Revised 5/5/2021

FIN WHALE (*Balaenoptera physalus velifera*): Hawaii Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Fin whales are found from temperate to subpolar ocean around the world, with a distributional hiatus between the Northern and Southern Hemispheres between 20° and 30° on either side of the equator (Edwards *et al*. 2015). In the North Pacific fin whales tend to occur in temperate to sub-polar latitudes (Mizroch *et al*. 1984, 2009). North Pacific fin whales are genetically distinct from those in the North Atlantic and Southern Hemisphere (Archer *et al*. 2013). Archer *et al*. (2019a) used mitochondrial DNA and single-nucleotide polymorphisms (SNPs) to demonstrate that North Atlantic and North Pacific genetic samples could be correctly assigned to their respective ocean basins with 99% accuracy. North Pacific fin whales are recognized as a separate subspecies: *Balaenoptera physalus velifera*. Fin whales are considered rare in Hawaiian waters, though occasional sightings have been reported. Balcomb (1987) observed 8-12 fin whales in a multispecies feeding assemblage on 20 May 1966 approx. 250 mi. south of Honolulu. Additional sightings were reported north of Oahu in May 1976, in the Kauai Channel in February 1979 (Shallenberger 1981), north of Kauai in February 1994 (Mobley *et al.* 1996), and off Lanai in 2012 (Baird 2016). Summer/fall shipboard surveys of the waters within the U.S. Exclusive Economic Zone (EEZ) of the Hawaiian Islands resulted in five sightings in 2002, two sightings in 2010, and two sightings in 2017 (Figure 1; Barlow 2006, Bradford *et al*. 2017, Yano *et al.* 2018). Oleson *et al*. (2014) reported fin whale song recorded near Hawaii Island from October through April, and noted the occurrence of a predominant song pattern similar to that recorded off southern California and in the Bering Sea, suggesting a broadly connected population throughout that range. Further examination of the spectral features of individual fin whale song notes and the inter-note timing within fin whale song throughout the Pacific indicates a broad diversity of song types, with songs recorded in Hawaii being distinctly different than those heard at the other eastern and central Pacific monitoring sites or in arctic waters (Archer *et al*. 2019b)

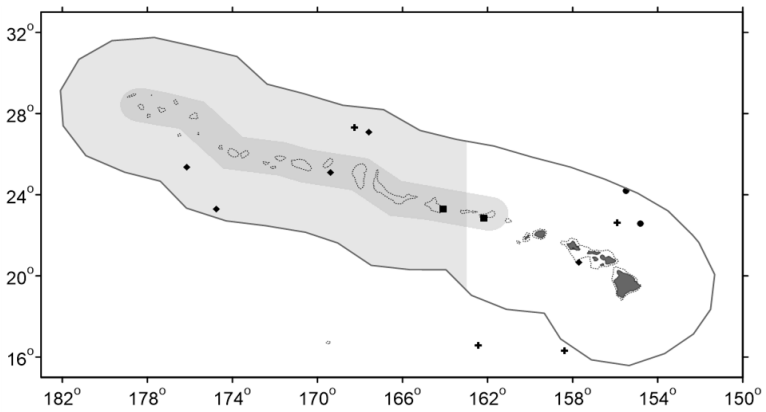

Figure 1. Locations of fin whale sightings from longline observer records (crosses; NMFS/PIR, unpublished data) and sighting locations during the 2002 (diamonds), 2010 (circle), and 2017 (square) shipboard surveys of U.S. EEZ waters surrounding the Hawaiian Islands (Barlow 2006, Bradford *et al.* 2017, Yano *et al.* 2018). Outer line represents approximate boundary of survey area and U.S. EEZ. Dark gray shading indicates of the original Papahanaumokuakea Marine National Monument, with the lighter gray shading denoting the full 2016 Expansion area. Dotted line represents the 1000 m isobath.

The International Whaling Commission (IWC) recognized two stocks of fin whales in the North Pacific: the East China Sea and the rest of the North Pacific (Donovan 1991). Mizroch *et al.* (1984) cite evidence for additional fin whale subpopulations in the North Pacific, and acoustic evidence provides additional support for finer population structure (Archer *et al*. 2019b). There is still insufficient information to accurately determine population structure, but from a conservation perspective it may be risky to assume panmixia in the entire North Pacific. In the North Atlantic, fin whales were locally depleted in some feeding areas by commercial whaling (Mizroch *et al.* 1984), in part because subpopulations were not recognized. The Marine Mammal Protection Act (MMPA) stock assessment reports recognize three stocks of fin whales in the North Pacific: 1) the Hawaii stock (this report), 2) the California/Oregon/Washington stock, and 3) the Alaska stock. The Hawaiian 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 U.S. EEZ waters of the Hawaiian Islands (NMFS 2005).

POPULATION SIZE

Encounter data from summer/fall shipboard line-transect surveys of the entire Hawaiian Islands EEZ were recently reevaluated for each survey year, resulting in the following abundance estimates of fin whales in the Hawaii EEZ (Bradford *et al.* 2021; Table 1).

Table 1. Line-transect abundance estimates for fin whales derived from surveys of the entire Hawaii EEZ in 2002, 2010, and 2017 (Bradford *et al.* 2021).

Year	Abundance	CV	95% Confidence Limits
2017	203	0.99	40-1,028
2010	158	1.07	29-871
2002	509	0.73	141-1,842

The updated design-based abundance estimates use sighting data from throughout the central Pacific to estimate the detection function and use Beaufort sea-state-specific trackline detection probabilities for fin whales from Barlow *et al.* (2015). Although previous estimates from the Hawaii EEZ have been published using subsets of this data, Bradford *et al.* (2021), uses a consistent approach for estimating all abundance parameters and resulting estimates are considered the best available for the summer/fall period. Winter surveys have not been carried out in the Hawaiian Archipelago and it is likely that winter abundance of this migratory species within the Hawaiian EEZ is not accurately reflected by the summer/fall estimates. The best estimate of abundance is 203 (CV=0.99) fin whales based on a 2017 survey (Bradford *et al.* 2021). Using passive acoustic detections from a hydrophone north of Oahu, MacDonald and Fox (1999) estimated an average density of 0.027 calling fin whales per 1000 km^2 within about 16 km from shore. However, the relationship between the number of whales present and the number of calls detected is not known, and therefore this acoustic method does not provide an estimate of absolute abundance for fin whales.

Minimum Population Estimate

The minimum population size is calculated as the lower 20th percentile of the log-normal distribution (Barlow *et al*. 1995) around the 2017 abundance estimate or 101 fin whales within the Hawaiian Islands EEZ during the summer/fall survey period.

Current Population Trend

Trend information for this stock cannot be assessed from summer/fall abundance surveys alone, as the species is not expected to reside in Hawaiian waters in large numbers during that period. Winter surveys or alternative observations (e.g. acoustic studies) will be required to assess the trend for fin whales in Hawaiian waters.

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 stock of fin whales is calculated as the minimum population size within the U.S EEZ of the Hawaiian Islands (101) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (the default value for an endangered species with Nmin <1500; Taylor *et al*. 2003), resulting in a PBR of 0.2 fin whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

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. Between 2014 and 2018, one fin whale was observed entangled in the SSLL fishery (100% observer coverage), and none were observed in the DSLL fishery (18-22% observer coverage) (Bradford 2018a, 2018b, 2020, Bradford & Forney 2017, McCracken 2019). The SSLL entanglement occurred outside of the Hawaiian Islands EEZ and the whale was judged to be not seriously injured (Bradford and Forney 2017). The 5-yr annual mortality and serious injury estimate for fin whales is 0 both inside and outside the Hawaiian Islands EEZ (McCracken 2019). Two additional unidentified cetaceans judged to be large whales based on the observer's

description were taken in the DSLL, and some of these may have been fin whales.

Historical Mortality

Large numbers of fin whales were taken by commercial whalers throughout the North Pacific from the early 20th century until the 1970s (Tønnessen and Johnsen 1982). Approximately 46,000 fin whales were taken from the North Pacific by commercial whalers between 1947 and 1987 (C. Allison, IWC, pers. comm.). Some of the whales taken may have been from a population or populations that migrate seasonally into the Hawaiian EEZ. The species has been protected in the North Pacific by the IWC since 1976.

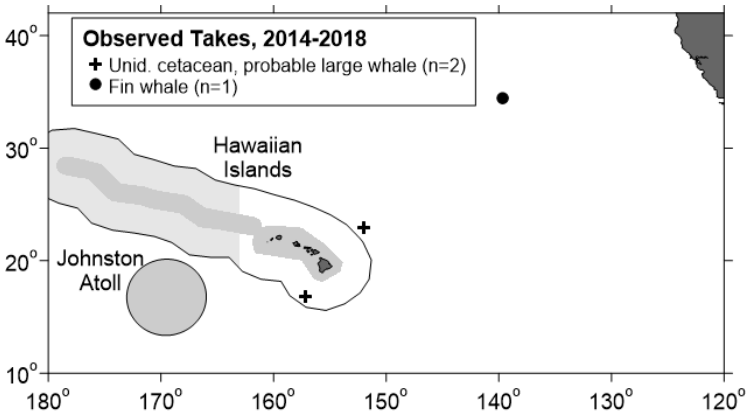

Figure 2. Location of observed fin whale take within the shallow-set fishery (circle), and unidentified cetaceans considered to be large whales based on the observer's description (crosses) in the deep-set fishery, 2014-2018. Solid lines represent the U. S. EEZ. Gray shading notes areas closed to commercial fishing, with the PMNM Expansion area closed since August 2016.

STATUS OF STOCK

The status of fin whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Fin whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the Hawaiian stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. Because there have been no reported fishery related mortality or serious injuries within the Hawaiian Islands EEZ, the total fishery-related mortality and serious injury of this stock can be considered to be insignificant and approaching zero. Increasing levels of anthropogenic sound in the world's oceans has been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound (Croll *et al.* 2002). Behavioral changes associated with exposure to simulated mid-frequency sonar, including no change in behavior, cessation of feeding, increased swimming speeds, and movement away from simulated sound sources has been documented in tagged blue whales (Goldbogen *et al.* 2013), but it is unknown if fin whales respond in the same manner to such sounds.

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