SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

There are two species of pilot whales in the western North Atlantic - the long-finned pilot whale, *Globicephala melas melas*, and the short-finned pilot whale, *G. macrorhynchus*. These species can be 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). Pilot whales (*Globicephala* sp.) in the western North Atlantic occur primarily along the continental shelf break from Florida to the Nova Scotia Shelf (Mullin and Fulling 2003). 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, and 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 remain uncertain. However, south of Cape Hatteras most pilot whale sightings are expected to be short-finned pilot whales, while north of approximately 42°N most pilot whale sightings are expected to be long-finned pilot whales (Figure 1; Garrison and Rosel 2017). Short-finned pilot whales are also documented in the wider Caribbean (Bernard and Riley 1999) and along the continental shelf and continental slope in the northern Gulf of Mexico (Mullin and Fulling 2004; Maze-Foley and Mullin 2006).

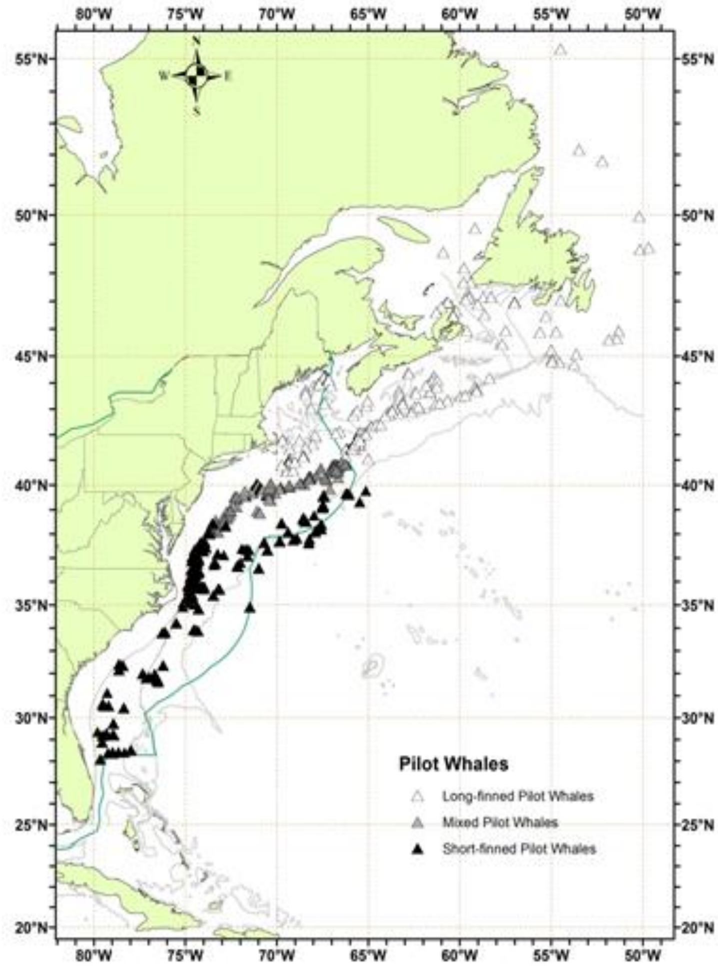

Figure 1. Distribution of long-finned (open symbols), short-finned (black symbols), and possibly mixed (gray symbols; could be either species) pilot whale sightings from NEFSC and SEFSC shipboard and aerial surveys during 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, 2011 and 2016, and DFO's 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 200-m, 1000-m and 4000-m depth contours. The green line indicates the U.S. EEZ.

Thorne *et al.* (2017) tracked 33 short-finned pilot whales off Cape Hatteras in 2014 and 2015 using satellite-linked telemetry tags. Kernel density estimates of habitat use by whales during tracking were concentrated along the continental shelf break from Cape Hatteras north to Hudson Canyon, but whale distribution also included shelf break waters south of Cape Lookout, shelf break waters off Nantucket Shoals, and deeper offshore waters of the Gulf Stream east and north of Cape Hatteras, reinforcing that the continental shelf break is an important foraging habitat for short-finned pilot whales in the western North Atlantic. Finally, short-finned pilot whales that have stranded alive along the U.S. Atlantic coast and subsequently were released and tracked via satellite telemetry have travelled hundreds of kilometers from their release sites to other areas of the U.S. Atlantic and to the Caribbean (e.g., Irvine *et al.* 1979; Wells *et al.* 2013). Whether these movements are representative of normal species' patterns is unknown because they were generated from stranded animals.

An analysis of stock structure within the western North Atlantic Stock has not been completed so there are insufficient data to determine whether there are multiple demographically-independent populations within this stock. Studies to evaluate genetic population structure in short-finned pilot whales throughout the region will improve understanding of stock structure. Pending these results, the *Globicephala macrorhynchus* population occupying U.S. Atlantic waters is managed separately from both the northern Gulf of Mexico stock and the Puerto Rico and U.S. Virgin Islands stock.

POPULATION SIZE

The best available estimate for short-finned pilot whales in the western North Atlantic is 28,924 (CV=0.24; Table 1; Palka 2012; Garrison 2016; Garrison and Rosel 2017; Garrison and Palka 2018). This estimate is from summer 2016 shipboard surveys covering waters from central Florida to the lower Bay of Fundy and is considered the best available abundance estimate because it is based on the most recent surveys covering the full range of short-finned pilot whales in U.S. Atlantic waters. Because long-finned and short-finned pilot whales are difficult to distinguish at sea, sightings data were reported as *Globicephala* sp. Pilot whale sightings from these surveys were strongly concentrated along the continental shelf break; however, pilot whales were also observed over the continental slope in waters associated with the Gulf Stream (Figure 1). These survey data have been combined with an analysis of the spatial distribution of the two pilot whale species based on genetic analyses of biopsy samples to derive separate abundance estimates for each species (Garrison and Rosel 2017).

Earlier Abundance Estimates

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

Recent Surveys and Abundance Estimates for *Globicephala* sp.

Abundance estimates of 3,810 (CV=0.42) 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 (see next section) was used to estimate the abundance of short-finned pilot whales from these surveys. For the northeast survey, this resulted in an abundance estimate of 3,810 (CV=0.42) short-finned pilot whales. In the southeast, the model indicated that this survey included habitats expected to exclusively contain short-finned pilot whales resulting in an abundance estimate of 25,114 (CV=0.27).

Spatial Distribution and Abundance Estimates for *Globicephala macrorhynchus*

Pilot whale biopsy samples 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. Samples from stranded specimens that were morphologically identified to species were used to assign clades in the phylogeny to species and thereby identify all survey samples. The probability of a sample being from a short-finned (or long-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 short-finned pilot whale was near zero at water temperatures <22°C, and near one at temperatures >25°C. The probability of being a short-finned pilot whale also decreased 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 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 2016 based upon contemporaneous satellite derived sea surface temperature. The sightings from the shipboard surveys covering waters from Florida to New Jersey were predicted to consist entirely of short-finned pilot whales. The vessel portion of the northeast surveys from New Jersey to the southern flank of Georges Bank included waters along the shelf break and waters further offshore extending to the U.S. EEZ. Pilot whales were observed in both areas during the survey. Along the shelf break, the model predicted a mixture of both species, but the sightings in offshore waters near the Gulf Stream were again predicted to consist predominantly of short-finned pilot whales (Garrison and Rosel 2017). The best abundance estimate for short-finned pilot whales is thus the sum of the southeast survey estimate (25,114; CV=0.27) and the estimated number of short-finned pilot whales from the northeast vessel survey (3,810; CV=0.42). The best available abundance estimate is thus 28,924 (CV=0.24).

Table 1. Summary of recent abundance estimates for the western North Atlantic short-finned pilot whale (Globicephala macrorhynchus) by month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{est}) and coefficient of variation (CV). Estimates for the entire stock area (COMBINED) include pooled CVs.

Month/Year	Area	N_{est}	CV
Jun–Aug 2016	New Jersey to lower Bay of Fundy	3,810	0.42
Jun–Aug 2016	Central Florida to New Jersey	25,114	0.27
Jun–Aug 2016	Central Florida to lower Bay of Fundy (COMBINED)	28,924	0.24

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 short-finned pilot whale is 28,924 animals (CV=0.24). The minimum population estimate is 23,637 (Table 2).

Current Population Trend

There are three available coastwide abundance estimates for short-finned pilot whales from the summers of 2004, 2011, and 2016. 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. The southeast component of these surveys all were expected to contain exclusively short-finned pilot whales, and the logistic regression model was used to partition pilot whale sightings from the northeast portion of the survey between the short-finned and long-finned species based upon habitat characteristics. The resulting estimates were 24,674 (CV=0.52) in 2004, 21,515 (CV=0.36) in 2011, and 28,924 (CV=0.24) in 2016 (Garrison and Palka 2018). A generalized linear model indicated no significant trend in these abundance estimates. The key uncertainty is the assumption that the logistic regression model accurately represents the relative distribution of short-finned vs. long-finned pilot whales in each year.

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 short-finned pilot whales is 23,637. The maximum productivity rate is 0.04, the default value for cetaceans. The “recovery” factor is 0.5 because the stock's status relative to optimum sustainable population (OSP) is unknown and the CV of the average mortality estimate is less than 0.3 (Wade and Angliss 1997). PBR for the western North Atlantic short-finned pilot whale is 236 (Table 2).

Table 2. Best and minimum abundance estimates for the Western North Atlantic short-finned pilot whale with Maximum Productivity Rate (R_{max}), Recovery Factor (F_r) and PBR.

N_{est}	N_{est} CV	N_{min}	F_r	R_{max}	PBR
28,924	0.24	23,637	0.5	0.04	236

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The estimated mean annual fishery-related mortality and serious injury during 2015–2019 due to the large pelagics longline fishery was 136 short-finned pilot whales (CV=0.14; Table 3). Uncertainty in this estimate arises because it incorporates a logistic regression model to predict the species of origin (long-finned or short-finned pilot whale) for each bycaught whale. The statistical uncertainty in the assignment to species is incorporated into the abundance estimates; however, the analysis assumes that the collected biopsy samples adequately represent the distribution of the two species and that the resulting model correctly predicts shifts in distribution in response to changes in environmental conditions.

In bottom trawl, mid-water trawl, and gillnet fisheries, pilot whale mortalities were observed north of 40°N latitude in areas expected to have only long-finned pilot whales. Takes and bycatch estimates for these fisheries are therefore attributed to the long-finned pilot whale stock.

Fishery Information

There are three commercial fisheries that interact, or that potentially could interact, with this stock in the Atlantic Ocean. These include two Category I fisheries (the Atlantic Ocean, Caribbean, Gulf of Mexico large pelagics longline and the Atlantic Highly Migratory Species longline fisheries) and one Category III fishery (the Atlantic Ocean, Gulf of Mexico, Caribbean commercial passenger fishing vessel (hook and line) fishery). All recent gillnet and trawl interactions have been assigned to long-finned pilot whales using model-based predictions. Detailed fishery information is reported in Appendix III.

Earlier Interactions

See Appendix V for information on historical takes.

Pelagic Longline

The Atlantic Ocean, Caribbean, Gulf of Mexico 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 2015 to 2019 was 136 short-finned pilot whales (CV=0.14; Table 3). During 2015–2019, 77 serious injuries were observed in the following fishing areas of the North Atlantic: Florida East Coast, Mid-Atlantic Bight, Northeast Coastal, and South Atlantic Bight. During 2015–2019, one mortality was observed (in 2016) in the Florida East Coast fishing area (Garrison and Stokes 2017; 2019; 2020a; 2020b; 2021).

Prior to 2014, estimated bycatch in the pelagic longline fishery was assigned to the short-finned pilot whale stock because the observed interactions all occurred at times and locations where available data indicated that long-finned pilot whales were very unlikely to occur. Specifically, the highest bycatch rates of undifferentiated pilot whales were observed during September–November along the mid-Atlantic coast (south of 38°N; Garrison 2007), and biopsy data collected in this area during October–November 2011 indicated that only short-finned pilot whales occurred in this region (Garrison and Rosel 2017). Similarly, all genetic data collected from interactions in the pelagic longline fishery have indicated interactions with short-finned pilot whales. However, in recent years, pilot whale interactions (including serious injuries) were observed farther north and along the southern flank of Georges Bank. Therefore, the logistic regression model (described above in 'Spatial Distribution and Abundance Estimates for *Globicephala macrorhynchus*) was applied using contemporaneous sea surface temperature data to estimate the probability that these interactions were from short-finned vs. long-finned pilot whales (Garrison and Rosel 2017). Due to high water temperatures (ranging from 22 to 25ºC) at the time of the observed takes, these interactions were estimated to have a >90% probability of coming from short-finned pilot whales. The estimated probability was used to apportion the estimated mortality and serious injury in the pelagic longline fishery between the short-finned and long-finned pilot whale stocks (Garrison and Stokes 2016; 2017; 2019; 2020a; 2020b; 2021).

Between 1992 and 2004, most of the marine mammal bycatch in the U.S. pelagic longline fishery was recorded in U.S. Atlantic EEZ waters between South Carolina and Cape Cod (Garrison 2007). From January to March, observed bycatch was concentrated on the continental shelf edge northeast of Cape Hatteras, North Carolina. During April–June, bycatch was recorded in this area as well as north of Hydrographer Canyon in water over 1,000 fathoms (1830m) deep. During the July–September period, observed takes occurred on the continental shelf edge east of Cape Charles, Virginia, and on Block Canyon slope in over 1,000 fathoms of water. October–December bycatch occurred between the 20- and 50-fathom (37- and 92-m) isobaths between Barnegat Bay, New Jersey, and Cape Hatteras, North Carolina.

The Atlantic Highly Migratory Species longline fishery operates outside the U.S. EEZ. No takes of short-finned pilot whales within high seas waters of the Atlantic Ocean have been observed or reported thus far.

See Table 3 for bycatch estimates and observed mortality and serious injury for the current five-year period, and Appendix V for historical estimates of annual mortality and serious injury.

Table 3. Summary of the incidental mortality and serious injury of short-finned pilot whales (Globicephala macrorhynchus) by the pelagic longline 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 annual observed serious injury and mortality recorded by on-board observers, the annual estimated serious injury and mortality, the combined annual estimates of serious injury and mortality (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]	Percent Observer Coverage[c]	Observed Serious Injury	Observed Mortality	Estimated Serious Injury	Estimated Mortality	Estimated Combined Mortality	Est. CVs	Mean Annual Mortality
Pelagic Longline	2015	74	Obs. Data, Logbook	12	32	0	200	0	200	0.24	136 (0.14)
	2016	60		15	14	1	106	5.1	111	0.31	
	2017	65		12	14	0	133	0	133	0.29	
	2018	57		10	7	0	102	0	102	0.39	
	2019	50		10	10	0	131	0	131	0.37	

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

Hook and Line

During 2015–2019, there were no documented takes by this fishery. The most recent take occurred in 2013. It is not possible to estimate the total number of interactions with hook and line gear because there is no systematic observer program.

Other Mortality

Pilot whales have a propensity to mass strand throughout their range, but the role of human activity in these events is unknown. Between two and 168 pilot whales have stranded annually, either individually or in groups, along the eastern U.S. seaboard since 1980 (NMFS 1993; NOAA National Marine Mammal Health and Stranding Response Database unpublished data). During 2015–2019, 47 short-finned pilot whales were reported stranded between Massachusetts and Florida (Table 4; Northeast Regional Marine Mammal Stranding Network; Southeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 25 August 2020 (SER) and 23 July 2020 (NER)). These strandings included two mass stranding events of live animals in 2019. Evidence of human interaction was detected for two animals (one animal pushed out to sea by the public and one with ingested plastic debris; neither interaction was believed to be the cause of the stranding). No evidence of human interaction was detected for 15 strandings, and for the remaining 30 strandings, it could not be determined if 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.

Table 4. Short-finned pilot whale (Globicephala macrorhynchus) strandings along the Atlantic coast, 2015–2019. Data are from the NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 25 August 2020 (SER) and 23 July 2020 (NER). EEZ=U.S. Exclusive Economic Zone (offshore U.S. waters).

State	2015	2016	2017	2018	2019	TOTALS
Massachusetts	0	0	0	0	3[a]	3
New York	0	0	0	4	0	4
Maryland	0	0	0	0	1	1
Virginia	0	0	0	0	1	1
North Carolina	2	0	1	2	2	7
South Carolina	0	0	0	0	5	5
Georgia	1	0	1	0	21[b]	23
Florida	2	0	0	1	0	3
TOTALS	5	0	2	7	33	47

a. These 3 animals were a live mass stranding event.
b. These 21 animals were part of a mass stranding event of ~50 live whales.

There are a number of difficulties associated with the interpretation of stranding data. Stranding data underestimate the extent of human and fishery-related mortality and serious injury, particularly for offshore species such as pilot whales, because 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; 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.

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 in the Faroes. 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 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 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 short-finned pilot whale is not listed as threatened or endangered under the Endangered Species Act, and the western North Atlantic stock is not a strategic stock under the MMPA because the mean annual human-caused mortality and serious injury does not exceed PBR. The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown. Total U.S. fishery-related mortality and serious injury attributed to short-finned pilot whales exceeds 10% of the calculated PBR and therefore cannot be considered to be insignificant and approaching zero mortality and serious injury rate. There is no evidence for a trend in population size for this stock.

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