FALSE KILLER WHALE (*Pseudorca crassidens*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The false killer whale is distributed worldwide throughout warm temperate and tropical oceans (Jefferson *et al.* 2008). This species is usually sighted in offshore waters but in some cases inhabits waters closer to shore, particularly around oceanic islands (e.g., Hawaii, Baird *et al.* 2013). While sightings from the U.S. western North Atlantic have been uncommon (Figure 1), the combination of sighting, stranding and bycatch records indicates that this species routinely occurs in the western North Atlantic. False killer whales have been sighted in U.S. Atlantic waters from southern Florida to Maine (Schmidly 1981). There are periodic records (primarily stranding) from southern Florida to Cape Hatteras dating back to 1920 (Schmidly 1981). Most of the records are from the southern half of Florida and include a mass stranding in 1970 that may have numbered as many as 175 individuals (Caldwell *et al*. 1970; Schmidly 1981).

Genetic analyses (Chivers *et al.* 2007; Martien *et al.* 2014) indicate false killer whales exhibit significant population structuring in the Pacific, with restricted gene flow among whales sampled near the main Hawaiian Islands, the Northwestern Hawaiian Islands, and pelagic waters of the eastern and the central North Pacific. Martien *et al.* (2014) also found their two Atlantic samples to be genetically divergent from those in the Pacific. False killer 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 evidence for strong population structuring in other areas (Martien *et al.* 2014) and further supported because the two stocks occupy distinct marine ecoregions (Spalding *et al.* 2007; Moore and Merrick 2011). Given the paucity of sightings, there are insufficient data to determine whether the western North Atlantic stock comprises multiple demographically independent populations. 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.

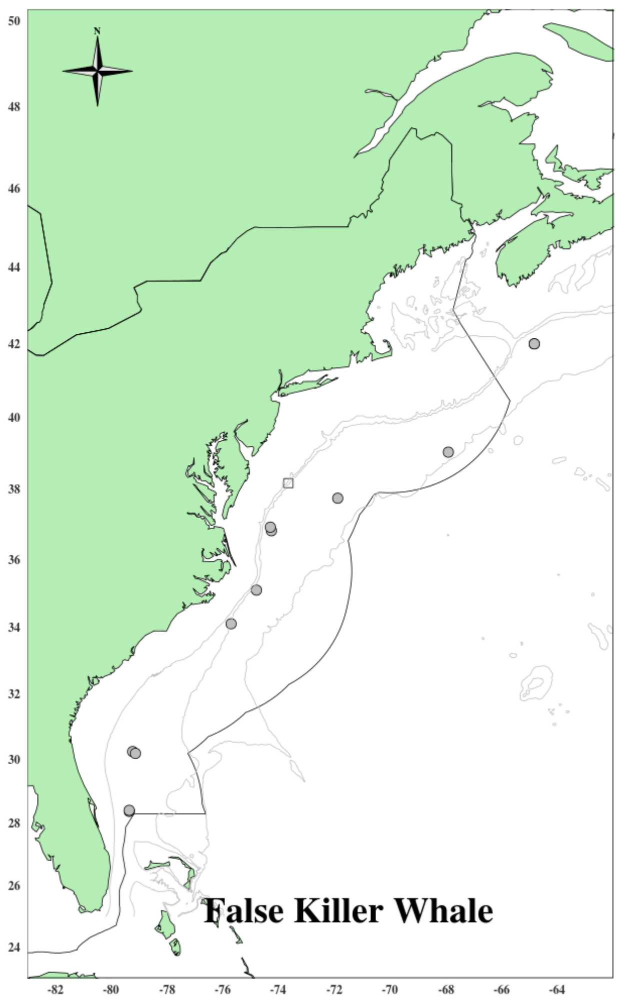

Figure 1. Distribution of false killer whale sightings from NEFSC and SEFSC shipboard (circles) and aerial (squares) surveys during 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010, 2011 and 2016. Isobaths are the 200m, 1,000m, and 4,000m depth contours. The darker line indicates the U.S. EEZ.

POPULATION SIZE

The best available abundance estimate for western North Atlantic false killer whales is 1,791 (CV=0.56; Table 1; Garrison 2020; Palka 2020). This estimate is from summer 2016 surveys covering waters from central Florida to the lower Bay of Fundy.

Recent surveys and abundance estimates

There were no sightings of false killer whales during aerial and shipboard surveys conducted during June-August 2011 from central Virginia to the lower Bay of Fundy. The aerial portion covered 6,850 km of tracklines over waters north of New Jersey between the coastline and 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 3,811 km of tracklines between central Virginia and Massachusetts in waters deeper than the 100-m depth contour out to beyond the U.S. EEZ. Both sighting platforms used a double-platform data collection procedure.

An abundance estimate of 442 (CV=1.06; Table 1) false killer whales based one sighting was 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 25x bigeye binoculars. A total of 4,445 km of tracklines was 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).

Abundance estimates of 1,182 (CV=0.63) and 609 (CV=1.08) false killer whales 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 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. It should be noted that the abundance estimate from the second vessel survey was based on a single sighting and therefore has a very high uncertainty.

Table 1. Summary of abundance estimates for the western North Atlantic false killer whale* (Pseudorca crassidens) *by 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
Jun-Aug 2011	central Virginia to lower Bay of Fundy	0	0-
Jun-Aug 2011	central Florida to central Virginia	442	1.06
Jun-Aug 2011	central Florida to lower Bay of Fundy (COMBINED)	442	1.06
Jun–Aug 2016	New Jersey to lower Bay of Fundy	1,182	0.63
Jun–Aug 2016	central Florida to New Jersey	609	1.08
Jun–Aug 2016	central Florida to lower Bay of Fundy (COMBINED)	1,791	0.56

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 false killer whales is 1,791 (CV=0.56). The minimum population estimate for false killer whales is 1,154.

Current Population Trend

False killer whales are rarely sighted during abundance surveys, and the resulting estimates of abundance are both highly variable between years and highly uncertain. The rare encounter rates limit the ability to assess or interpret trends in population size.

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 history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one half the maximum net productivity rate, and a recovery factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size is 1,154. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the western North Atlantic false killer whale stock is 12.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Total annual estimated fishery-related mortality and serious injury to this stock during 2013–2017 was presumed to be zero, as there were no reports of mortalities or serious injuries to false killer whales in the western North Atlantic.

Fishery Information

The commercial fisheries that interact, or that could potentially interact, with this stock in the Atlantic Ocean are the Category I Atlantic Highly Migratory Species longline and Atlantic Ocean, Caribbean, Gulf of Mexico large pelagics longline fisheries (Appendix III). Percent observer coverage (percentage of sets observed) for these longline fisheries for each year during 2013–2017 was 9, 10, 12, 15, and 12, respectively.

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

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. There were no observed mortalities or serious injuries to false killer whales by this fishery in the Atlantic Ocean during 2013–2017 (Garrison and Stokes 2014; 2016; 2017; 2019; 2020).

Other Mortality

There was one reported stranding of a false killer whale in the U.S. Atlantic Ocean during 2013–2017 (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 13 June 2018 (SER) and 8 June 2018 (NER)). This stranding occurred off Florida in 2013, and it could not be determined if there was evidence of human interaction. Historically, there have been intermittent false killer whale strandings. From 1990 through 2012, the following seven false killer whale strandings occurred: one animal in 2009 and one in 2002 in North Carolina; two in Florida in 1997; one in Massachusetts in 1997; one in Georgia in 1996; and one in Florida in 1995. Stranding data probably 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). 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

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.

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), but research on contaminant levels for this stock is lacking.

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

False killer 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 no fishery-related mortality or serious injury has been observed in the last five years, there was a recorded interaction with the pelagic longline fishery in 2011. False killer whale interactions with longline fisheries in the Pacific are of considerable concern, but little is known about interactions in the Atlantic. Thus, insufficient information is available to determine whether the total fishery-related mortality and serious injury for this stock is insignificant and approaching a zero mortality and serious injury rate. The status of false killer whales in the U.S. EEZ relative to OSP is unknown. There are insufficient data to determine population trends for this stock.

REFERENCES CITED

Baird, R.W., D.L. Webster, J.M. Aschettino, G.S. Schorr and D.J. McSweeney 2013. Odontocete cetaceans around the main Hawaiian Islands: Habitat use and relative abundance from small-boat sighting surveys. Aquat. Mamm. 39(3):253–269.

Barlow, J., S.L. Swartz, T.C. Eagle and P.R. Wade 1995. U.S. marine mammal stock assessment: guidelines for preparation, background, and a summary of the 1995 assessments. NOAA Tech. Memo. NMFS-OPR-6. 73 pp. Available from: https://repository.library.noaa.gov/view/noaa/6219

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., M.C. Caldwell and C.M. Walker, Jr. 1970. Mass and individual strandings of false killer whales, *Pseudorca crassidens*, in Florida. J. Mamm. 51:634–636.

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.

Chivers, S.J., R.W. Baird, D.J. McSweeney, D.L. Webster, N.M. Hedrick and J.C. Salinas. 2007. Genetic variation and evidence for population structure in eastern North Pacific false killer whales (*Pseudorca crassidens*). Can. J. Zool. 85:783–794.

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. Stokes 2013. Estimated bycatch of marine mammals and turtles in the U.S. Atlantic pelagic longline fleet during 2013. NOAA Tech. Memo. NMFS-SEFSC-655, 62 pp.

Garrison, L.P. and L. Stokes. 2014. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2013. NOAA Tech. Memo. NMFS-SEFSC-667. 61 pp. Available from: https://repository.library.noaa.gov/view/noaa/4932

Garrison, L.P. and L. Stokes. 2016. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2014. NOAA Tech. Memo. NMFS-SEFSC-696. 62 pp. Available from: https://repository.library.noaa.gov/view/noaa/14390

Garrison, L.P. and L. Stokes. 2017. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2015. NOAA Tech. Memo. NMFS-SEFSC-709. 61 pp.

Garrison, L.P. and L. Stokes. 2019. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2016. Southeast Fisheries Science Center, Protected Resources and Biodiversity Division, 75 Virginia Beach Dr., Miami, FL 33140. PRBD Contribution # PRBD-2019-01. 62 pp.

Garrison, L.P. and L. Stokes. 2020. Estimated bycatch of marine mammals and sea turtles in the U.S. Atlantic pelagic longline fleet during 2017. PRD Contribution. #PRDB-2020-05. 61 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.

Jefferson, T.A., M.A. Webber and R.L. Pitman 2008. Marine mammals of the world. Academic Press, London. 573 pp.

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. Pages 108–189 *in*: S. T. Buckland, D. R. Andersen, K. P. Burnham, J. L. Laake and L. Thomas (eds.), Advanced distance sampling, Oxford University Press, New York.

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.

Martien, K.K., S.J. Chivers, R.W. Baird, F.I. Archer, A.M. Gorgone, B.L. Hancock-Hanser, D. Mattila, D.J. McSweeney, E.M. Oleson, C. Palmer, V.L. Pease, K.M. Robertson, G.S. Schorr, M.B. Schultz, D.L. Webster and B.L. Taylor. 2014. Nuclear and mitochondrial patterns of population structure in North Pacific false killer whales (*Pseudorca crassidens*). J. Heredity 105:611–626.

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.

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. Available from: https://repository.library.noaa.gov/view/noaa/17892

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. Available at: 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. 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.

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.

Schmidly, D.J. 1981. Marine mammals of the Southeastern United States coast and Gulf of Mexico. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-80/41. 163 pp.

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.

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. Available from: 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. Available from: 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.