the number of unobserved hauls as recorded in self-reported fishery information. Variances were estimated using bootstrap re-sampling techniques. By-catch of beaked whales has only occurred from Georges Canyon to Hydrographer Canyon along the continental shelf break and continental slope during July to October. Thirty-five fishery-related beaked whale mortalities were observed between 1989 and 1995. The estimated annual fishery-related mortality (CV in parentheses) was 60 in 1989 (0.21), 76 in 1990 (0.26), 13 in 1991 (0.21), 9.7 in 1992 (0.24), 12 in 1993 (0.16) 4.8 in 1994 (0.08), 9.1 in 1995 (0), and 13 in 1996 (0.12) (Table 2). Annual mortality estimates do not include any animals injured and released alive. The 1992-1996 total average estimated annual fishery-related mortality of beaked whales in the U.S. EEZ was 9.7 (CV = 0.07) (Table 2). The 1992-1996 period provides a better characterization of the current pelagic drift gillnet fishery. Table 3 summarizes the number of animals released alive and classified as injured or non-injured. It also includes the ratio of observed to estimated mortalities for this fishery.

Table 2. Summary of the incidental mortality for the undifferentiated complex of beaked whales which include Cuvier's beaked whale (*Ziphius cavirostris*), and *Mesoplodon* beaked whale, by commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).

Fishery	Years	Vessels [1]	Data Type [2]	Observer Coverage [3]	Observed Mortality	Estimated Mortality [4]	Estimated CVs [4]	Mean Annual Mortality
Pelagic Drift Gillnet	92-96	1994=12 1995=11 1996=10	Obs. Data Logbook	.40, .42, .87, .99, .64	1, 5, 4, 9, 8	9.7, 12, 4.8, 9.1[5] 13	.24, .16, .08, 0, .12	9.7 (.07)
TOTAL								9.7 (.07)

1 1994 - 1996 shown, other years not available on an annual basis.

2 Observer data (Obs. Data) are used to measure bycatch rates, and the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. Mandatory logbook (Logbook) data are used to measure total effort, and the data are collected at the Southeast Fisheries Science Center (SEFSC).

3 The observer coverage and unit of effort for the Pelagic Drift Gillnet is a set.

4 For 1991-1993, pooled bycatch rates were used to estimate bycatch in months that had fishing effort but did not have observer coverage. This method is described in Northridge (1996). Because observer coverage increased substantially from 1994-1996, bycatch rates for this period are single year estimates.

5 One vessel was not observed and recorded 1 set in a 10 day trip in the SEFSC mandatory logbook. If you assume the vessel fished 1.4 sets per day as estimated from the 1995 SS data, the point estimate may increase by 0.8 animals. However, the SEFSC mandatory logbook data was taken at face value, and therefore it was assumed that 1 set was fished within this trip, and the point estimate would then increase by 0.1 animals.

Table 3. Summary for the undifferentiated complex of beaked whales which include Cuvier's Beak Whales (*Ziphius cavirostris*) and Mesoplodon beaked whales released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured)

Fishery	Years	Ratio	Injured[1]	Uninjured
Pelagic Drift Gillnet	92-96	1/9.7, 5/12, 4/4.8, 9/9.1, 8/13	0, 0, 0, 1[2] 0	0, 0, 0, 0, 0

1 Injured and released alive animals are not included in the Table 2 mortality estimates.

2 The observer recorded this animal being released alive and having the "gear in/around a single body part".

Other Mortality

From 1992-1996, 21 beaked whales (11(includes one tentative identification) -Gervais's beaked whales;2 -True's beaked whale; 1- Blainville's beaked whale; 6 -Cuvier's beaked whale- one 1996 animal showed signs of human interactions propeller marks) stranded along the U.S. Atlantic coast between Florida and Massachusetts (NMFS unpublished data).

STATUS OF STOCK

The status of Cuvier's beaked whale relative to OSP in U.S. Atlantic EEZ is unknown. This species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine population

trends and the level of human-caused mortality and serious injury is unknown because of uncertainty regarding species identification in observed fisheries. If one were to assume that the incidental fisheries mortality of the four *Mesoplodon* spp. and *Z. cavirostris* was random with respect to species (i.e., in proportion to their relative abundance), then the minimum population estimate for all of those stocks would need to sum to at least 970 in order for an annual mortality of 9.7 animals not to exceed the PBR of any one of these species. Because an assumption of unselective incidental fishing mortality is probably overly optimistic and represents a best case situation, it is likely that a combined minimum population estimate of substantially greater than 970 would be necessary for an annual mortality of 9.7 to not exceed the PBR of any one of these five stocks. The largest recent abundance estimate available for beaked whales in the western North Atlantic was 1,519 (CV = 0.69) which would result in a minimum population estimate of 895 beaked whales; however, this estimate does not include a correction factor for submerged animals which may be substantial. Although a species specific PBR cannot be determined, the total fishery mortality and serious injury for this group is not less than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This is a strategic stock because of uncertainty regarding stock size and evidence of fishery-related mortality and serious injury.

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