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# SHORT-FINNED PILOT WHALE (*Globicephala macrorhynchus*): Hawai‘i 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 sighted during shipboard surveys of the waters within the U.S. Exclusive Economic Zone (EEZ) of the Hawaiian Islands, including a high frequency of encounters nearshore within the Northwestern Hawaiian Islands (Figure 1).

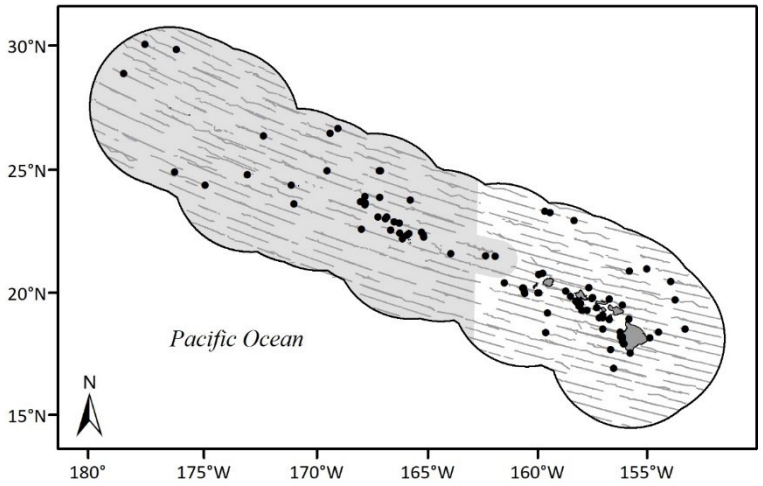


**Figure 1.** Short-finned pilot whale sighting locations (circles) and survey effort (gray lines) during the 2002 (Barlow 2006), 2010 (Bradford *et al*. 2017), and 2017 (Yano *et al.* 2018) shipboard surveys of the U.S. EEZ around the Hawaiian Islands (outer black line). The Papahānaumokuākea Marine National Monument in the western portion of the EEZ is shaded gray.

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). Genetic analysis of samples from throughout the global range of short-finned pilot whales suggest three types within the species, an Atlantic type, a western/central pacific and Indian Ocean (Naisa) type, and an eastern tropical Pacific and northern Japan (Shiho) type. Significant differentiation in mtDNA control region sequences further suggest that the three forms represent two subspecies, the Shiho short-finned pilot whale and the Naisa short-finned pilot whale, with evidence of further divergence among the Naisa types in the Atlantic and Pacific (Van Cise *et al*. 2019). Pilot whales in Hawaiian waters are of the Naisa type. The Shiho and Naisa forms appear also to be distinguishable based on the acoustic features of their whistle and burst-pulse sounds, providing further evidence for divergence between these subspecies (Van Cise *et al*. 2017b).

Photo-identification, telemetry, acoustic, and genetic studies suggest that at least two demographically-independent populations of short-finned pilot whales reside 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 Hawai‘i Island (Mahaffy *et al.* 2015). Further, two groups of 14 individuals have been seen off Hawai‘i Island and elsewhere in the main Hawaiian Islands, one off O‘ahu and the other off Kaua‘i, indicating some degree of connectivity within the main Hawaiian Islands (MHI). Satellite telemetry data from over 60 individuals tagged throughout the MHI also support the occurrence of at least two populations (Baird 2016, Oleson *et al.* 2013). An assessment of foraging hotspots off Hawai‘i Island revealed tight association between satellite-tagged short-finned pilot whales and the 1000-2500m depth range (Abecassis *et al.* 2015). Further, Van Cise *et al*. (2017a) used nuclear SNPs to assess population structure within short-finned pilot whales around the Hawaiian Archipelago and found evidence for an island-associated population in the 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 Hawai‘i Island and those near O‘ahu and Kaua‘i (Van Cise *et al.* 2017a). Differences in the acoustic features of short-finned pilot whale social clusters recorded within the MHI further supports the existence of demographically-independent populations within the MHI (Van Cise *et al*. 2017b). Formal assessment of demographic-independence has not been completed, but division of this population into one or more island-associated stocks may be warranted in the future.

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 Hawai‘i stock includes animals found both within the Hawaiian Islands EEZ and in adjacent high seas waters; however, because data on abundance, distribution, and human-caused impacts are largely lacking for high seas waters, the status of this stock is evaluated based on data from the U.S. EEZ around the Hawaiian Islands (NMFS 2005).

**POPULATION SIZE**

Encounter data from shipboard line-transect surveys of the Hawaiian Islands EEZ were recently reevaluated, resulting in updated model-based abundance estimates of short-finned pilot whales in the entirety of the Hawaiian Islands EEZ (Becker *et al*. 2021, 2022; Table 1).

**Table 1.** Model-based line-transect abundance estimates for short-finned pilot whales in the Hawaiian Islands EEZ in 2002 and 2010 (Becker *et al.* 2021) and 2017 and 2020 (Becker *et al*. 2022), derived from NMFS surveys in the central Pacific since 2000. The Becker *et al.* (2022) analysis incorporates a more comprehensive model-based approach to estimating model uncertainty, such that the CVs and 95% confidence limits for 2002/2010 and 2017/2020 are not directly comparable.

| Year | Model-based Abundance | CV | 95% Confidence Limits |
|---|---|---|---|
| 2020 | 19,242 | 0.23 | 12,289-30,129 |
| 2017 | 17,237 | 0.23 | 11,009-26,989 |
| 2010 | 15,343 | 0.17 | 11,039-21,326 |
| 2002 | 15,198 | 0.17 | 10,900-21,191 |

Sighting data from 2002 to 2020 within the Hawaiian Islands EEZ were used to derive habitat-based models of animal density for two periods: 2002-2017 (Becker *et al.* 2021) and 2017-2020 (Becker *et al.* 2022). The most recent set of models include three notable changes from the 2002-2017 models: use of calibrated group size estimates, as in Bradford *et al.* (2021), exclusion of a spatial term on model selection, requiring more explicit reliance on environmental variables, and incorporating new approaches (Miller *et al.* 2022) for more comprehensively estimating uncertainty in model predictions that account for the combined uncertainty around all parameter estimates. The modeling framework incorporated Beaufort-specific trackline detection probabilities for short-finned pilot whales from Barlow *et al.* (2015). Models were used to predict density and abundance for each survey year based on the environmental conditions within that year (see Forney *et al*. 2015, Becker *et al*. 2016). Bradford *et al*. (2021) produced design-based abundance estimates for short-finned pilot whales in 2002, 2010, and 2017 that can be used as a point of comparison to the model-based estimates for those years. While on average the estimates are similar between the two approaches, the annual design-based estimates show greater variability between years than do the model-based estimates (Figure 2). The model-based approach reduces variability through explicit examination of habitat relationships across the full dataset, while the design-based approach evaluates encounter data for each year separately and thus is more susceptible to the effects of encounter rate variation. Model based-estimates are based on the implicit assumption that changes in abundance are attributed to environmental variability alone. Explicitly incorporating a trend term into the model is not possible due to the insufficient sample size to test for temporal effects. Despite not fully accounting for inter-annual variation in total

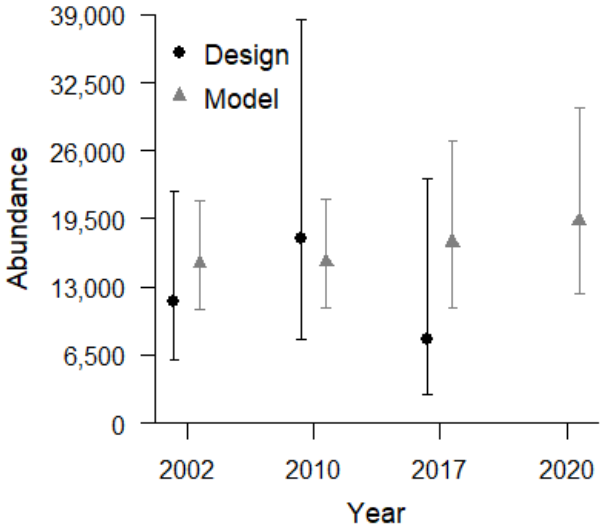


**Figure 2.** Comparison of design-based (black circles, Bradford *et al.* 2021) and model-based (gray triangles, Becker *et al*. 2021, 2022) estimates of abundance for short-finned pilot whales for each survey year (2002, 2010, 2017, 2020).

abundance, the model-based estimates are considered the best available estimate for each survey year. Becker *et al.* (2022) and Bradford *et al.* (2022) evaluated seasonal changes in the abundance of short-finned pilot whales within the main Hawaiian Islands using summer-fall data from 2017 and winter survey data from 2020. Although the model identified moderately lower densities of short-finned pilot whales in the MHI in winter, the design-based analysis showed a 7-fold increase in density during the same period, though confidence limits partly overlap for both analyses. The disparate results may demonstrate the impacts of encounter rate variation on the annual design-based estimates, though also suggest additional data will be needed to understand habitat relationships and seasonal movements of this species in Hawaiian waters. Previously published abundance estimates for the Hawaiian Islands EEZ (Barlow 2006, Becker *et al.* 2012, Forney *et al.* 2015, Bradford *et al*. 2017) used a subset of the dataset used by Becker *et al*. (2021, 2022) and Bradford *et al.* (2021) to derive line-transect parameters, such that these estimates have been superseded by the estimates presented here. The best estimate of abundance is based on the 2020 survey, or 19,242 (CV=0.23) short-finned pilot whales.

**Minimum Population Estimate**

The minimum population estimate is calculated as the lower 20th percentile of the log-normal distribution (Barlow *et al.* 1995) of the 2020 abundance estimate (from Becker *et al.* 2022) or 15,894 short-finned pilot whales.

**Current Population Trend**

The model-based abundance estimates for short-finned pilot whales provided by Becker *et al.* (2021, 2022) do not explicitly allow for examination of population trend other than that driven by environmental factors. Model-based examination of short-finned pilot whale population trends including sighting data beyond the Hawaiian Islands EEZ will be required to more fully examine trend for this stock.

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate for this species in Hawaiian waters.

## POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Hawai‘i short-finned pilot whale stock is calculated as the minimum population estimate (15,894) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for a species of unknown status with no known fishery mortality within the U.S. EEZ of the Hawaiian Islands; Wade and Angliss 1997), resulting in a PBR of 159 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 Hawai‘i (Nitta & Henderson, 1993). Short-finned pilot whales have been observed with fishing gear trailing from their mouths or have stranded with gear and other debris in their stomach, though the specific gear types have not been identified (Baird 2016, Bradford and Lyman 2018, 2019). In 2017, two short-finned pilot whales stranded together as part of a mass stranding event on Kauai. One of the whales had 12-15 lbs of nylon line and plastic present within its forestomach and the other had scarring on the upper right jaw consistent with previous fisheries interaction, though in neither case were these findings considered to be related to the cause of death (Bradford and Lyman 2019). In 2020, a short-finned pilot whale was observed off Hawai‘i Island with trailing line from its mouth, suggesting the whale was hooked in the mouth or had ingested the hook (Bradford and Lyman 2023), an injury that is considered serious according to criteria for assessing serious injury in marine mammals (NMFS 2023). 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 2.** Summary of available information on incidental mortality and serious injury (MSI) of short-finned pilot whales (GM) and including those presumed to be short-finned pilot whales based on assignment of unidentified blackfish (UB) to this species in commercial longline fisheries, within and outside of the U.S. EEZ (McCracken & Cooper 2022b). Mean annual takes are based on 2017-2021 data unless otherwise indicated. Information on all observed takes (T) and MSI is included. Total takes were prorated to deaths, serious injuries, and non-serious injuries based on the observed proportions of each outcome. UB are prorated 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.

| | | | | Outside U.S. EEZ | | Hawaiian Islands EEZ | |
|---|---|---|---|---|---|---|---|
| **Fishery Name** | **Year** | **Data Type** | **Percent Observer Coverage** | **Observed GM T/MSI**<br>**Observed UB T/MSI** | **Estimated MSI (CV)** | **Observed GM T/MSI**<br>**Observed UB T/MSI** | **Estimated MSI (CV)** |
| **Hawai'i-based deep-set longline fishery** | 2017 | Observer data | 20% | 0<br>0 | 0 (-) | 0<br>0 | 0 (-) |
| | 2018 | | 18% | 0<br>1/1 | 0.9 (0.8) | 0<br>0 | 0 (-) |
| | 2019 | | 21% | 0<br>1/0 | 0.4 (1.1) | 0 | 0 (-) |
| | 2020 | | 15% | 0<br>0 | 0 | 0 | 0 (-) |
| | 2021 | | 18% | 0<br>1/1 | 5.4 (1.0) | 0<br>0 | 0 (-) |
| **Mean Estimated Annual Take (CV) 2017-2021** | | | | | **1.3 (1.6)** | | **0** |
| **Hawai'i-based shallow-set longline fishery** | 2017 | | 100% | 0<br>0 | 0 | 0<br>0 | 0 |
| | 2018 | | 100% | 0<br>0 | 0 | 0<br>0 | 0 |
| | 2019 | | 100% | 0<br>0 | 0 | 0 | 0 |
| | 2020 | | 100% | 0<br>0 | 0 | 0 | 0 |
| | 2021 | | 100% | 0<br>0 | 0 | 0 | 0 |
| **Mean Annual Takes (100% coverage) 2017-2021** | | | | 0 | 0 | 0 | 0 |
| **Minimum total annual takes within U.S. EEZ (2017-2021)** | | | | | | | **0** |

There are currently two distinct longline fisheries based in Hawai'i: 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 Papahānaumokuākea Marine National Monument (PMNM) and within the Longline Exclusion Zone around the MHI and the Pacific Remote Islands and Atolls (PRIA) MNM around Johnston Atoll. The PMNM originally included the waters within a 50 nmi radius around the NWHI. In August, 2016, the PMNM area was expanded to extend to the 200 nmi EEZ boundary west of 163° W. Between 2017-2021, no short-finned pilot whales were observed hooked or entangled in the SSLL fishery (100% observer coverage), and one was observed taken in the DSLL fishery (15-21% observer coverage) (Figure 3, McCracken and Cooper, 2022b), outside 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 2023), this short-finned pilot whale was considered seriously injured. Two additional unidentified "blackfish" (unidentified cetaceans known to be either false killer whales or short-finned pilot whales) were taken during 2017-2021, McCraken and Cooper, 2022b), both within the DSLL fishery. Both of the blackfish interactions occurred outside the Hawaiian Islands EEZ, with one considered seriously injured and one considered non-seriously

injured. Takes of unidentified blackfish are prorated to false killer whale and short-finned pilot whale based on distance from shore (McCracken 2010), given patterns of previous bycatch for each species. 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.

The total estimated number of dead or seriously injured dolphins is calculated based on observer coverage rate, the location of the observed take (inside or outside of the EEZ), and the ratio of observed dead and seriously injured whales versus those judged to be not seriously injured. Observer coverage is measured on a per-trip basis throughout the calendar year as described by McCracken (2019). In years with large fluctuations in observer coverage, such as during the early days of the COVID-19 pandemic when observer coverage dropped to less than 10% during the second quarter of the year, the annual bycatch estimation process may be subset into several periods, as described in McCracken & Cooper (2022a). Average 5-yr estimates of annual mortality and serious injury for 2017-2021 are 1.3 (CV=1.6) short-finned pilot whales outside of the U.S. EEZ, and 0 within the Hawaiian Islands EEZ (Table 2, McCracken and Cooper 2002b). Two additional unidentified cetaceans, likely to be blackfish based on the observer's description, were taken in the DSLL fishery and may have been short-finned pilot whales.

**STATUS OF STOCK**

The Hawai'i 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. In the past 5 years, one short-finned pilot whale was observed in nearshore waters seriously injured by fishing gear, although the source of the gear is unknown (Bradford and Lyman 2023). There is no systematic monitoring for interactions with protected species within near-shore fisheries that may take this species, thus total mean annual takes (0.2 yr) are undetermined. Given the absence of recent recorded longline fishery-related mortality or serious injuries and low levels of nearshore fisheries interactions within the U.S. EEZ, the total fishery mortality and serious injury for short-finned pilot whales can be considered to be insignificant and approaching zero. Two short-finned pilot whales were found stranded in separate incidents following Navy sonar training exercises in Hawai'i in 2014 (Bradford and Lyman 2018). Examination of the whales could not conclusively link these stranding to use of sonar, though other blackfish have shown sensitivity to sonar training events in Hawaiian waters (Southall *et al*. 2006) and elsewhere (Brownell *et al*. 2009). Two of five short-finned pilot whales that died in a mass stranding on Kauai in 2017 had tissues infected with beaked whale circovirus (Clifton *et al.* 2023), which can lead to serious illness and immunosuppression, though it is not clear what effect that infection had in these strandings.

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