DWARF SPERM WHALE (*Kogia sima*):
Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The dwarf sperm whale (*Kogia sima*) is distributed worldwide in temperate to tropical waters (Caldwell and Caldwell 1989; McAlpine 2009). Pygmy sperm whales and dwarf sperm whales (*K. sima*) are difficult to differentiate at sea (Caldwell and Caldwell 1989; Bloodworth and Odell 2008; McAlpine 2009), and sightings of either species are often categorized as *Kogia* sp. Sightings of *Kogia* whales in the western North Atlantic occur in oceanic waters along the continental shelf break and slope from Canada to Florida (Figure 1; Mullin and Fulling 2003; Roberts et al. 2015). In addition, stranding records for *Kogia* spp. are common from Canada to Florida (Bloodworth and Odell 2008; Berini et al. 2015). Based on the results of passive acoustic monitoring, Hodge et al. (2018) reported that *Kogia* are common in the western North Atlantic in continental shelf break and slope waters between Virginia and Florida, and more common than suggested by visual surveys. Because there are confirmed sightings within waters of Canada and the Bahamas, this is likely a transboundary stock (e.g., Halpin et al. 2009; Dunn 2013; Figure 1).

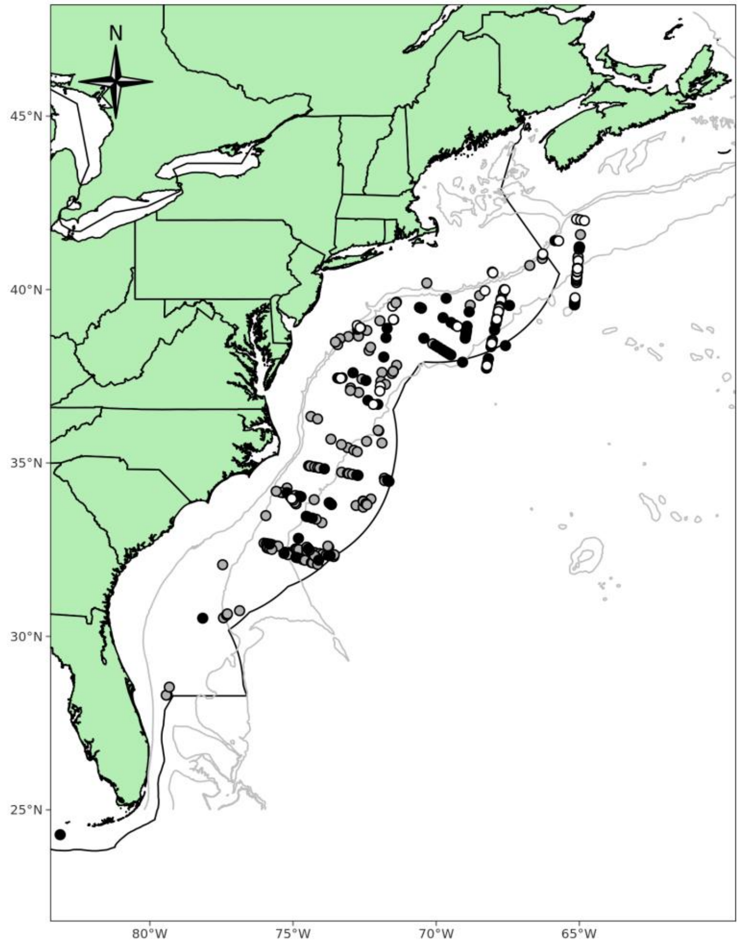

Figure 1. Distribution of Kogia spp. sightings from NEFSC and SEFSC shipboard and aerial surveys during 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, 2011, 2016 and 2021. Black circles represent sightings of dwarf sperm whales; white circles represent sightings of pygmy sperm whales; and gray circles represent sightings of unidentified Kogia. Isobaths are the 200-m, 1,000-m, and 4,000-m depth contours. The darker line indicates the U.S. EEZ.

In addition to similarities in appearance, dwarf sperm whales and pygmy sperm whales demonstrate similarities in their foraging ecology as well as their acoustic signals. Staudinger et al. (2014) conducted diet and stable isotope analyses on stranded pygmy and dwarf sperm whales from the mid-Atlantic coast and found that the two species shared the same primary prey (cephalopods, primarily squid) and fed in similar habitats. The acoustic signals of dwarf and pygmy sperm whales cannot be distinguished from each other at this time because the signals of the two species are too similar to each other and to other species with narrow-band, high-frequency clicks (Merkens et al. 2018).

Across its geographic range, including the western North Atlantic, the population biology of dwarf sperm whales is inadequately known (Staudinger et al. 2014). Dwarf sperm whales in the western North Atlantic are managed separately from those in the northern Gulf of Mexico. Although there have been no directed studies of the degree of demographic independence between the two areas, this management structure is consistent with the fact that the western North Atlantic and Gulf of Mexico belong to distinct marine ecoregions (Spalding et al. 2007; Moore and Merrick 2011). Within the western North Atlantic, the range of *Kogia* sightings traverses multiple marine ecoregions (Spalding et al. 2007) and crosses Cape Hatteras, a known biogeographic break for other marine species, so it is possible that multiple demographically independent populations exist within the western North Atlantic stock. Additional morphological, acoustic, genetic, and/or behavioral data are needed to further delineate population structure within the western North Atlantic and across the broader geographic area.

POPULATION SIZE

Total numbers of dwarf sperm whales off the U.S. Atlantic coast are unknown. Because *K. sima* and *K. breviceps* are difficult to differentiate at sea, the reported abundance estimates are for both species of *Kogia* combined. The best estimate for *Kogia* spp. in the western North Atlantic is 9,474 (CV=0.36; Table 1; Garrison and Dias 2023; Palka 2023). This estimate is from summer 2021 surveys covering waters from central Florida to the lower Bay of Fundy. This estimate is almost certainly negatively biased. One component of line transect estimates is *g(0)*, the probability of seeing an animal on the transect line. Estimating *g(0)* is difficult because it consists of accounting for both perception bias (i.e., at the surface but missed) and availability bias (i.e., below the surface while in range of the observers), and many uncertainties (e.g., group size and diving behavior) can confound both (Marsh and Sinclair 1989; Barlow 1999). The long dive times of *Kogia* spp. contribute to a lower probability that animals will be available at the surface and therefore more negative bias. Data on dive-surface behaviors for Kogia spp. were used to estimate and correct for availability bias (Palka et al. 2017), and a two-team approach was used to estimate perception bias (see below). However, Kogia spp. are very difficult to see when at the surface in even moderate sea states, so it is probable that some unquantified negative bias remains in the best abundance estimates.

Earlier Abundance Estimates

Please see Appendix IV for a summary of abundance estimates, including earlier estimates and survey descriptions.

Recent Surveys and Abundance Estimates

Abundance estimates of 4,548 (CV=0.49) and 3,202 (CV=0.59) *Kogia* spp. were generated from two non-overlapping vessel surveys conducted in 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 U.S. EEZ (NEFSC and SEFSC 2018). The second vessel survey covered waters from Central Florida to approximately 38ºN latitude between the 100-m isobaths and 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 a species abundance estimate for the stock area.

More recent abundance estimates of 4,012 (CV=0.54) and 5,462 (CV=0.47) Kogia spp. were generated from vessel surveys conducted in U.S. waters of the western North Atlantic during the summer of 2021 (Table 1; Garrison and Dias 2023; Palka 2023). One survey was conducted from 16 June to 23 August in waters north of 36ºN latitude and consisted of 5,871 km of on-effort trackline along the shelf break and offshore to the outer edge of the U.S. EEZ (NEFSC and SEFSC 2022). The second vessel survey covered waters from central Florida (25ºN latitude) to approximately 38ºN latitude between the 200-m isobaths and the outer edge of the U.S. EEZ during 12 June–31 August. A total of 5,659 km of trackline was covered on effort (NEFSC and SEFSC 2022). 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. For both surveys, a correction was applied (probability at surface = 0.539 [CV=0.307]; Palka et al. 2017) to account for availability bias. Estimates from the two surveys were combined and CVs pooled to produce a species abundance estimate for the stock area.

Table 1. Summary of abundance estimates for the western North Atlantic* Kogia *spp. with month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV). The estimate considered best is in bold font.

Month/Year	Area	N_{best}	CV
Jun–Aug 2016	New Jersey to lower Bay of Fundy	4,548	0.49

Month/Year	Area	N_{best}	CV
Jun–Aug 2016	central Florida to New Jersey	3,202	0.59
Jun–Aug 2016	central Florida to lower Bay of Fundy (COMBINED)	7,750	0.38
Jun–Aug 2021	New Jersey to lower Bay of Fundy	4,012	0.54
Jun–Aug 2021	central Florida to New Jersey	5,462	0.47
Jun–Aug 2021	**central Florida to lower Bay of Fundy (COMBINED)**	**9,474**	**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 *Kogia* spp. is 9,474 (CV=0.36). The minimum population estimate for *Kogia* spp. is 7,080 animals (Table 2).

Current Population Trend

There are three available coastwide abundance estimates for *Kogia* spp. from the summers of 2011, 2016, and 2021. Each of these is derived from vessel surveys with similar survey designs and all three used the two-team independent observer approach to estimate abundance. An availability bias correction factor (0.539, CV=0.307; Palka et al. 2017) was applied to the 2021 estimate, and in order to do an appropriate trend analysis, this correction was also applied to previous estimates. The resulting estimates were 7,022 (CV=0.25) in 2011; 14,378 (CV=0.20) in 2016; and 9,474 (CV=0.36) in 2021 (Garrison and Dias 2023). (A generalized linear model did not indicate a statistically significant (p=0.728) trend in these estimates. The high level of uncertainty in these estimates limits the ability to detect a statistically significant trend. In addition, interpretation of trends is complicated by two methodological factors. First, the ability to detect *Kogia* spp. visually is highly dependent upon weather and visibility conditions which may contribute to differences between estimates. Second, during 2016 and 2021 the surveys did not use scientific echosounders during some survey periods. Changing the use of echosounders may affect the surfacing/diving patterns of the animals and thus have an influence on the availability of animals to the visual survey teams. Finally, a key uncertainty in this assessment of trend is that interannual variation in abundance may be caused by either changes in spatial distribution associated with environmental variability or changes in the population size of the stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. 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 *Kogia* spp. is 7,080. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.4 because the CV of the average mortality estimate is greater than 0.8 (Wade and Angliss 1997). PBR for western North Atlantic *Kogia* spp. is 57 (Table 2).

Table 2. Best and minimum abundance estimates for western North Atlantic* Kogia *spp. with Maximum Productivity Rate (R_{max}), Recovery Factor (F_r) and PBR.

N_{est}	CV N_{est}	N_{min}	F_r	R_{max}	PBR
9,474	0.36	7,080	0.4	0.04	57

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated fishery-related mortality and serious injury to dwarf and pygmy sperm whales combined in the Western North Atlantic during 2017–2021 was 0.8 due to interactions with the large pelagics longline commercial fishery (Table 3). Mean annual mortality and serious injury during 2017–2021 for dwarf sperm whales due to other human-caused actions was presumed to be 0. The minimum total mean annual human-caused mortality and serious injury for dwarf sperm whales is unknown because the estimate of fishery-related mortality and serious injury includes both dwarf and pygmy sperm whales and does not include any estimate for dwarf sperm whales alone. Recorded takes of dwarf and pygmy sperm whales in fisheries in the western North Atlantic are rare. However, observer coverage in the fisheries is relatively low. Furthermore, the likelihood is low that a whale killed at sea due to a fishery interaction or vessel-strike will be recovered (Williams et al. 2011). These factors introduce some uncertainty into estimating the true level of human-caused mortality and serious injury for this stock.

Fishery Information

There are two commercial fisheries that interact, or that could potentially interact, with this stock in the Atlantic Ocean. They are the Category I Atlantic Highly Migratory Species longline and the Atlantic Ocean, Caribbean, Gulf of Mexico large pelagics longline fisheries (Appendix III). Percent observer coverage (percentage of sets observed) for these longline fisheries in the Atlantic for each year during 2017–2021 was 11, 10, 10, 9, and 8, respectively (Table 3).

The Atlantic Highly Migratory Species longline fishery operates outside the U.S. EEZ. No takes of dwarf sperm whales or *Kogia* sp. within high seas waters of the Atlantic Ocean have been observed or reported thus far.

The large pelagics longline fishery operates in the U.S. Atlantic (including Caribbean) and Gulf of Mexico EEZ, and pelagic swordfish, tunas and billfish are the target species. The estimated annual average serious injury and mortality attributable to the Atlantic Ocean large pelagics longline fishery for the five-year period from 2017 to 2021 was 0.8 Kogia spp. (CV=1; Table 3; Garrison and Stokes 2020a; 2020b; 2021; 2023a; 2023b).

Table 3. Summary of the incidental mortality and serious injury of* Kogia *spp. by the U.S. commercial large pelagics longline 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 annual observed mortality and serious injury using on-board observer data, the annual estimated mortality and serious injury, the combined annual estimates of mortality and serious injury (Estimated Combined Mortality), the estimated CV of the combined annual mortality estimates (Est. CVs) and the mean of the combined mortality estimates (CV in parentheses).

Fishery	Years	Vessels[a]	Data Type[b]	Observer Coverage[c]	Observed Serious Injury	Observed Mortality	Estimated Serious Injury	Estimated Mortality	Estimated Combined Mortality	Est. CVs	Mean Annual Mortality
Pelagic Longline	2017	65	Obs. Data, Logbook	11	0	0	0	0	0	-	0.8 (1.00)
	2018	57		10	0	0	0	0	0	-	
	2019	50		10	0	0	0	0	0	-	
	2020	50		9	1	0	4	0	4	1	
	2021	49		8	0	0	0	0	0	-	

a. Number of vessels in the fishery is based on vessels reporting effort to the pelagic longline logbook.
b. Observer data (Obs. Data) are used to measure bycatch rates and the data are collected within the Northeast Fisheries Observer Program (NEFOP) and the Southeast Pelagic Longline Observer Program.
c. Percentage of sets observed

STATUS OF STOCK

Dwarf sperm whales are not listed as threatened or endangered under the Endangered Species Act, and the western North Atlantic stock is not considered strategic under the Marine Mammal Protection Act. While there is some uncertainty in estimating fishery-related mortality and serious injury for this stock alone, it is believed that U.S. fishery-related mortality and serious injury of *Kogia* spp. is less than 10% of the calculated PBR of *Kogia* spp. and, therefore, can be considered to be insignificant and approaching the zero mortality and serious injury rate. The status of dwarf sperm whales relative to optimum sustainable population is unknown. No statistically significant trend in abundance was detected for *Kogia* spp. over the years 2011–2021; however, there are key methodological issues and uncertainty that limit the ability to evaluate trend.

OTHER FACTORS THAT MAY BE AFFECTING THE STOCK

Strandings

During 2017–2021, 37 dwarf sperm whales were reported stranded along the U.S. East Coast (Table 4; NOAA

National Marine Mammal Health and Stranding Response Database unpublished data, accessed 13 October 2022 (Southeast Region [SER]) and 18 September 2022 (Northeast Region [NER])). Evidence of human interaction was detected for four of the strandings (all were pushed out to sea by members of the public). No evidence of human interaction was detected for 17 strandings, and for the remaining 16 strandings, it could not be determined if there was evidence of human interaction. In addition, there were 16 records of unidentified stranded *Kogia*. Evidence of human interaction was detected for four of the strandings (all were pushed out to sea by members of the public). For the remaining 12 strandings, it could not be determined whether there was evidence of human interaction. It should be noted that evidence of human interaction does not necessarily mean the interaction caused the animal's stranding or death.

Stranding data underestimate the extent of human and fishery-related mortality and serious injury because not all of the marine mammals that die or are seriously injured in human interactions wash ashore, or, if they do, they are not all recovered (Peltier et al. 2012; Wells et al. 2015; Carretta et al. 2016). In particular, shelf and slope stocks in the western North Atlantic are less likely to strand than nearshore coastal stocks. Additionally, not all carcasses will show evidence of human interaction, entanglement or other fishery-related interaction due to decomposition, scavenger damage, etc. (Byrd et al. 2014). Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of human interaction.

Table 4. Dwarf and pygmy sperm whale (**Kogia sima*** ***(Ks),*** **Kogia breviceps** ***(Kb) and*** **Kogia** ***sp. (Sp)) strandings along the U.S. Atlantic coast, 2017–2021. Data are from the NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 13 October 2022 (SER) and 18 September 2022 (NER). Strandings that were not reported to species have been reported as*** **Kogia** ***sp. The level of technical expertise among stranding network personnel varies, and given the potential difficulty in correctly identifying stranded*** **Kogia** ***whales to species, reports to specific species should be viewed with caution.***

STATE	2017			2018			2019			2020			2021			TOTALS		
	Ks	**Kb**	**Sp**	**Ks**	**Kb**	**Sp**	**Ks**	**Kb**	**Sp**	**Ks**	**Kb**	**Sp**	**Ks**	**Kb**	**Sp**	**Ks**	**Kb**	**Sp**
Maine	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
Massachusetts	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0
Rhode Island	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
Connecticut	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
New York	2	1	0	0	0	0	0	0	1	0	1	0	0	0	0	2	2	1
New Jersey	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0	5	0
Delaware	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
Maryland	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Virginia	0	2	1	1	0	0	1	0	0	0	0	0	1	0	0	3	2	1
North Carolina	0	2	1	1	2	2	5	5	0	2	2	0	3	5	1	11	16	4
South Carolina	1	3	0	2	4	0	1	3	1	0	2	1	0	3	2	4	15	4
Georgia	0	2	0	2	1	0	1	0	0	1	0	1	0	2	0	4	5	1
Florida	3	7	1	4	4	0	2	2	2	0	3	2	3	5	0	12	21	5
TOTALS	**6**	**20**	**3**	**10**	**15**	**2**	**10**	**11**	**4**	**4**	**9**	**4**	**7**	**17**	**3**	**37**	**72**	**16**

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., Schwacke et al. 2002; Jepson et al. 2016; Hall et al. 2018). Bryan et al. (2012) examined liver and kidney samples from stranded pygmy sperm whales from the U.S. Atlantic and Gulf of Mexico and found that all samples contained mercury concentrations in excess of the USEPA action limits, potentially levels hazardous to the health of whales and putting them at greater risk of disease. Because animals are exposed to mercury through the consumption of their prey, and the foraging ecology of dwarf sperm whales is similar to that of pygmy sperm whales (Staudinger et al. 2014), dwarf sperm whales are likely also experiencing potentially hazardous levels of mercury. Reed et al. (2015) examined metal concentrations in dwarf sperm whales stranded along the South Carolina coast, and found that levels of mercury for all adults and cadmium for most adults, exceeded FDA historical levels of concern, while concentrations of some metals were low.

Harmful algal blooms have been responsible for large-scale marine mammal mortality events as well as chronic, harmful health effects and reproductive failure (Fire et al. 2009). Diatoms of the genus *Pseudo-nitzschia* produce domoic acid, a neurotoxin. Fire et al. (2009) sampled pygmy and dwarf sperm whales stranded along the U.S. East Coast from Virginia to Florida, and more than half (59%) of the samples tested positive for domoic acid, indicating year-round, chronic exposure, whereas other cetaceans stranded in the same area had no detectable domoic acid. Harmful algal blooms may be occurring in offshore areas not currently being monitored, and the detection only in *Kogia* species suggests a possible unknown, unique aspect of their foraging behavior or habitat utilization (Fire et al. 2009).

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; Pinsky et al. 2013; Poloczanska et al. 2013; 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 changes in distribution and population size of cetacean species may interact with changes in distribution of prey species and how the ecological shifts will affect human impacts to the species.

REFERENCES CITED

Barlow, J. 1999. Trackline detection probability for long-diving whales. pp. 209-221 *In:* G.W. Garner, S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald and D.G. Robertson (eds.) Marine mammal survey and assessment methods. Balkema, Rotterdam. 287 pp.

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. 73pp. http://www.nmfs.noaa.gov/pr/pdfs/sars/guidelines1995.pdf

Berini, C.R., L.M. Kracker and W.E. McFee. 2015. Modeling pygmy sperm whale (*Kogia breviceps*, De Blainville 1838) strandings along the southeast coast of the United States from 1992 to 2006 in relation to environmental factors. NOAA Tech. Memo. NOS-NCCOS-203. 44 pp. https://repository.library.noaa.gov/view/noaa/12941

Bloodworth, B.E. and D.K. Odell. 2008. *Kogia breviceps* (Cetacea: Kogiidae). Mamm. Species 819:1–12.

Bryan, C.E., W.C. Davis, W.E. McFee, C.A. Neumann, J.Schulte, G.D. Bossart, S.J. Christopher. 2012. Influence of mercury and selenium chemistries on the progression of cardiomyopathy in pygmy sperm whales, *Kogia breviceps*. Chemosphere 89:556–562.

Byrd, B.L., A.A. Hohn, G.N. Lovewell, K.M. Altman, S.G. Barco, A. Friedlaender, C.A. Harms, W.A. McLellan, K.T. Moore, P.E. Rosel and V.G. Thayer. 2014. Strandings illustrate marine mammal biodiversity and human impacts off the coast of North Carolina, USA. Fish. Bull. 112:1–23.

Caldwell, D.K. and M.C. Caldwell. 1989. Pygmy sperm whale *Kogia breviceps* (de Blainville 1838): dwarf sperm whale *Kogia simus* Owen, 1866. pp. 235–260 *In:* S.H. Ridgway and R. Harrison (eds.) Handbook of marine mammals, Vol. 4: River dolphins and the larger toothed whales. Academic Press, San Diego. 442 pp.

Carretta, J.V., K. Danil, S.J. Chivers, D.W. Weller, D.S. Janiger, M. Berman-Kowalewski, K.M. Hernandez, J.T. Harvey, R.C. Dunkin, D.R. Casper, S. Stoudt, M. Flannery, K. Wilkinson, J. Huggins and D.M. Lambourn. 2016. Recovery rates of bottlenose dolphin (Tursiops truncatus) carcasses estimated from stranding and survival rate data. Mar. Mamm. Sci. 32(1):349–362.

Carroll, A.G., R. Przeslawski, A. Duncan, M. Gunning, B. Bruce. 2017. A critical review of the potential impacts of marine seismic surveys on fish & invertebrates. Mar. Pollut. Bull. 114:9–24.

Dunn, C. 2013. Bahamas Marine Mammal Research Organisation Opportunistic Sightings. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/329) on 2023-09-05.

Fire, S.E., Z. Wanga, T.A. Leighfield, S.L. Morton, W.E. McFee, W.A. McLellan, R.W. Litaker, P.A. Tester, A.A. Hohn, G. Lovewell, C. Harms, D.S. Rotstein, S.G. Barco, A. Costidis, B. Sheppard, G.D. Bossart, M. Stolen, W. Noke Durden and F.M. van Dolah. 2009. Domoic acid exposure in pygmy and dwarf sperm whales (*Kogia* spp.) from southeastern and mid-Atlantic U.S. waters. Harmful Algae 8:658–664.

Garrison, L.P. 2016. Abundance of marine mammals in waters of the U.S. East Coast during summer 2011. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, FL 33140. PRBD Contribution # PRBD-2016-08. 21 pp.

Garrison, L.P. 2020. Abundance of cetaceans along the southeast U.S. east coast from a summer 2016 vessel survey. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, FL 33140. PRD Contribution # PRD-2020-04, 17 pp.

Garrison, L.P. and L.A. Dias. 2023. Abundance of marine mammals in waters of the southeastern U.S. Atlantic during summer 2021. SEFSC MMTD Contribution: #MMTD-2023-01. 23 pp. https://repository.library.noaa.gov/view/noaa/49152

Garrison, L.P. and L. Stokes. 2020a. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2017. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, Florida 33140. PRD Contribution # PRD-2020-05. 61 pp.

Garrison, L.P. and L. Stokes. 2020b. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2018. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, Florida 33140. PRD Contribution # PRD-2020-08. 56 pp.

Garrison, L.P. and L. Stokes. 2021. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2019. NOAA Tech. Memo. NMFS-SEFSC-750. 59 pp.

Garrison, L.P. and L. Stokes. 2023a. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2020. NOAA Tech. Memo. NMFS-SEFSC-764. 66 pp.

Garrison, L.P. and L. Stokes. 2023b. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2021. NOAA Tech. Memo. NMFS-SEFSC-765. 65 pp.

Gomez, C., J.W. Lawson, A.J. Wright, A.D. Buren, D. Tollit and V. Lesage. 2016. A systematic review on the behavioural responses of wild marine mammals to noise: The disparity between science and policy. Can. J. Zool. 94:801–819.

Grieve, B.D., J.A. Hare and V.S. Saba. 2017. Projecting the effects of climate change on *Calanus finmarchicus* distribution within the US Northeast continental shelf. Sci. Rep. 7:6264.

Hall, A.J., B.J. McConnell, L.J. Schwacke, G.M. Ylitalo, R. Williams and T.K. Rowles. 2018. Predicting the effects of polychlorinated biphenyls on cetacean populations through impacts on immunity and calf survival. Environ. Poll. 233:407–418.

Halpin, P.N., A.J. Read, E. Fujioka, B.D. Best, B. Donnelly, L.J. Hazen, C. Kot, K. Urian, E. LaBrecque, A. Dimatteo, J. Cleary, C. Good, L.B. Crowder and K.D. Hyrenbach. 2009. OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. Oceanography 22(2):104–115. https://doi.org/10.5670/oceanog.2009.42.

Hodge, L.E.W., S. Baumann-Pickering, J.A. Hildebrand, J.T. Bell, E.W. Cummings, H.J. Foley, R.J. McAlarney, W.A. McLellan, D.A. Pabst, Z.T. Swaim, D.M. Waples and A.J. Read. 2018. Heard but not seen: Occurrence of *Kogia* spp. along the western North Atlantic shelf break. Mar. Mamm. Sci. 34:1141–1153.

Jepson, P.D., R. Deaville, J.L. Barber, A. Aguilar, A. Borrell, S. Murphy, J. Barry, A. Brownlow, J. Barnett, S. Berrow and A.A. Cunningham. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. Sci. Rep.-U.K. 6:18573.

Laake, J.L. and D.L. Borchers. 2004. Methods for incomplete detection at distance zero. pp. 108–189 *In:* S.T. Buckland, D.R. Andersen, K.P. Burnham, J.L. Laake, D.L. Borchers and L. Thomas (eds.) Advanced distance sampling. Oxford University Press, New York. 416 pp.

MacLeod, C.D. 2009. Global climate change, range changes and potential implications for the conservation of marine cetaceans: a review and synthesis. Endang. Species Res. 7:125–136.

Marsh, H. and D.F. Sinclair. 1989. Correcting for visibility bias in strip transect surveys of aquatic fauna. J. Wildl. Manage. 53:1017–1024.

McAlpine, D.F. 2009. Pygmy and dwarf sperm whales. pp. 936–938. *In*: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.) Encyclopedia of marine mammals, Second edition. Academic Press, San Diego. 1352 pp.

Merkens, K., D. Mann, V.M. Janik, D. Claridge, M. Hill and E. Oleson. 2018. Clicks of dwarf sperm whales (*Kogia sima*). Mar. Mamm. Sci. 34(4):963–978.

Moore, J.E. and R. Merrick, eds. 2011. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS III Workshop, February 15–18, 2011, La Jolla, California. Dept. of Commerce, NOAA Tech. Memo. NMFS-OPR-47, 107 pp. https://repository.library.noaa.gov/view/noaa/4022

Morley, J.W., R.L. Selden, R.J. Latour, T.L. Frolicher, R.J. Seagraves and M.L. Pinsky. 2018. Projecting shifts in thermal habitat for 686 species on the North American continental shelf. PLoS ONE 13(5):e0196127.

Mullin, K.D. and G.L. Fulling. 2003. Abundance and distribution of cetaceans in the southern U.S. North Atlantic Ocean during summer 1998. Fish. Bull., U.S. 101:603–613.

NMFS [National Marine Fisheries Service]. 2018. 2018 Revisions to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (Version 2.0): Underwater thresholds for onset of permanent and temporary threshold shifts. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-OPR-59, 167 pp. https://repository.library.noaa.gov/view/noaa/17892

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2022. 2021 Annual report of a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US waters of the Western North Atlantic Ocean – AMAPPS III. 125 pp. https://repository.library.noaa.gov/view/noaa/41734

Northeast Fisheries Science Center (NEFSC) and Southeast Fisheries Science Center (SEFSC). 2018. Annual report of a comprehensive assessment of marine mammal, marine turtle, and seabird abundance and spatial distribution in US Waters of the Western North Atlantic Ocean. U.S. Dept. Commer., Northeast Fish. Sci. Cent. Ref. Doc. 18-04. 141 pp. https://www.fisheries.noaa.gov/resource/publication-database/atlantic-marine-assessment-program-protected-species.

Nowacek, D.P., C.W. Clark, D. Mann, P.J.O. Miller, H.C. Rosenbaum, J.S. Golden, M. Jasny, J. Kraska and B.L. Southall. 2015. Marine seismic surveys and ocean noise: time for coordinated and prudent planning. Front. Ecol. Environ. 13:378–386.

Nye, J., J. Link, J. Hare and W. Overholtz. 2009. Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf. Mar. Ecol. Prog. Ser. 393:111–129.

Palka, D. 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. https://repository.library.noaa.gov/view/noaa/4312

Palka, D. 2020. Cetacean abundance estimates in US northwestern Atlantic Ocean waters from summer 2016 line transect surveys conducted by the Northeast Fisheries Science Center. Northeast Fish. Sci. Cent. Ref. Doc. 20-05.

Palka, D. 2023. Cetacean abundance in the U.S. Northwestern Atlantic Ocean, summer 2021. US Dept Commer Northeast Fish Sci Cent Ref Doc 23-08. 59 pp.

Palka, D.L., S. Chavez-Rosales, E. Josephson, D. Cholewiak, H.L. Haas, L. Garrison, M. Jones, D. Sigourney, G. Waring, M. Jech, E. Broughton, M. Soldevilla, G. Davis, A. DeAngelis, C.R. Sasso, M.V. Winton, R.J. Smolowitz, G. Fay, E. LaBrecque, J.B. Leiness, M. Warden, K. Murray and C. Orphanides. 2017. Atlantic Marine Assessment Program for Protected Species: 2010-2014. US Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Washington, DC. OCS Study BOEM 2017-071. 211 pp. Accessible at: https://espis.boem.gov/final%20reports/5638.pdf.

Peltier, H., W. Dabin, P. Daniel, O. Van Canneyt, G. Dorémus, M. Huon and V. Ridoux. 2012. The significance of stranding data as indicators of cetacean populations at sea: Modelling the drift of cetacean carcasses. Ecol. Indic. 18:278–290.

Pinsky, M.L., B. Worm, M.J. Fogarty, J.L. Sarmiento and S.A. Levin. 2013. Marine taxa track local climate velocities, Science 341:1239–1242.

Poloczanska, E.S., C.J. Brown, W.J. Sydeman, W. Kiessling, D.S. Schoeman, P.J. Moore, K. Brander, J.F. Bruno, L.B. Buckley, M.T. Burrows, C.M. Duarte, B.S. Halpern, J. Holding, C.V. Kappel, M.I. O'Connor, J.M. Pandolfi, C. Parmesan, F. Schwing, S.A. Thompson and A.J. Richardson. 2013. Global imprint of climate change on marine life. Nat. Clim. Change 3:919–925.

Reed, L.A. W.E. McFee, P.L. Pennington, E.F. Wirth and M.H. Fulton. 2015. A survey of trace element distribution in tissues of the dwarf sperm whale (*Kogia sima*) stranded along the South Carolina coast from 1990-2011. Mar. Pollut. Bull. 100:501–506.

Roberts, J.J., B.D. Best, L. Mannocci, E. Fujioka, P.N. Halpin, D.L. Palka, L.P. Garrison, K.D. Mullin, T.V.N. Cole, C.B. Khan, W.M. McLellan, D.A. Pabst and G.G. Lockhart. 2015. Density model for *Kogia* whales (*Kogia* spp.) for the U.S. East Coast Version 3.2, 2015-10-07, and Supplementary Report. Marine Geospatial Ecology Lab, Duke University, Durham, North Carolina. http://seamap.env.duke.edu/models/Duke-EC-GOM-2015/

Schwacke, L.H., E.O. Voit, L.J. Hansen, R.S. Wells, G.B. Mitchum, A.A. Hohn and P.A. Fair. 2002. Probabilistic risk assessment of reproductive effects of polychlorinated biphenyls on bottlenose dolphins (*Tursiops truncatus*) from the southeast United States coast. Env. Toxic. Chem. 21(12):2752–2764.

Sousa, A., F. Alves, A. Dinis, J. Bentz, M.J. Cruz and J.P. Nunes. 2019. How vulnerable are cetaceans to climate change? Developing and testing a new index. Ecol. Indic. 98:9–18.

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 57:573–583.

Staudinger, M.D., R.J. McAlarney, W.A. McLellan and D.A. Pabst. 2014. Foraging ecology and niche overlap in pygmy (*Kogia breviceps*) and dwarf (*Kogia sima*) sperm whales from waters of the U.S. mid-Atlantic coast. Mar. Mamm. Sci. 30(2):626–655.

Thomas, L., J.L. Laake, E. Rexstad, S. Strindberg, F.F.C. Marques, S.T. Buckland, D.L. Borchers, D.R. Anderson, K.P. Burnham, M.L. Burt, S.L. Hedley, J.H. Pollard, J.R.B. Bishop and T.A. Marques. 2009. Distance 6.0. Release 2. [Internet]. University of St. Andrews (UK): Research Unit for Wildlife Population Assessment. http://distancesampling.org/Distance/.

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. https://repository.library.noaa.gov/view/noaa/15963

Wells, R.S., J.B. Allen, G. Lovewell, J. Gorzelany, R.E. Delynn, D.A. Fauquier and N.B. Barros. 2015. Carcass-recovery rates for resident bottlenose dolphins in Sarasota Bay, Florida. Mar. Mamm. Sci. 31(1): 355–368.

Williams, R., S. Gero, L. Bejder, J. Calambokidis, S.D. Kraus, D. Lusseau, A.J. Read and J. Robbins. 2011. Underestimating the damage: Interpreting cetacean carcass recoveries in the context of the Deepwater Horizon/BP incident. Conserv. Lett. 4:228–233.