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

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of Cuvier's beaked whales is poorly known, and is based mainly on stranding records (Leatherwood *et al.* 1976). Strandings have been reported from Nova Scotia along the eastern U.S. coast south to Florida, around the Gulf of Mexico, and within the Caribbean (Leatherwood *et al.* 1976; CETAP 1982; Heyning 1989; Houston 1990; MacLeod *et al.* 2006; Jefferson *et al.* 2008). Acoustic presence has been demonstrated from recordings collected from North Carolina to Nova Scotia (Stanistreet 2018).

Stock structure in the North Atlantic is unknown. A study of 20 Cuvier's beaked whales satellite-tagged offshore of Cape Hatteras, North Carolina, between 2014 and 2017 suggested that these animals have very restricted movements and could be a resident population (Foley 2018). Because the current stock spans multiple eco-regions (Longhurst 2007; Spalding *et al.* 2007), it is plausible that the stock could actually contain multiple demographically independent populations that should themselves be stocks.

Cuvier's beaked whale sightings have occurred principally along the continental shelf edge in the Mid-Atlantic region off the northeast U.S. coast (CETAP 1982; Waring *et al.* 1992; Waring *et al.* 2001; Hamazaki 2002; Palka 2006). Monthly aerial surveys conducted off Cape Hatteras between 2011 and 2015 recorded Cuvier's beaked whales sighted during every month of the year (McLellan *et al.* 2018) and acoustic recordings confirm consistent year-round presence (Stanistreet *et al.* 2017).

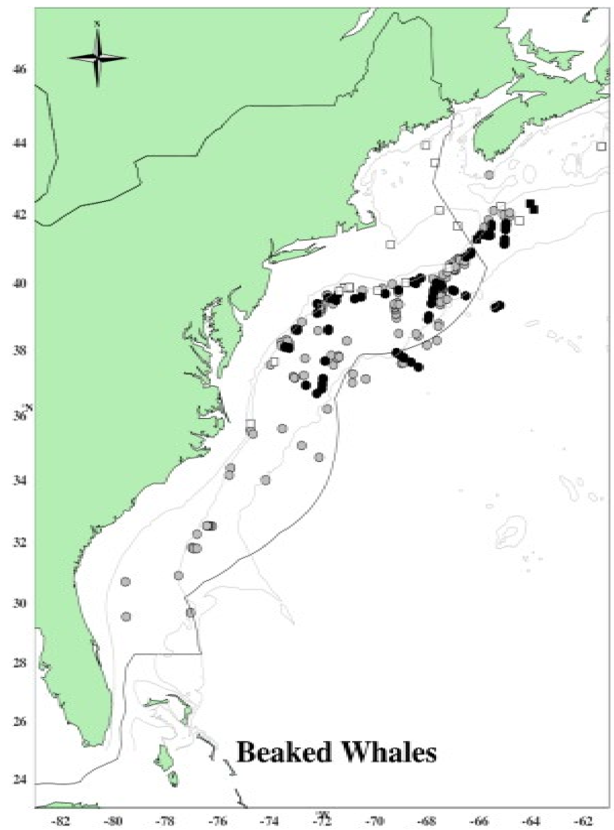

Figure 1. Distribution of beaked whale (includes Ziphius and Mesoplodon spp.) sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, and 2007, 2008, 2010, 2011 and 2016 and DFO's 2007 TNASS and 2016 NAISS surveys. Isobaths are the 200-m, 1000-m and 4000-m depth contours. Circle symbols represent shipboard sightings and squares are aerial sightings. Black symbols are sightings identified as Cuvier's beaked whales.

POPULATION SIZE

The best abundance estimate for undifferentiated beaked whales is sum of the northeast and southeast 2016 surveys—5,744 (CV=0.36). This estimate, derived from shipboard and aerial surveys, covers most of this stock's known range. Because the survey areas did not overlap, the estimates from the two surveys were added together and the CVs pooled using a delta method to produce an abundance estimate for the stock area.

Earlier abundance estimates

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

Recent surveys and abundance estimates

Abundance estimates of 3,897 (CV=0.47) and 1,847 (CV=0.49) Cuvier's beaked whales (not including Mesoplodon spp.) were generated from vessel surveys conducted in U.S. waters of the western North Atlantic during the summer of 2016 (Table 1; Garrison 2020; Palka 2020). One survey was conducted from 27 June to 25 August in waters north of 38ºN latitude and consisted of 5,354 km of on-effort trackline along the shelf break and offshore to the outer limit of the U.S. EEZ (NEFSC and SEFSC 2018). The second vessel survey covered waters from Central Florida to approximately 38ºN latitude between the 100-m isobath and the outer limit of the U.S. EEZ during 30 June–19 August. A total of 4,399 km of trackline was covered on effort (NEFSC and SEFSC 2018). Both surveys utilized two visual teams and an independent observer approach to estimate detection probability on the trackline (Laake and Borchers 2004). Mark-recapture distance sampling was used to estimate abundance. Estimates from the two surveys were combined and CVs pooled to produce an abundance estimate for the stock area, yielding an combined total of 5,744 Cuvier's beaked whales (CV=0.36). These estimates are known to be biased low due to the fact that unidentified Ziphiidae abundance was estimated at 3,755 (CV=0.42) in the NE and at 2,812 (CV=0.43) in the SE, and these numbers likely include an unknown number of Cuvier's beaked whales.

An abundance estimate of 4,962 (CV=0.37) Cuvier's beaked whales (not including Mesoplodon spp.) was generated from a shipboard and aerial survey conducted during June–August 2011 (Palka 2012). The aerial portion that contributed to the abundance estimate covered 5,313 km of tracklines that were 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 3,107 km of tracklines that were in water offshore of North Carolina to Massachusetts (waters that were 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). Shipboard data were inspected to determine if there was significant responsive movement to the ship (Palka and Hammond 2001). Because there was an insignificant amount of responsive movement for this species, the 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 (MRDS) option in the computer program Distance (version 6.0, release 2, Thomas et al. 2009).

An abundance estimate of 1,570 (CV=0.65) Cuvier's beaked whales (not including Mesoplodon spp.) was also 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).

Table 1. Summary of abundance estimates for the wester North Atlantic stock of Cuvier's beaked whales. 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−Aug 2011	central Virginia to lower Bay of Fundy	4,962	0.37
Jun−Aug 2011	central Virginia to central Florida	1,570	0.65
Jun−Aug 2011	Central Florida to lower Bay of Fundy (COMBINED)	6,532	0.32
Jun−Sep 2016	Central Virginia to lower Bay of Fundy	3,897	0.47
Jun−Aug 2016	Central Florida to Virginia	1,847	0.49
Jun−Aug 2016	Central Florida to lower Bay of Fundy (COMBINED)	5,744	0.36

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 5,744 (CV=0.36). The minimum population estimate for undifferentiated beaked whales in the western North Atlantic is 4,282.

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). There is current work to standardize the strata-specific previous abundance estimates to consistently represent the same regions and include appropriate corrections for perception and availability bias. These standardized abundance estimates will be used in state-space trend models that incorporate environmental factors that could potentially influence the process and observational errors for each stratum.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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

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

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a recovery factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for undifferentiated beaked whales is 4,282. 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. PBR for Cuvier's beaked whales is 43.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The 2013–2017 minimum annual rate of human-caused mortality of Cuvier's beaked whales averaged 0.2 animals per year. This is from 1 stranding record that reported signs of human interaction (plastic ingestion; Table 2).

Fishery Information

Detailed U.S. fishery information is reported in Appendix III.

Earlier Interactions

See Appendix V for more information on historical takes.

Other Mortality

During 2013–2017, 7 Cuvier's beaked whales stranded along the U.S. Atlantic coast (Table 2; NOAA National Marine Mammal Health and Stranding Response Database, accessed 23 October 2018). One animal showed evidence of a human interaction.

Several unusual mass strandings of beaked whales throughout their worldwide range have been associated with naval activities (Cox *et al*. 2006; D'Amico *et al.* 2009; Fernandez *et al*. 2005; 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. Necropsies of 6 dead beaked whales revealed evidence of tissue trauma associated with an acoustic or impulse injury that caused the animals to strand. Subsequently, the animals died due to extreme physiologic stress associated with the physical stranding (i.e., hyperthermia, high endogenous catecholamine release) (Cox *et al.* 2006).

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. Cuvier's beaked whale (Ziphius cavirostris) strandings along the U.S. Atlantic coast.

State	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**
New York	0	1	1	0	0	**2**
North Carolina	0	0	0	1	1	**2**
Florida[a]	1	1	0	0	1	**3**
Total	**1**	**2**	**1**	**1**	**2**	**7**

a. Animal in Florida in 2014 had plastic bags and line in first stomach chamber.

HABITAT ISSUES

The chronic impacts of contaminants (polychlorinated biphenyls [PCBs] and chlorinated pesticides [DDT, DDE, dieldrin, etc.]) on marine mammal reproduction and health are of concern (e.g., Pierce *et al.* 2008; Jepson *et al.* 2016; Hall *et al.* 2018; Murphy *et al.* 2018), but research on contaminant levels for the western north Atlantic beaked whales is lacking.

Anthropogenic sound in the world's oceans has been shown to affect marine mammals, with vessel traffic, seismic surveys, and active naval sonars being the main anthropogenic contributors to low- and mid-frequency noise in oceanic waters (e.g., Nowacek *et al.* 2015; Gomez *et al.* 2016; NMFS 2018). The long-term and population consequences of these impacts are less well-documented and likely vary by species and other factors. Impacts on marine mammal prey from sound are also possible (Carroll *et al.* 2017), but the duration and severity of any such prey effects on marine mammals are unknown.

Climate-related changes in spatial distribution and abundance, including poleward and depth shifts, have been documented in or predicted for plankton species and commercially important fish stocks (Nye *et al*. 2009; Head *et al*. 2010; Pinsky *et al*. 2013; Poloczanska *et al.* 2013; Hare *et al*. 2016; Grieve *et al.* 2017; Morley *et al.* 2018) and cetacean species (e.g., MacLeod 2009; Sousa *et al.* 2019). There is uncertainty in how, if at all, the distribution and population size of this species will respond to these changes and how the ecological shifts will affect human impacts to the species.

STATUS OF STOCK

The western North Atlantic stock of Cuvier's beaked whale is not a strategic stock because average annual human-related mortality and serious injury does not exceed PBR. The total U.S. fishery mortality and serious injury for this group of species is less than 10% of the calculated PBR and, therefore, can be considered to be insignificant and approaching zero mortality and serious injury rate. The status of Cuvier's beaked whale relative to OSP in the U.S. Atlantic EEZ is unknown. This species is not listed as threatened or endangered under the Endangered Species Act.

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