LONG-FINNED PILOT WHALE (*Globicephala melas melas*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two species of pilot whales in the western Atlantic—the long-finned pilot whale, *Globicephala melas melas*, and the short-finned pilot whale, *G. macrorhynchus*. These species are difficult to differentiate at sea and cannot be reliably visually identified during either abundance surveys or observations of fishery mortality without high-quality photographs (Rone and Pace 2012); therefore, the ability to separately assess the two species in Atlantic waters is complex and requires additional information on seasonal spatial distribution. In the North Atlantic the long-finned pilot whale is distributed from North Carolina to North Africa (and the Mediterranean) and north to Iceland, Greenland and the Barents Sea (Sergeant 1962; Leatherwood et al. 1976; Abend 1993; Bloch et al. 1993; Abend and Smith 1999). The stock structure of the North Atlantic population is uncertain (ICES 1993; Fullard et al. 2000). Morphometric (Bloch and Lastein 1993) and genetic (Siemann 1994; Fullard et al. 2000) studies have provided little support for stock separation across the Atlantic (Fullard et al. 2000). However, Fullard et al. (2000) have proposed a stock structure that is related to sea-surface temperature: 1) a cold-water population west of the Labrador/North Atlantic current, and 2) a warm-water population that extends across the Atlantic in the Gulf Stream.

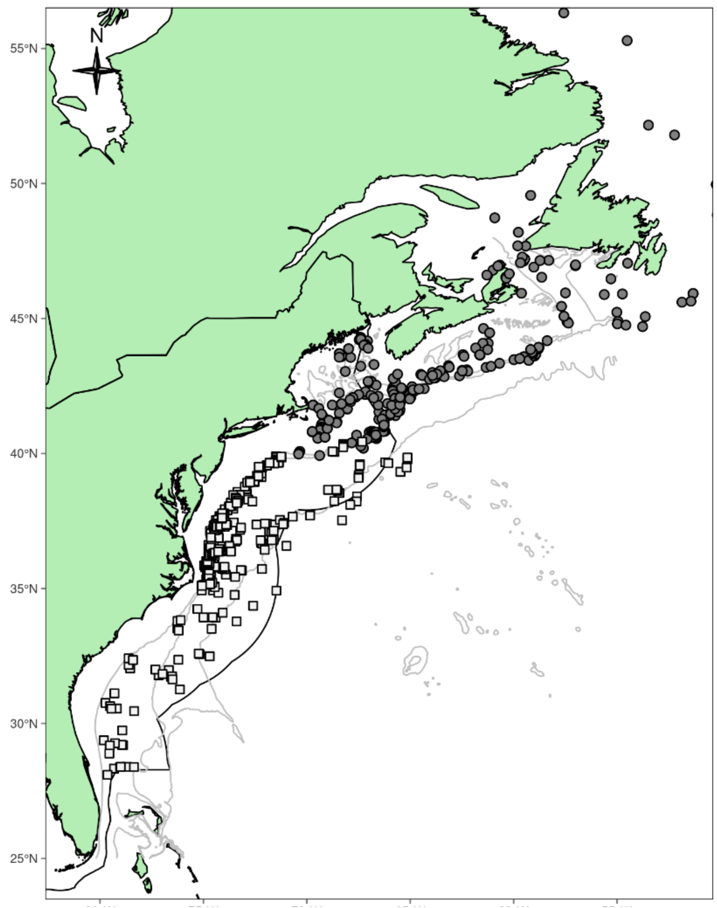

Figure 1. Distribution of long-finned (filled circles) and short-finned (open squares) pilot whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006, 2007, 2011, 2016, and 2021 and the Department of Fisheries and Oceans Canada 2007 TNASS and 2016 NAISS surveys. The inferred distribution of the two species is preliminary and is valid for June–August only. Isobaths are the 1000-m and 3000-m depth contours.

The Northwest Atlantic population represents a transboundary stock occupying waters in both the U.S. and Canada. In U.S. Atlantic waters, pilot whales (*Globicephala* spp.) are distributed principally along the continental shelf edge off the northeastern U.S. coast in winter and early spring (Figure 1; CETAP 1982; Payne and Heinemann 1993; Abend and Smith 1999; Hamazaki 2002). In late spring, pilot whales move onto Georges Bank and into the Gulf of Maine and more northern waters and remain in these areas through late autumn (CETAP 1982; Payne and Heinemann 1993). Pilot whales tend to occupy areas of high relief or submerged banks. They are also associated with the Gulf Stream wall and thermal fronts along the continental shelf edge (Waring et al. 1992). Long-finned and short-finned pilot whales overlap spatially along the mid-Atlantic shelf break between Delaware and the southern flank of Georges Bank (Payne and Heinemann 1993; Rone and Pace 2012). Long-finned pilot whales have occasionally been observed stranded as far south as Florida, while short-finned pilot whales have occasionally been observed stranded as far north as Massachusetts (Pugliares et al. 2016). The exact latitudinal ranges of the two species therefore remain uncertain, although south of Cape Hatteras, most pilot whale sightings are expected to be short-finned pilot whales, while north of ~42°N most pilot whale sightings are expected to be long-finned pilot whales (Figure 1; Garrison and Rosel 2017).

POPULATION SIZE

The best available estimate for long-finned pilot whales in the western North Atlantic is 39,215 (CV=0.30; Table 1; Garrison 2020; Palka 2020; Lawson and Gosselin 2018). This estimate is the sum of the estimates generated from the northeast U.S. summer 2016 surveys covering U.S. waters from central Virginia to Maine and the Department of Fisheries and Oceans Canada summer 2016 survey covering Canadian waters from the U.S. to Labrador. 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 a species abundance estimate for the stock area. These survey data have been combined with an analysis of the spatial distribution of the 2 species of pilot whales based on genetic analyses of biopsy samples to derive separate abundance estimates (Garrison and Rosel 2017). Estimates generated from the 2021 surveys are more recent and focus on U.S. waters, although more of the stock range was covered in the 2016 survey.

Key uncertainties in the population size estimate include the uncertain separation between the short-finned and long-finned pilot whales; the small negative bias due to the lack of an abundance estimate in the region between the US and the Newfoundland/Labrador survey area; and the uncertainty due to the unknown precision and accuracy of the availability bias correction factor that was applied.

Recent Surveys and Abundance Estimates for *Globicephala* spp.

Abundance estimates of 8,166 (CV=0.31) and 25,114 (CV=0.27) *Globicephala* sp. were generated from vessel surveys conducted in the northeast and southeast U.S., respectively, during the summer of 2016. The Northeast survey was conducted during 27 June–25 August and consisted of 5,354 km of on-effort trackline. The majority of the survey was conducted in waters north of 38ºN latitude and included trackline along the shelf break and offshore to the U.S. EEZ. Pilot whale sightings were concentrated along the shelf-break between the 1,000-m and 2,000-m isobaths and along Georges Bank (NMFS 2017). The Southeast 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. Pilot whales were observed in high densities along the shelf-break between Cape Hatteras and New Jersey and also in waters further offshore in the mid-Atlantic and off the coast of Florida (NMFS 2017; Garrison and Palka 2018). Both the Northeast and Southeast 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. A logistic regression model was used to estimate the abundance of long-finned pilot whales from these surveys. For the northeast survey, this resulted in an abundance estimate of 10,997 (CV=0.51) long-finned pilot whales. In the southeast, the model indicated that this survey included habitats expected to exclusively contain short-finned pilot whales so no estimate for long-finned pilot whales was generated.

An abundance estimate of 28,218 (CV=0.36) long-finned pilot whales from the Newfoundland/Labrador region was generated from an aerial survey conducted by the Department of Fisheries and Oceans, Canada (DFO). This survey covered Atlantic Canadian shelf and shelf break waters extending from the northern tip of Labrador to the U.S border off southern Nova Scotia in August and September of 2016 (Lawson and Gosselin 2018). A total of 29,123 km was flown over the Gulf of St. Lawrence/Bay of Fundy/Scotian Shelf stratum using two Cessna Skymaster 337s and 21,037 km were flown over the Newfoundland/Labrador stratum using a DeHavilland Twin Otter. The Newfoundland estimate was derived from the Twin Otter data using two-team mark-recapture multi-covariate distance sampling methods. An availability bias correction factor, which was based on the cetaceans' surface intervals, was also applied. The Gulf of St. Lawrence/Bay of Fundy/Scotian Shelf survey detected 10 pilot whale groups, however, no abundance estimate was produced.

A more recent abundance estimate of 5,734 (CV=0.62) long-finned pilot whales was 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. Estimates from the two surveys were combined and CVs pooled to produce a species abundance estimate for the stock area. The 2016 estimate is larger than that from 2021 because the 2016 estimate is derived from a survey area extending from Newfoundland to

Florida, which is about 1,300,000 km2 larger than the 2021 survey area.

Spatial Distribution and Abundance Estimates

Biopsy samples from pilot whales were collected during summer months (June–August) from South Carolina to the southern flank of Georges Bank between 1998 and 2007. These samples were identified to species using phylogenetic analysis of mitochondrial DNA sequences. Stranded specimens that were morphologically identified to species were used to assign clades in the phylogeny to species and thereby identify all samples. The probability of a sample being from a long-finned (or short-finned) pilot whale was evaluated as a function of sea-surface temperature, latitude, and month using a logistic regression. This analysis indicated that the probability of a sample coming from a long-finned pilot whale was near 1 at water temperatures <22°C, and near 0 at temperatures >25°C. The probability of a long-finned pilot whale also increased with increasing latitude. Spatially, during summer months, this regression model predicted that all pilot whales observed in offshore waters near the Gulf Stream are most likely short-finned pilot whales. The area of overlap between the two species occurs primarily along the shelf break off the coast of New Jersey between 38°N and 40°N latitude (Garrison and Rosel 2017).

This model was used to partition the abundance estimates from surveys conducted during the summer of 2021. The sightings from the southeast shipboard surveys covering waters from Florida to New Jersey were predicted to consist entirely of short-finned pilot whales. The aerial portion of the northeast surveys covered the Gulf of Maine and the Bay of Fundy where the model predicted that only long-finned pilot whales would occur. The vessel portion of the northeast surveys recorded a mix of both species along the shelf break, and the sightings in offshore waters near the Gulf Stream were predicted to consist predominantly of short-finned pilot whales (Garrison and Rosel 2017).

Table 1. Summary of recent abundance estimates for the western North Atlantic long-finned pilot whale (**Globicephala melas melas*****) by month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{est}) and coefficient of variation (CV). The estimate considered best is in bold font.***

Month/Year	Area	N_{est}	CV
Jun–Aug 2016	Central Virginia to Lower Bay of Fundy	10,997	0.51
Aug–Sep 2016	Newfoundland/Labrador	28,218	0.36
Jun–Sep 2016	**Central Virginia to Labrador (COMBINED)**	**39,215**	**0.30**
Jun–Aug 2021	New Jersey to lower Bay of Fundy	5,711	0.62
Jun–Aug 2021	Central Florida to New Jersey	0	0
Jun–Aug 2021	Central Florida to lower Bay of Fundy (COMBINED)	5,711	0.62

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 western North Atlantic long-finned pilot whales is 39,215 animals (CV=0.30).This was based on the combined 2016 surveys,which covered a greater proportion of the stock range than the more recent 2021 survey The minimum population estimate for long-finned pilot whales is 30,627.

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. 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 long-finned pilot whales is 30,627. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor is 0.5 because this stock is of unknown status relative to optimum sustainable population (OSP) and the CV of the average mortality estimate is less than 0.3 (Wade and Angliss 1997). PBR for the western North Atlantic long-finned pilot whale is 306 (Table 2).

Table 2. Best and minimum abundance estimates for western North Atlantic long-finned pilot whale (**Globicephala melas melas*****) with Maximum Productivity Rate (R_{max}), Recovery Factor (F_r) and PBR.***

N_{est}	CV	N_{min}	F_r	R_{max}	PBR
39,215	0.30	30,627	0.5	0.04	306

Total annual estimated average human-caused mortality or serious injury during 2017–2021 was 5.5long-finned pilot whales (CV=0.29 from U.S. fisheries using observer data and an annual average of 0.2 animals from non-fishery stranding records (Table 3). In bottom trawls, mid-water trawls and the gillnet fisheries, mortalities were generally observed north of 40°N latitude and in areas where long-finned pilot whales were expected to occur. Takes in these fisheries were therefore considered to be long-finned pilot whales. Takes in the pelagic longline fishery were partitioned according to a logistic regression model (Garrison and Rosel 2017).

Table 3. Total annual estimated average human-caused mortality and serious injury for the western North Atlantic long-finned pilot whale (**Globicephala melas melas*****).***

Years	Source	Annual Avg.	CV
2017–2021	U.S. commercial fisheries using observer data	5.5	0.29
2017–2021	Non-fishery human caused stranding mortalities	0.2	-
TOTAL		5.7	0.29

Fishery Information

Detailed fishery information is reported in Appendix III.

Earlier Interactions

See Appendix V for more information on historical takes.

United States

Pelagic Longline

During 2017–2021, pilot whale interactions (all serious injuries) were apportioned between the short-finned and long-finned pilot whale stocks according to a logistic regression model (Garrison and Rosel 2017; Garrison and Stokes 2023a; and 2023b). See Table 3 for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for historical bycatch information.

Northeast Bottom Trawl

Fishery-related bycatch rates for years 2017–2021 were estimated using an annual stratified ratio-estimator (Lyssikatos and Chavez-Rosales 2022). See Table 4 for bycatch estimates and observed mortality and serious injury for the current 5-year period, and Appendix V for historical bycatch information.

Canada

Unknown numbers of long-finned pilot whales have been taken in Newfoundland, Labrador, Scotian shelf and Bay of Fundy groundfish gillnets; Atlantic Canada and Greenland salmon gillnets; and Atlantic Canada cod traps (Read 1994).

Table 4. Summary of the incidental mortality and serious injury of long-finned pilot whales (**Globicephala melas melas*****) by U.S. commercial fisheries including the years sampled (Years), the type of data used (Data Type), the annual observer coverage coverage (Observer Coverage), the observed mortalities and serious injuries recorded by on-board observers, the estimated annual mortality and serious injury, the combined annual estimates of mortality and serious injury (Estimated Combined Mortality), the estimated CV of the combined estimates (Est. CVs) and the mean of the combined estimates (CV in parentheses). These are minimum observed counts as expanded estimates are not available.***

Fishery	Years	Data Type [a]	Observer Coverage [b]	Observed Serious Injury[c]	Observed Mortality	Estimated Serious Injury[e]	Estimated Mortality	Estimated Combined Mortality	Estimated CVs	Mean Combined Annual Mortality
Northeast Bottom Trawl	2017 2018 2019 2020 2021	Obs. Data, Logbook	0.12 0.12 0.16 0.08 0.19	0 0 0 0 0	0 0 1 1 2	0 0 0 0 0	0 0 5.4 1.8 7.5	0 0 5.4 1.8 7.5	na na 0.88 0.88 0.62	2.9 (0.46)
Pelagic Longline Fishery	2017 2018 2019 2020 2021	Obs. Data, Logbook Data	0.12 0.10 0.10 0.09 0.08	1 1 1 1 1	0 0 0 0 0	3.3 0.4 0.4 5.7 2.8	0 0 0 0 0	3.3 0.4 0.4 5.7 2.8	0.98 0.93 1.0 0.44 0.67	2.53(0.36)
TOTAL										5.5 (0.29)

a. Observer data (Obs. Data) are used to measure bycatch rates and the data are collected within the Northeast Fisheries Observer Program (NEFOP). NEFSC collects landings data (unallocated Dealer Data and Allocated Dealer Data) which are used as a measure of total landings. Mandatory Vessel Trip Reports (VTR; Trip Logbook) are used to determine the spatial distribution of landings and fishing effort. Total landings are used as a measure of total effort for the coastal gillnet fishery.
b. The observer coverages for the northeast sink gillnet fishery are ratios based on tons of fish landed. Northeast bottom trawl and northeast mid-water trawl fishery coverages are ratios based on trips.
c. Expanded estimates are not available for this fishery.
d. Serious injuries were evaluated for the period and include both at-sea monitor and traditional observer data (Josephson and Lyssikatos 2023).

STATUS OF STOCK

The long-finned pilot whale is not listed as threatened or endangered under the Endangered Species Act.he western North Atlantic stock is not considered strategic under the MMPA because the mean annual human-caused mortality and serious injury does not exceed PBR. Total U.S. fishery-related mortality and serious injury for long-finned pilot whales is more than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. Due to lack of observed fisheries data from Canada, the U.S. fishery-related mortality and serious injury represents a minimum estimate for the stock. The status of this stock relative to OSP is unknown. A population trend analysis for this stock has not been conducted.

Based on the low levels of uncertainty described in the above sections, it is expected these uncertainties will have little effect on the designation of the status of this stock.

OTHER FACTORS THAT MAY BE CAUSING A DECLINE OR IMPEDING RECOVERY

Strandings

Pilot whales have a propensity to mass strand throughout their range, but the role of human activity in these events is unknown. From 2017 to 2021, 11 long-finned pilot whales (Globicephala melas melas) were reported stranded between Maine and Florida, including the EEZ (Table 4; NOAA National Marine Mammal Health and Stranding Response Database, accessed 15 October 2022). Of these, one of the animals had plastic in its stomach, indicating human interaction (Table 5).

Table 5. Pilot whale (*Globicephala melas melas*) strandings along the Atlantic coast, 2017-2021. The level of technical expertise among stranding network personnel varies, and given the potential difficulty in correctly identifying stranded pilot whales to species, reports to specific species should be viewed with caution.

State	2017	2018	2019	2020	2021	Total
Nova Scotia[a]	12	12	12	3	9	29
Newfoundland and Labrador[b]	1	0	1	15	10	28
Maine	1	1	1	0	1	5
Massachusetts[c]	1	1	1	3	1	5
New York	0	0	0	0	1	1
TOTAL	**15**	**6**	**4**	**21**	**22**	**68**

a. Data supplied by Nova Scotia Marine Animal Response Society (pers. comm.).
b. See Ledwell and Huntington 2018, 2019, 2020, 2021a, 2021b.
c. 2021 Massachusetts animal coded as human interaction due to plastic in stomach.

Stranding data probably underestimate the extent of human and fishery-related mortality and serious injury, particularly for offshore species such as pilot whales. Not all of the whales 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). Additionally, because of decomposition and scavenger damage, not all carcasses will show evidence of human interaction, entanglement or other fishery-related interaction . (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.

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). Moderate levels of these contaminants have been found in pilot whale blubber (Taruski et al. 1975; Muir et al. 1988; Weisbrod et al. 2000). Weisbrod et al. (2000) examined polychlorinated biphenyl and chlorinated pesticide concentrations in bycaught and stranded pilot whales in the western North Atlantic. Contaminant levels were similar to or lower than levels found in other toothed whales in the western North Atlantic, perhaps because they are feeding further offshore than other species (Weisbrod et al. 2000). Dam and Bloch (2000) found very high PCB levels in long-finned pilot whales around the Faroe Islands. Also, high levels of toxic metals (mercury, lead, cadmium) and selenium were measured in pilot whales harvested in the Faroe Island drive fishery (Nielsen et al. 2000). However, the population effect of the observed levels of such contaminants on this stock is unknown.

Anthropogenic sound has been shown to affect marine mammals. Vessel traffic, seismic surveys, and active naval sonars are the main human-caused contributors to low- and mid-frequency noise in oceanic waters (e.g., Nowacek et al. 2015; Gomez et al. 2016; NMFS 2018). Exposure experiments conducted in the northern Norwegian Seas between 2006 and 2009 indicated that long-finned pilot whales conducted fewer deep dives during low-frequency active sonar exposures, while their diving behavior did not change when mid-frequency active sonar exposures were performed (Sivle et al. 2012) The long-term and population consequences of these impacts are less well-documented and likely vary by species and other factors. Impacts from sound on marine mammal prey are also possible (Carroll et al. 2017), but the duration and severity of 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).

Chavez-Rosales et al. (2022) documented an overall 178 km northeastward spatial distribution shift of the seasonal core habitat of Northwest Atlantic cetaceans that was related to changing habitat/climatic factors. This study used sighting data collected during seasonal aerial and shipboard line transect abundance surveys from 2010 to 2017. During this time frame, the weighted centroid of long-finned pilot whale core habitat moved less than 70 km in all seasons. 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.

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