Revised 6/1/2018

SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Hawaii Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Short-finned pilot whales are found in all oceans, primarily in tropical and warm-temperate waters. They are commonly observed around the main Hawaiian Islands and are also present around the Northwestern Hawaiian Islands (Shallenberger 1981, Baird *et al.* 2013, Bradford et al 2013). Summer/fall shipboard surveys of the waters within the U.S. Exclusive Economic Zone (EEZ) of the Hawaiian Islands resulted in 25 sightings in 2002 and 36 in 2010, including a higher frequency of encounters near shore within the Northwestern Hawaiian Islands (Figure 1; Barlow 2006, Bradford *et al.* 2017). Twenty-three strandings of short-finned pilot whales have been documented from the Hawaiian Islands since 1957, including five mass strandings in May and October of 1958 and 1959 (Tomich 1986; Nitta 1991; Maldini *et al.* 2005, NMFS-PIR Marine Mammal Response Network database). There have been four strandings since 2007.

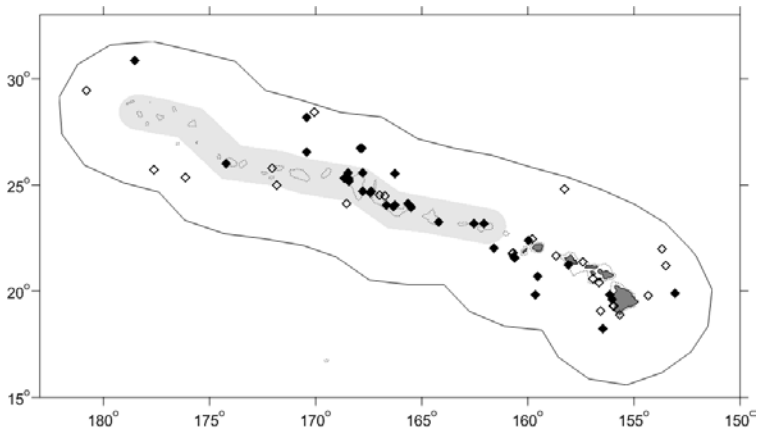

Figure 1. Short-finned pilot whale sighting locations during the 2002 (open diamonds) and 2010 (black diamonds) shipboard surveys of U.S. EEZ waters surrounding the Hawaiian Islands (Barlow 2006, Bradford et al 2017); see Appendix 2 for details on timing and location of survey effort). Outer solid line represents approximate boundary of survey area and U.S. EEZ. Gray shading indicates area of Papahanaumokuakea Marine National Monument. Dotted line represents the 1000 m isobath.

Two forms of short-finned pilot whales have been identified in Japanese waters based on pigmentation patterns and differences in the shape of the heads of adult males (Kasuya *et al.* 1988). The pilot whales in Hawaiian waters are similar morphologically to the Japanese "southern form" or naisa morphotype. Recent genetic analyses confirm that short-finned pilot whales in Hawaiian waters are genetically similar to this naisa morphotype and that they may be differentiated using mtDNA markers from those animals in the eastern tropical Pacific and temperate Pacific waters (Van Cise *et al.* 2015).

Photo-identification and telemetry studies suggest there may be inshore and pelagic populations of short-finned pilot whales in Hawaiian waters. Resighting and social network analyses of individuals photographed off Hawaii Island suggest the occurrence of one large and several smaller social clusters that use those waters, with some individuals within the smaller social clusters commonly resighted off Hawaii Island (Mahaffy *et al.* 2015). Further, two groups of 14 individuals have been seen at Hawaii and elsewhere in the main Hawaiian Islands, one off Oahu and the other off Kauai. Satellite telemetry data from over 60 individuals tagged throughout the main Hawaiian Islands also support the occurrence of at least two populations (Baird 2016, Oleson et al 2013). An assessment of foraging hotspots off Hawaii Island revealed tight association between satellite-tagged short-finned pilot whales and the 1000-2500m depth range (Abecassis *et al.* 2015). More recently, Van Cise *et al.* (2017) used nuclear SNPs to assess population structure within Hawaii short-finned pilot whales and found evidence for an island-associated population in the main Hawaii Islands (MHI). Although there was some support for separation of short-finned pilot whales in the northwestern Hawaiian Islands (NWHI) from other pelagic animals, additional genetic samples may be required to test this separation further. In addition, genetic data combined with social affiliation and habitat associations suggest the MHI population is further divided into social groups, and these groups may even rise to the level of demographic-independence between those found primarily near Hawaii Island and those near Oahu and Kauai (Van Cise *et al.* 2017). Delineation of island-associated stocks in Hawaii is under review.

Fishery interactions with short-finned pilot whales demonstrate that this species also occurs in U.S. EEZ waters of Palmyra Atoll and Johnston Atoll, but it is not known whether these animals are part of the Hawaii stock or

whether they represent separate stocks of short-finned pilot whales. For the Marine Mammal Protection Act (MMPA) stock assessment reports, short-finned pilot whales within the Pacific U.S. EEZ are divided into two discrete, non-contiguous areas: 1) Hawaiian waters (this report), and 2) waters off California, Oregon and Washington. The Hawaii stock includes animals found both within the Hawaiian Islands EEZ and in adjacent high seas waters. The status of the Hawaii stock is evaluated based on abundance, distribution, and human-caused impacts within the Hawaiian Islands EEZ, as such datasets are largely lacking for high seas waters (NMFS 2005).

POPULATION SIZE

Encounter data from a 2010 shipboard line-transect survey of the entire Hawaiian Islands EEZ was recently evaluated using Beaufort sea-state-specific trackline detection probabilities for short-finned pilot whales, resulting in an abundance estimate of 19,503 (CV = 0.49) short-finned pilot whales (Bradford *et al.* 2017) in the Hawaii stock. A 2002 shipboard line-transect survey of the same area resulted in an abundance estimate of 8,846 (CV=0.49) short-finned pilot whales (Barlow 2006). Species abundances estimated from the 2002 HICEAS survey used pooled small dolphin, large dolphin, and large whale g(0) (the probability of sighting and recording an animal directly on the track line) estimates stratified by group size (Barlow 1995). Since then, Barlow (2015) developed a more robust method for estimating species-specific g(0) values that are adjusted for the Beaufort sea states that are encountered during a survey. This new method was used for analyzing the data from the 2010 survey, but has not yet been used to analyze the 2002 data.

Minimum Population Estimate

The minimum population size is calculated as the lower 20th percentile of the log-normal distribution (Barlow *et al.* 1995) of the 2010 abundance estimate for the Hawaiian Islands EEZ or 13,197 short-finned pilot whales.

Current Population Trend

Abundance analyses of the 2002 and 2010 datasets used different g(0) values. The 2002 survey data have not been reanalyzed using this method. This change precludes evaluation of population trends at this time. Assessment of population trend will likely require additional survey data and reanalysis of all datasets using comparable methods.

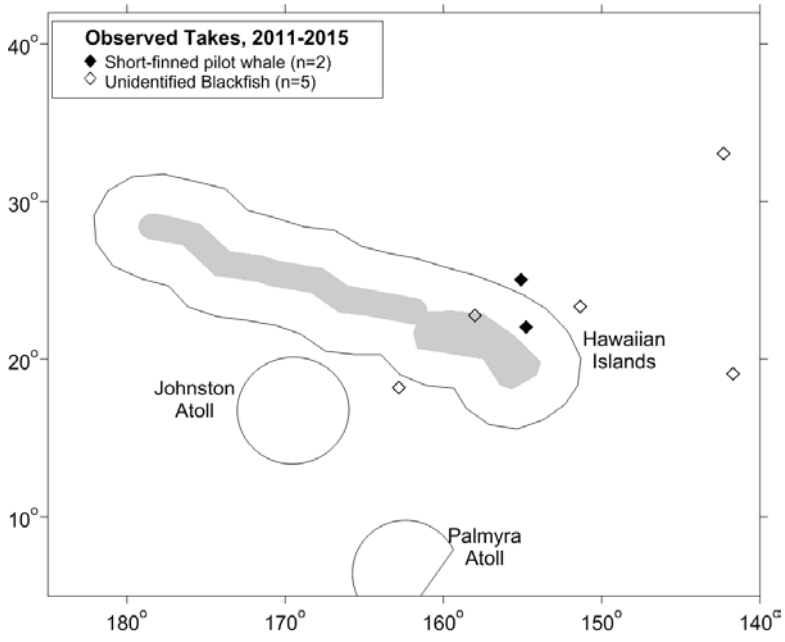

Figure 2. Locations of short-finned pilot whale takes (filled diamonds) and possible takes of this species (open diamonds) in Hawaii-based longline fisheries, 2011-2015. Some take locations overlap. Solid lines represent the U. S. EEZ. Gray shading notes areas closed to longline fishing. Fishery descriptions are provided in Appendix 1.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Hawaii short-finned pilot whale stock is calculated as the minimum population estimate (13,197) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.40 (for a species of unknown status with a Hawaiian Islands EEZ fishery mortality and serious injury rate CV> 0.80; Wade and Angliss 1997), resulting in a PBR of 106 short-finned pilot whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Information on fishery-related mortality of cetaceans in Hawaiian waters is limited, but the gear types used in Hawaiian fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Entanglement in gillnets and hooking or entanglement in various hook and line fisheries have been reported for small cetaceans in Hawaii (Nitta & Henderson, 1993). Short-finned pilot whales have been observed with fishing gear trailing from their mouths, though the specific gear types have not been identified (Baird 2016). In 2014, a short-finned pilot whale was found stranded on Oahu with large amounts of debris in its stomach, including approximately 20 lbs. of fishing line, nets, and plastic drogues (Bradford and Lyman in review). The necropsy team judged that the whale had not eaten in at least 24 hrs, but it was not clear what role the debris played in the whale's death. No estimates of human-caused mortality or serious injury are currently available for nearshore hook and line or gillnet fisheries because these fisheries are not observed or monitored for protected species bycatch.

Table 1. Summary of available information on incidental mortality and serious injury of short-finned pilot whales (Hawaii stock) and including those presumed to be short-finned pilot whales based on assignment of unidentified blackfish to this species in commercial longline fisheries, within and outside of the U.S. EEZs (McCracken 2017). Mean annual takes are based on 2011-2015 data unless otherwise indicated. Information on all observed takes (T) and combined mortality events & serious injuries (MSI) is included. Total takes were prorated to deaths, serious injuries, and non-serious injuries based on the observed proportions of each outcome. Unidentified blackfish are pro-rated as either false killer whales or short-finned pilot whales according to their distance from shore (McCracken 2010). CVs are estimated based on the combination of annual short-finned pilot whale and blackfish variances and do not yet incorporate additional uncertainty introduced by prorating the unidentified blackfish.

				Observed total interactions (T) and mortality events, and serious injuries (MSI), and total estimated mortality and serious injury (M&SI) of short-finned pilot whales (GM)			
				Outside U.S. EEZs		**Hawaiian EEZ**	
Fishery Name	**Year**	**Data Type**	**Percent Observer Coverage**	**Obs. GM T/MSI** **Obs. UB T/MSI**	**Estimated M&SI (CV)**	**Obs. GM T/MSI** **Obs. UB T/MSI**	**Estimated M&SI (CV)**
Hawaii-based deep-set longline fishery	2011	Observer data	20%	0 1/0	1.6 (1.1)	0 1/1	0.1 (0.9)
	2012		20%	0 1/1	0.6 (0.8)	0 0	0 (-)
	2013		20%	1/1 0	4.1(0.9)	0 0	0 (-)
	2014		21%	0 0	0 (-)	0 0	0 (-)
	2015		21%	0 1/1[†]	0.7 (0.9)	1/1 0	4.3 (0.9)
Mean Estimated Annual Take (CV)					**1.4 (1.5)**		**0.9 (1.2)**
Hawaii-based shallow-set longline fishery	2011	Observer data	100%	0 1/1	0.3	0 0	0
	2012		100%	0 0	0	0 0	0
	2013		100%	0 0	0	0 0	0
	2014		100%	0 0	0	0 0	0
	2015		100%	0 0	0	0 0	0
Mean Annual Takes (100% coverage)					**0.1**		**0**
Minimum total annual takes within U.S. EEZ							**0.9 (1.2)**

[†] Injury status could not be determined based on information collected by the observer. Injury status is prorated (see text).

There are currently two distinct longline fisheries based in Hawaii: a deep-set longline (DSLL) fishery that targets primarily tunas, and a shallow-set longline fishery (SSLL) that targets swordfish. Both fisheries operate within

U.S. waters and on the high seas, but are prohibited from operating within the Papahanaumokuakea Marine National Monument, a region that extends 50 nmi from shore around the Northwestern Hawaiian Islands, and within the Longline Exclusion Area, a region extending 25-75 nmi from shore around the main Hawaiian Islands. Between 2011 and 2015, no short-finned pilot whales were observed hooked or entangled in the SSLL fishery (100% observer coverage), and two short-finned pilot whales were observed taken in the DSLL fishery (20-21% observer coverage) (Bradford 2017, Bradford and Forney 2017, McCracken 2017), one in high-seas waters and the other inside the Hawaiian Islands EEZ. Based on an evaluation of the observer's description of the interaction and following the most recently developed criteria for assessing serious injury in marine mammals (NMFS 2012), one short-finned pilot whales was observed dead and the other was considered seriously injured ((Bradford 2017, Bradford and Forney 2017). Five additional unidentified "blackfish" (unidentified cetaceans known to be either false killer whales or short-finned pilot whales) were taken during 2011-2015 (Bradford 2017, Bradford and Forney 2017), one within the SSLL fishery and four in the DSLL fishery. The single SSLL interaction occurred outside the Hawaiian EEZ and the animal was considered seriously injured. Of the four DSLL interactions, one occurred inside the Hawaii EEZ and was considered seriously injured, and three occurred outside the Hawaii EEZ, with one considered seriously injured, one considered not seriously injured, and one whose injury status could not be determined based on the information provided by the observer. Unidentified blackfish are prorated to each stock based on distance from shore (McCracken 2010). The distance-from-shore model was chosen following consultation with the Pacific Scientific Review Group, based on the model's performance and simplicity relative to a number of other more complicated models with similar output (McCracken 2010). Proration of unidentified blackfish takes introduces unquantified uncertainty into the bycatch estimates, but until all animals taken can be identified to species (e.g., photos, tissue samples), this approach ensures that potential impacts to all stocks are assessed. Average 5-yr estimates of annual mortality and serious injury for 2011-2015 are 1.5 (CV = 1.5) short-finned pilot whales outside of U.S. EEZs and 0.9 (CV = 1.2) within the Hawaiian Islands EEZ. Four additional unidentified cetaceans were taken in the DSLL fishery, and one unidentified cetacean was taken in the SSLL fishery, some of which may have been short-finned pilot whales.

STATUS OF STOCK

The Hawaii stock of short-finned pilot whales is not considered strategic under the 1994 amendments to the MMPA. The status of short-finned pilot whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Short-finned pilot whales are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor designated as "depleted" under the MMPA. The estimated rate of mortality and serious injury within the Hawaiian Islands EEZ (0.9 animals per year) is less than the PBR (106). Based on the available data, which indicate total fishery-related takes are less than 10% of PBR, the total fishery mortality and serious injury for short-finned pilot whales can be considered to be insignificant and approaching zero.

REFERENCES

Abecassis, M., J. Polovina, R.W. Baird, A. Copeland, J.C. Drazen, R. Domokos, E.M. Oleson, Y. Jia, G.S. Schorr, D.L. Webster, D. Andrews. 2015. Characterizing a foraging hotspot for short-finned pilot whales and Blainville's beaked whales located off the west side of Hawaii Island by using tagging and oceanographic data. PLoS ONE 10(11): e0142628, doi:10.137/journal.pone.0142628.

Baird, R.W. 2016. The lives of Hawaii's whales and dolphins: natural history and conservation. University of Hawaii Press, Honolulu, HI.

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. Aquatic Mammals, in press.Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Marine Mammal Science 22: 446–464.

Barlow 1995. The abundance of cetaceans in California waters.Part I: ship surveys in summer and fall of 1991. Fish.Bull. 93:1–14.

Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. Marine Mammal Science 22: 446–464.

Barlow 2015. Inferring trackline detection probabilities, g(0), for cetaceans from apparent densities in different survey conditions. Mar. Mamm. Sci. 31:923–943.

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. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 p.

Bradford, A.L. 2017. Injury Determinations for Marine Mammals Observed Interacting with Hawaii and American

Samoa Longline Fisheries During 2015–2016. NOAA Tech Memo NMFS-PIFSC-xxx.
Bradford, A.L. and K.A. Forney. 2017. Injury determinations for cetaceans observed interacting with Hawaii and American Samoa longline fisheries during 2010-2014. NOAA-TM-NMFS-PIFSC-62, doi:10.7289/V5/TM-PIFSC-62
Bradford, A.L., K.A. Forney, J. E.M. Oleson, J. Barlow. 2017. Abundance estimates of cetaceans from a line-transect survey within the U.S Hawaiian Islands Exclusive Economic Zone. Fishery Bulletin 115: 129-142.
Bradford, A.L. and E. Lyman. In review. Injury determinations for humpback whales and other cetaceans reported to the Hawaiian Islands Disentanglement and Pacific Islands Marine Mammal Response Networks during 2013-2015. PIFSC Working Paper WP-xxx.
Kasuya, T., T. Miyashita, and F. Kasamatsu. 1988. Segregation of two forms of short-finned pilot whales off the Pacific coast of Japan. Sci. Rep. Whales Res. Inst. 39:77-90.
Kobayashi, D. R. and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fisheries Research 23: 11-22.
Mahaffy, S.D., R.W. Baird, D.J. McSweeney, D.L. Webster, G.S. Schorr. 2015. High site fidelity, strong associations, and long-term bonds: short-finned pilot whales off the island of Hawaii. Marine Mammal Science, doi: 10.1111/mms.12234.
Maldini, D., L. Mazzuca, and S. Atkinson. 2005. Odontocete stranding patterns in the Main Hawaiian Islands (1937-2002): How do they compare with live animal surveys? Pacific Science 59(1):55-67.
McCracken, M.L. 2010. Adjustments to false killer whale and short-finned pilot whale bycatch estimates. NMFS, Pacific Islands Fisheries Science Center Working paper WP-10-007, 23p.
McCracken, M. 2017. Preliminary assessment of incidental interactions with marine mammals in the Hawaii longline deep and shallow set fisheries from 2011 to 2015. PIFSC Internal Report IR-17-003.
Miyashita, T. 1993. Abundance of dolphin stocks in the western North Pacific taken by the Japanese drive fishery. Rep. Int. Whal. Commn. 43:417-437.
Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In*: J.E. Reynolds III, D.K. Odell (eds.), Marine Mammal Strandings in the United States, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.
Nitta, E. and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. Mar. Fish. Rev. 55(2):83-92.
NMFS. 2005. Revisions to Guidelines for Assessing Marine Mammal Stocks. 24 pp.
NOAA. 2012. NOAA Fisheries Policy Directive 02-038-01 Process for Injury Determinations (01/27/12).
Oleson, E.M., R.W. Baird, K.K. Martien, and B.L. Taylor. 2013. Island-associated stocks of odontocetes in the main Hawaiian Islands: A synthesis of available information to facilitate evaluation of stock structure. PIFSC Working Paper WP-13-003.
Perrin, W.F., G. P. Donovan and J. Barlow. 1994. Gillnets and Cetaceans. Rep. Int. Whal. Commn., Special Issue 15, 629 pp.
Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.
Tomich, P. Q. 1986. Mammals in Hawaii: A Synopsis and Notational Bibliography. Bishop Museum Press, Hawaii, 375 pp.
Van Cise, A.M., P.A. Morin, R.W. Baird, A.R. Lang, K.M. Robertson, S.J. Chivers, R.L. Brownell, K.K. Martien. 2015. Redrawing the map: mtDNA provides new insight into the distribution and diversity of short-finned pilot whales in the Pacific Ocean. Marine Mammal Science doi:10.1111/mms.12315.
Van Cise, A.M., K.K. Martien, R.W. Baird, S.B. Mahaffy, P.A. Morin. 2017. When friends are family: nuclear SNPs reveal reciprocal influence between social structure and genetic structure in Hawaiian pilot whales. Presented to the Pacific Scientific Review Group. 13-15 February, 2017. PSRG-2017-13.
Wade, P. R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, WA. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 pp.