6/5/2023 (New SAR)

HUMPBACK WHALE (*Megaptera novaeangliae kuzira*) - Hawai‘i Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

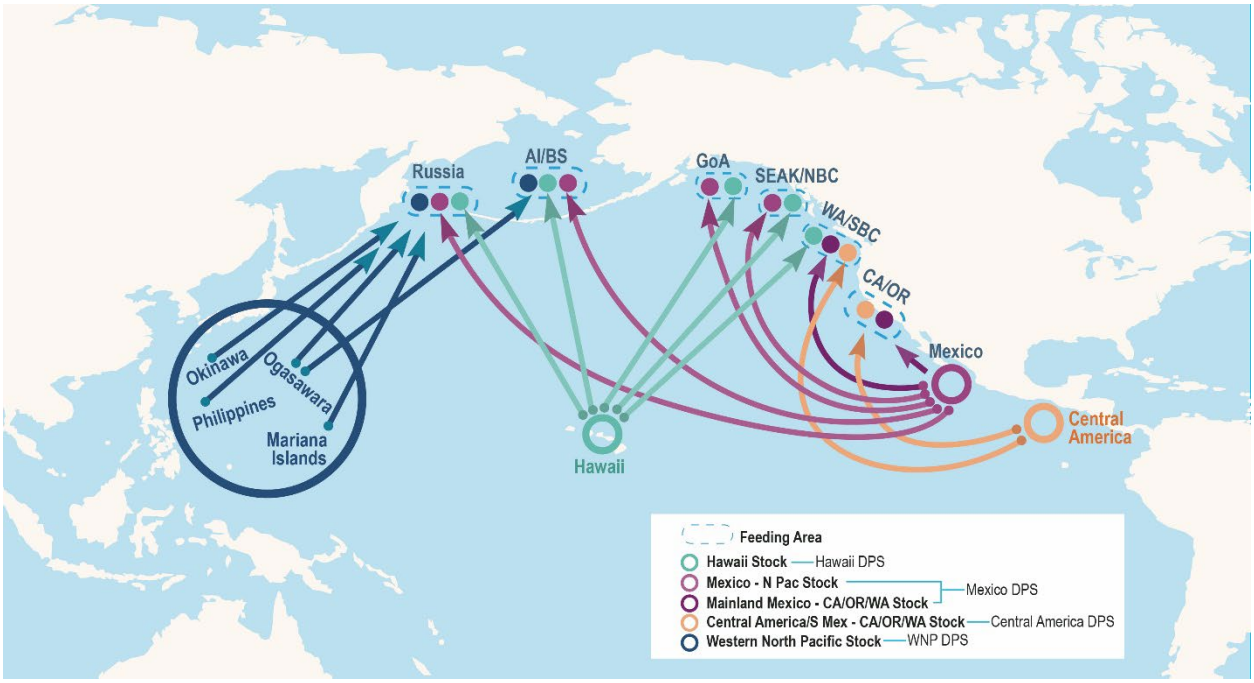

Figure 1. Pacific basin map showing wintering areas of five humpback whale stocks mentioned in this report. Also shown are summering feeding areas mentioned in the text. High-latitude summer feeding areas include Russia, Aleutian Islands / Bering Sea (AI/BS), Gulf of Alaska (GoA), Southeast Alaska / Northern British Columbia (SEAK/NBC), Washington / Southern British Columbia (WA/SBC), and California / Oregon (CA/OR).

Humpback whales occur worldwide and migrate seasonally from high latitude subarctic and temperate summering areas to low latitude subtropical and tropical wintering areas. Three subspecies are recognized globally (North Pacific, Atlantic, and Southern Hemisphere), based on restricted gene flow between ocean basins (Jackson et al. 2014). The North Pacific subspecies (*Megaptera novaeangliae kuzira*) occurs basin-wide, with summering areas in waters of the Russian Far East, Beaufort Sea, Bering Sea, Chukchi Sea, Gulf of Alaska, Western Canada, and the U.S. West Coast. Known wintering areas include waters of Okinawa and Ogasawara in Japan, Philippines, Mariana Archipelago, Hawaiian Islands, Revillagigedos Archipelago, Mainland Mexico, and Central America (Baker et al. 2013, Barlow et al. 2011, Calambokidis et al. 2008, Clarke et al. 2013, Fleming and Jackson 2011, Hashagen et al. 2009). In describing humpback whale population structure in the Pacific, Martien et al. (2020, 2023) note that “migratory whale herds”, defined as groups of animals that share the same summering and wintering area, are likely to be demographically independent due to their strong, maternally-inherited fidelity to migratory destinations. Despite whales from multiple wintering areas sharing some summer feeding areas, Baker et al. (2013) reported significant genetic differences between North Pacific summering and wintering areas, driven by strong maternal site fidelity to feeding areas and natal philopatry to wintering areas. This differentiation is supported by photo ID studies showing little interchange of whales between summering areas (Calambokidis et al. 2001).

NMFS has identified 14 distinct population segments (DPSs) of humpback whales worldwide under the Endangered Species Act (ESA) (81 FR 62259, September 8, 2016), based on genetics and movement data (Baker et al. 2013, Calambokidis et al. 2008, Bettridge et al. 2015). In the North Pacific, 4 DPSs are recognized (with ESA listing status), based on their respective low latitude wintering areas: “Western North Pacific” (endangered), “Hawai‘i” (not listed), “Mexico” (threatened), and “Central America” (endangered). The listing status of each DPS was determined following an evaluation of the ESA section 4(a)(1) listing factors as well as an evaluation of demographic risk factors. The evaluation is summarized in the final rule revising the ESA listing status of humpback whales (81 FR 62259, September 8, 2016).

In prior stock assessments, NMFS designated three stocks of humpback whales in the North Pacific: the California/Oregon/Washington (CA/OR/WA) stock, consisting of winter populations in coastal Central America and coastal Mexico which migrate to the coast of California and as far north as southern British Columbia in summer; 2) the Central North Pacific stock, consisting of winter populations in the Hawaiian Islands which migrate primarily to northern British Columbia/Southeast Alaska, the Gulf of Alaska, and the Bering Sea/Aleutian Islands; and 3) the Western North Pacific stock, consisting of winter populations off Asia which migrate primarily to Russia and the Bering Sea/Aleutian Islands. These stocks, to varying extents, were not aligned with the more recently identified ESA DPSs (e.g., some stocks were composed of whales from more than one DPS), which led NMFS to reevaluate stock structure under the Marine Mammal Protection Act (MMPA).

NMFS evaluated whether these North Pacific DPSs contain one or more demographically independent populations (DIPs), where demographic independence is defined as "*…the population dynamics of the affected group is more a consequence of births and deaths within the group (internal dynamics) rather than immigration or emigration (external dynamics)*" (NMFS 2023a). Evaluation of the four DPSs in the North Pacific by NMFS resulted in the delineation of three DIPs, as well as four "units" that may contain one or more DIPs (Martien et al. 2021, Taylor et al. 2021, Wade et al. 2021, Oleson et al. 2022, Table 1). Delineation of DIPs is based on evaluation of "strong lines of evidence" such as genetics, movement data, and morphology (Martien et al. 2019). From these DIPs and units, NMFS designated five stocks. North Pacific DIPs / units / stocks are described below, along with the lines of evidence used for each. In some cases, multiple units may be combined into a single stock due to lack of sufficient data and/or analytical tools necessary for effective management or for pragmatic reasons (NMFS 2019).

Table 1. DPS of origin for North Pacific humpback whale DIPs, units, and stocks. Names are based on their general winter and summering area linkages. The stock included in *this* report is shown in bold font. All others appear in separate reports.

DPS	ESA Status	DIPs / units	Stocks
Central America	Endangered	Central America - CA-OR-WA DIP	Central America / Southern Mexico - CA-OR-WA stock
Mexico	Threatened	Mainland Mexico - CA-OR-WA DIP	Mainland Mexico – CA-OR-WA stock
		Mexico - North Pacific unit	Mexico - North Pacific stock
Hawai'i	Not Listed	Hawai'i - North Pacific unit	**Hawai'i stock**
		Hawai'i - Southeast Alaska / Northern British Columbia DIP	
Western North Pacific	Endangered	Philippines / Okinawa - North Pacific unit	Western North Pacific stock
		Marianas / Ogasawara - North Pacific unit	

Delineation of the **Central America/Southern Mexico – California/Oregon/Washington DIP** is based on two strong lines of evidence indicating demographic independence: genetics and movement data (Taylor et al. 2021). The DIP was designated as a stock because available data make it feasible to manage as a stock and because there are conservation and management benefits to doing so (NMFS 2023a, NMFS 2019, NMFS 2022a). Whales in this stock winter off the Pacific coast of Nicaragua, Honduras, El Salvador, Guatemala, Panama, Costa Rica and likely southern coastal Mexico (Taylor et al. 2021). Summer destinations for whales in this DIP include the U.S. West Coast waters of California, Oregon, and Washington (including the Salish Sea, Calambokidis et al. 2017).

Delineation of the **Mainland Mexico – California/Oregon/Washington DIP** is based on two strong lines of evidence indicating demographic independence: genetics and movement data (Martien et al. 2021). The DIP was designated as a stock because available data make it feasible to manage as a stock and because there are conservation and management benefits to doing so (NMFS 2023a, NMFS 2019, NMFS 2022b). Whales in this stock winter off the mainland Mexico states of Nayarit and Jalisco, with some animals seen as far south as Colima and Michoacán. Summer destinations for whales in the Mainland Mexico DPS include U.S. West Coast waters of California, Oregon, Washington (including the Salish Sea, Martien et al. 2021), Southern British Columbia, Alaska, and the Bering Sea.

The **Mexico – North Pacific unit** is likely composed of multiple DIPs, based on movement data (Martien et al. 2021, Wade 2021, Wade et al. 2021). However, because currently available data and analyses are not sufficient to delineate or assess DIPs within the unit, it was designated as a single stock (NMFS 2023a, NMFS 2019, NMFS 2022b). Whales in this stock winter off Mexico and the Revillagigedo Archipelago and summer primarily in Alaska waters (Martien et al. 2021).

The **Hawai‘i stock** consists of one DIP - **Hawai‘i - Southeast Alaska / Northern British Columbia DIP** and one unit - **Hawai‘i - North Pacific unit,** which may or may not be composed of multiple DIPs (Wade et al. 2021). The DIP and unit are managed as a single stock at this time, due to the lack of data available to separately assess them and lack of compelling conservation benefit to managing them separately (NMFS 2023a, NMFS 2019, NMFS 2022c). The DIP is delineated based on two strong lines of evidence: genetics and movement data (Wade et al. 2021). Whales in the Hawai‘i - Southeast Alaska/Northern British Columbia DIP winter off Hawai‘i and largely summer in Southeast Alaska and Northern British Columbia (Wade et al. 2021). The group of whales that migrate from Russia, western Alaska (Bering Sea and Aleutian Islands), and central Alaska (Gulf of Alaska excluding Southeast Alaska) to Hawai‘i have been delineated as the **Hawai‘i-North Pacific unit** (Wade et al. 2021). There are a small number of whales that migrate between Hawai‘i and southern British Columbia/Washington, but current data and analyses do not provide a clear understanding of which unit these whales belong to (Wade et al. 2021).

The **Western North Pacific stock** consists of two units- the **Philippines / Okinawa - North Pacific unit** and the **Marianas / Ogasawara - North Pacific unit**. The units are managed as a single stock at this time, due to a lack of data available to separately assess them (NMFS 2023a, NMFS 2019, NMFS 2022d). Recognition of these units is based on movements and genetic data (Oleson et al. 2022). Whales in the Philippines /Okinawa - North Pacific unit winter near the Philippines and Ryukyu Archipelago and migrate to summer feeding areas primarily off the Russian mainland (Oleson et al. 2022). Whales that winter off the Mariana Archipelago, Ogasawara, and other areas not yet identified and then migrate to summer feeding areas off the Commander Islands, and to the Bering Sea and Aleutian Islands comprise the Marianas / Ogasawara - North Pacific unit.

This stock assessment report includes information on the Hawai‘i stock. In previous marine mammal stock assessments, humpback whales that used the Hawai‘i wintering area were considered to be the “Central North Pacific” stock, but that stock also included whales in Alaska belonging to the Mexico DPS, as well as Hawai‘i DPS), so the Hawai‘i stock is not equivalent to the previous Central North Pacific stock for that reason. Whales in Alaska from the Mexico DPSs are now assessed separately in the Mexico-North Pacific humpback whale stock assessment report. Whales that winter off Hawai‘i and feed off Washington are now assessed as part of the Hawai‘i stock.

Population Size

Population Size in Hawai‘i

A large-scale study of humpback whales throughout the North Pacific was conducted from 2004 to 2006 (the Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project). A total of 2,367 unique individuals were seen in the Hawaiian wintering areas during the three winter field seasons of the SPLASH, and a preliminary mark-recapture abundance estimate of ~10,000 was estimated from the SPLASH data for Hawai‘i using a multi-strata Hilborn model (Calambokidis et al. 2008). Wade et al. (2016) and Wade (2021) finalized the multi-strata analysis, including providing a CV and confidence limits, resulting in an estimate for Hawai‘i of 11,540 (CV = 0.042) for 2004-2006.

Data from multiple line-transect surveys since 2002 have been used to develop and update species distribution models (SDMs) for cetaceans within the U.S. Exclusive Economic Zone (EEZ) around the Hawaiian Islands (Becker et al. 2012, 2021; Forney et al. 2015), but these surveys were primarily in summer and fall. Until recently, systematic ship survey data in the winter months were limited to a single focused survey of the Main Hawaiian Islands (MHI) from 6–24 February 2009 (PIFSC 2009), and a few ship transits in proximity to the MHI. To better understand the abundance and distribution of cetaceans in the winter months, a winter survey (Winter Hawaiian Islands Cetacean and Ecosystem Assessment Survey, or WHICEAS) was conducted within offshore waters around the MHI from 18 January to 12 March 2020 (Yano et al. 2020). Becker et al. (2022) used the 2002-2020 survey data, along with environmental variables, to build an SDM to estimate the density and abundance of humpback whales in the Hawaiian Islands EEZ for recent years (2017-2020). Since a significant seasonal difference in abundance was evident for humpback whales, the final SDM was used to derive spatially-explicit monthly density estimates based on the average of weekly predictions spanning 2017–2020. Peak numbers of humpback whales are expected to occur within the Hawaiian Islands EEZ from approximately mid-February to mid-March (Au et al. 2000). The functional plot for Julian date in the SDM was consistent with these findings, with peak numbers of humpback whales expected to occur within the Hawaiian Islands EEZ from approximately February 19 through March 22 (Becker et al. 2022). Therefore, to obtain a single abundance estimate, weekly predictions for this time period were averaged to estimate the density and number of whales within the study area during 2020, the most recent year in the time series and the year of the WHICEAS survey effort. This estimate represents the peak abundance of humpback whales in the Hawaiian Islands EEZ during 2020, but may under-represent the full abundance of whales that overwinter in the region because individual whales may not have a very long residence time in Hawai‘i; Craig et al. (2001) found that for the majority

of whales (66%), two weeks or less elapsed between their first and last identification within the same field season. Therefore, some individual whales might only be found in Hawai‘i outside of the peak period. The resulting estimate of abundance was 11,278 (CV = 0.56, 95% CI 4,049-31,412) (Becker et al. 2022), which is considered the best current estimate of abundance for Hawai‘i and for the stock as a whole.

Population Size in Summer Areas

Although the population size and estimate of minimum abundance for the stock are based on the abundance in Hawai‘i**,** abundance information from the summer feeding areas is also summarized here. The only comprehensive survey throughout most of the summer range was the SPLASH survey in 2004-2006. Resulting abundance estimates from a multi-strata mark-recapture analysis resulted in abundance estimates of 1,340 (CV = 0.30) for Russia, 7,758 for the Bering Sea and Aleutian Islands (CV = 0.20), 2,129 for the Gulf of Alaska (including the Shumagin Islands, CV = 0.081), 5,890 (CV = 0.08) for Southeast Alaska and northern British Columbia, and 347 (CV = 0.26) for southern British Columbia (CV = 0.26) (Wade et al. 2016, Wade 2021). However, in all of those areas those abundance estimates represent a mixture of whales from up to three winter areas, the western North Pacific (Asia), Hawai‘i, and Mexico, and so cannot represent the abundance of just the Hawai‘i stock in its summer areas. The one near exception is Southeast Alaska and northern British Columbia, where >90% of the whales were estimated to be from Hawai‘i at the time of the SPLASH surveys (Wade 2021, Lizewski et al 2021). Therefore, that abundance estimate (5,890) could serve as an estimate of the number of whales in the Hawai‘i - Southeast Alaska / Northern British Columbia DIP, though that estimate is now more than fifteen years old.

Relatively few estimates of abundance have been made for humpback whales in the summer areas of the Hawai‘i stock in the last decade, with most that are available being for relatively small portions of the range (e.g., Teerlink et al. 2015, Rone et al. 2017, Gabriele et al. 2017). One exception was a line-transect survey throughout nearly all humpback whale habitat in British Columbia, with estimates of 4,935 (CV = 0.13) for the offshore area, 1,816 (CV = 0.13) for the North Coast area, and 279 (CV = 0.40) for the Salish Sea area (inland waters of the Strait of Georgia and Strait of Juan de Fuca) (Wright et al. 2021). The first two of those areas correspond to the northern British Columbia stratum during the SPLASH project, while the third area corresponds to the southern British Columbia stratum. Therefore, the summed estimate of 6,751 would represent the abundance of the northern British Columbia portion of the Hawai‘i - Southeast Alaska / Northern British Columbia DIP. A more recent estimate of abundance for Southeast Alaska, if it becomes available, could be added to this to represent the abundance of the total DIP.

There are no recent abundance estimates for the summer range of the Hawai‘i - North Pacific unit.

Minimum Population Estimate

The minimum population estimate for this stock is the lower 20th percentile of the 2020 estimate from Hawai‘i of 11,278 (CV = 0.56; Becker et al. 2022), which is 7,265.

Current Population Trend

Until recently, most evidence indicated the number of humpback whales in Hawai‘i and Alaska have been increasing for decades. For example, a comparison of the estimate for the entire stock provided by Calambokidis et al. (1997) with the 1981 estimate of 1,407 (95% CI: 1,113-1,701) from Baker et al. (1987) suggests that abundance increased in Hawai‘i between the early 1980s and early 1990s. Mobley et al. (2001) estimated a trend of 7% per year for 1993 to 2000 using data from aerial surveys within the main Hawaiian Islands. Mizroch et al. (2004) estimated a rate of increase of 10% per year (95% CI: 3-16%) for humpbacks in Hawai‘i from a Pradel mark-recapture model fit to data from Hawai‘i for 1980 to 1996. For shelf waters of the northern Gulf of Alaska, Zerbini et al. (2006) estimated an annual rate of increase for humpback whales of 6.6% (95% CI: 5.2-8.6%) from 1987 to 2003. Comparisons of SPLASH abundance estimates for Hawai‘i to estimates for 1991 to 1993 gave estimates of annual increase that ranged from 5.5 to 6.0% (Calambokidis et al. 2008). No confidence limits were calculated for these rates of increase from SPLASH data. Teerlink et al. (2015) estimated an average annual rate of increase of 4.53% (95 % CI 3.28–5.79 %) for 1978-2009 for humpback whales in Prince William Sound, Alaska. Gabriele et al. (2017) estimated an annual rate of increase of 5.1% (95% CI -1.3-11.9%) from 1985-2013 for Glacier Bay and Icy Strait in Southeast Alaska.

Recently, however, the encounter rate of humpback whales and the number of calves declined in Prince William Sound after the marine heatwave in the Gulf of Alaska in 2014-2016, presumably due to disruption of lower trophic level prey (Arimitus et al. 2021). A large whale Unusual Mortality Event in the western Gulf of Alaska in 2015-2016 (Savage 2017) suggested this was, at least partially, a true decline rather than just a shift in distribution. A similar decline in abundance and calf production rates of humpback whales in Glacier Bay and Icy Strait in Southeast

Alaska (Neilson and Gabriele 2019) indicates this decline may have occurred widely throughout the Gulf of Alaska. Therefore, it is unknown if this population is currently increasing.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are several studies that have attempted to estimate the annual rate of increase for humpback whale populations in the North Pacific, though most are limited by sampling within a specific study region. Zerbini et al. (2010) analyzed life history rates to estimate that rates of increase for humpback whales can theoretically be as high as 12%, and observed rates of increase approximately that high have been observed in several Southern Hemisphere populations. Estimated rates of increase for the Hawai‘i stock include values for Hawai‘i of 7.0% from aerial surveys (Mobely et al. 2001), 5.5-6.0% from mark-recapture abundance estimates (Calambokidis et al. 2008), 10% (95% CI: 3-16%) from a model fit to mark-recapture data (Mizroch et al. 2004), and a value for the northern Gulf of Alaska of 6.6% (95% CI: 5.2-8.6%) from ship surveys (Zerbini et al. 2006). Although there is no estimate of the maximum net productivity rate (R_{MAX}) for the stock, it is reasonable to assume that R_{MAX} for this stock would be at least 7%. Until additional data become available for the Hawai‘i humpback whale stock, 7% will be used as R_{MAX} for this stock.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (7,265) times one half the estimated population growth rate for this stock of humpback whales (½ of 0.07) times a recovery factor of 0.5 (for a stock of unknown status relative to OSP), resulting in a PBR of 127.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2016 and 2020 is listed, by marine mammal stock, in Freed et al. (2022); however, only the mortality and serious injury data are included in the Stock Assessment Reports. Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NMFS (2023b). A summary of information used to determine whether an injury was serious or non-serious, as well as a table of prorate values used for large whale reports with incomplete information, is reported in Freed et al. (2022).

Human-caused mortality and serious injury of humpback whales observed in Alaska includes whales from three stocks: the Mexico-North Pacific stock, the Hawai‘i stock, and the Western North Pacific stock. Human-caused mortality and serious injury of the Hawai‘i stock also occurs in British Columbia, Washington, and Hawai‘i. Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed marine mammals off California, Oregon, and Washington between 2016 and 2020 is listed in Carretta et al. (2022), and information for NMFS-managed marine mammals off Hawai‘i is provided in reports by Bradford (2018a, 2018b, 2020, 2021, and 2023) and Bradford and Lyman (2018, 2019, 2020, 2022, 2023). Mortality and serious injury data are not currently available for British Columbia, although some information is available on humpback whales in Hawai‘i carrying British Columbia fishing gear.

To assess human-caused mortality and serious injury of the Hawai‘i stock in areas where multiple stocks overlap in summering areas, mortality and serious injury is prorated using point estimates of the summering to wintering area movement probabilities reported by Wade (2021). Mortality and serious injury occurring in Hawai‘i is prorated using point estimates of the wintering to summering area movement probabilities, specifically using the summed estimates for movements to Southeast Alaska / Northern British Columbia and to Southern British Columbia/Washington for prorating to the Hawai‘i-Southeast Alaska / Northern British Columbia DIP, and the summed estimates for movements to Russia, the Bering Sea / Aleutian Islands, and the Gulf of Alaska for prorating to the Hawai‘i - North Pacific unit (Wade 2021; Table 2).

Based on data described in the sections below, the minimum estimated mean annual level of human-caused mortality and serious injury for the Hawai‘i stock of humpback whales between 2016 and 2020 is 27.09 whales: 8.39 in U.S. commercial fisheries, 0.80 in Canadian commercial fisheries, 0.29 in recreational fisheries, 0.28 in Alaska subsistence fisheries, 0.34 in Washington tribal treaty fisheries, 4.83 in unknown (commercial, recreational, or subsistence) fisheries, 1.09 in marine debris, and 11.07 due to other causes (intentional unauthorized removal, vessel strikes, and entanglement in an Alaska Department of Fish and Game (ADF&G) salmon net pen and in mooring gear). This estimate is considered a minimum because observers have not been assigned to several fisheries that are known to interact with this stock and, due to limited Canadian observer program data, mortality and serious injury incidental to Canadian commercial fisheries (i.e., those similar to U.S. fisheries known to interact with humpback whales) is uncertain. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include vessel strikes and entanglement in fishing gear and marine debris.

Table 2. Movement probabilities from Wade (2021) (and unpublished CVs) used for prorating human-caused mortality and serious injury to the Hawai‘i - Southeast Alaska / Northern British Columbia DIP and the Hawai‘i - North Pacific unit, which together comprise the Hawai‘i stock. For this stock assessment report, whales that winter off Hawai‘i and summer off Washington are assigned to the Hawai‘i - Southeast Alaska / Northern British Columbia DIP because of their geographic proximity.

DIP/Unit	Location of Mortality or Serious Injury				
	Aleutian Islands/ Bering Sea	Gulf of Alaska	Southeast Alaska	Washington	Hawai‘i
Hawai‘i - Southeast Alaska / Northern British Columbia DIP	-	-	0.976 (CV = 0.006)	0.688 (CV = 0.130)	0.809 (CV = 0.043)
Hawai‘i - North Pacific unit	0.91 (CV = 0.024)	0.89 (CV = 0.022)	-	-	0.191 (CV = 0.179)

Fisheries Information

U.S. Commercial Fisheries

Information for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is available in Appendix 3 of the Alaska Stock Assessment Reports (observer coverage) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed May 2023).

Two humpback whale mortalities were observed in the Bering Sea/Aleutian Islands pollock trawl fishery between 2016 and 2020, resulting in a minimum estimated mean annual mortality and serious injury rate of 0.4 humpback whales, of which 0.36 were prorated to the Hawai‘i stock (Table 3; Breiwick 2013; MML, unpubl. data). There were no humpback whale injuries or mortalities in observed fisheries off Washington[1] (Carretta et al. 2022) or in the Hawai‘i longline fisheries between 2016 and 2020, although one unidentified cetacean described as a probable humpback whale was non-seriously injured in the Hawai‘i deep-set longline fishery in 2019 (Bradford 2018a, 2018b, 2020, 2021, 2023).

In 2012 and 2013, the Alaska Marine Mammal Observer Program placed observers on independent vessels in the state-managed Southeast Alaska salmon drift gillnet fishery to assess mortality and serious injury of marine mammals. Areas around and adjacent to Wrangell and Zarembo Islands (ADF&G Districts 6, 7, and 8) were observed during the 2012 and 2013 programs (Manly 2015). In 2013, one humpback whale was seriously injured. Based on the one observed serious injury, 11 serious injuries were estimated for Districts 6, 7, and 8 in 2013, resulting in an estimated mean annual mortality and serious injury rate of 5.5 humpback whales in 2012 and 2013, of which 5.37 were prorated to the Hawai‘i stock (Table 3). Because these three districts represent only a portion of the overall fishing effort in this fishery, this is considered to be a minimum estimate of mortality and serious injury for the fishery.

Mortality and serious injury in unobserved U.S. commercial fisheries reported to the NMFS Alaska Region, West Coast, and Pacific Islands Region marine mammal stranding networks and through Marine Mammal Authorization Program (MMAP) fisherman self-reports between 2016 and 2020 resulted in a minimum mean annual mortality and serious injury rate of: 1.90 humpback whales in Alaska, of which 1.69 were prorated to the Hawai‘i stock (Table 4; Freed et al. 2022), 1.1 humpback whales in Washington[2], of which 0.76 were prorated to the Hawai‘i stock (Table 4; Carretta et al. 2022), and 0.20 humpback whales in Hawai‘i, all of which were attributed to the Hawai‘i stock (Table 4; Bradford and Lyman 2018, 2019, 2020, 2022, 2023). These estimates result from an actual count of verified human-caused deaths and serious injuries and are minimums because not all entangled animals strand or are self-reported nor are all stranded animals found, reported, or have the cause of death determined.

[1] Jannot et al. (2021) report humpback whale mortalities and serious injuries in the Washington/Oregon/California sablefish pot fishery. Estimates are based on 2015-2019 data for the limited entry (LE) and open-access (OA) sablefish pot sectors combined. Two observer program entanglements since 2002 informed the bycatch estimates, both of which occurred in California and Oregon waters. Other sablefish pot cases opportunistically reported (at-sea sightings of entangled whales, strandings) have also been documented only in California and Oregon waters (Carretta et al. 2022). Because no entanglements have been documented for this fishery in Washington, the estimate from Jannot et al. (2021) is not prorated to the Hawai‘i stock.

[2] This includes whales sighted in waters outside of Washington where the mortality or serious injury source was confirmed to be a Washington fishery.

In summary, the minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries for the Hawai‘i stock between 2016 and 2020 is 8.39 humpback whales, based on observer data from Alaska (Table 3: 5.73) and reports (in which the commercial fishery is confirmed) to the NMFS Alaska (Table 4: 1.69), West Coast Region (Table 4: 0.76), and Pacific Islands Region stranding networks (Table 4: 0.20).

Other Fisheries

Reports to the NMFS Alaska Region, West Coast, and Pacific Islands Region marine mammal stranding networks of swimming, floating, or beachcast humpback whales entangled in fishing gear or with injuries caused by interactions with gear within the range of the Hawai‘i stock between 2016 and 2020 include: two entanglements (each with a serious injury prorated at 0.75) in recreational pot fisheries gear, resulting in a minimum mean annual mortality and serious injury rate of 0.30 whales, of which 0.29 were prorated to the Hawai‘i stock (Table 4; Freed et al. 2022); entanglements in Alaska subsistence crab pot gear and in unidentified Alaska subsistence gillnet (each with a serious injury prorated at 0.75), resulting in a minimum mean annual mortality and serious injury rate of 0.30 humpback whales, of which 0.28 were prorated to the Hawai‘i stock (Table 4; Freed et al. 2022); entanglements in Washington tribal treaty gillnet fishery gear, resulting in a resulting in a minimum mean annual mortality and serious injury rate of 0.50 humpback whales, of which 0.34 were prorated to the Hawai‘i stock (Table 4; Carretta et al. 2022); and entanglements in unknown (commercial, recreational, or subsistence) fishing gear, resulting in a minimum mean annual mortality and serious injury rate of 5.20 humpback whales (Table 4; 0.85 in Alaska, Freed et al. 2022; 1.00 in Washington, Carretta et al. 2022; and 3.35 in Hawai‘i, Bradford and Lyman 2018, 2019, 2020, 2022, 2023), of which 4.83 were prorated to the Hawai‘i stock. There were also reports of whales seen in Hawai‘i carrying pot gear from British Columbia (commercial and unknown), resulting in a minimum mean annual mortality and serious injury rate of 0.8 (Table 4; Bradford and Lyman 2018, 2019, 2020, 2022, 2023), all attributed to the Hawai‘i stock.

Table 3. Summary of incidental mortality and serious injury of humpback whales within the Hawai‘i stock range due to observed U.S. commercial fisheries between 2016 and 2020 (or the most recent data available) and the mean annual mortality and serious injury rate (Breiwick 2013; Manly 2015; MML, unpubl. data). Mean annual mortality estimates are prorated to the Hawai‘i - Southeast Alaska / Northern British Columbia (HI-SEAK/NBC) DIP and the Hawai‘i - North Pacific (HI-NPac) unit, which together comprise the Hawai‘i stock, by multiplying by the area-specific movement probabilities in Table 2. Methods for calculating percent observer coverage for Alaska fisheries are described in Appendix 3 of the Alaska Stock Assessment Reports.

Fishery name	Years	Data type	Percent observer coverage	Observed mortality	Estimated mortality (CV)	Mean estimated annual mortality - overall (CV)	Mean estimated annual mortality – by DIP/unit	
							DIP/unit	Estimate (CV)
Bering Sea/Aleutian Islands								
Bering Sea/Aleutian Is. pollock trawl	2016 2017 2018 2019 2020	obs data	99 99 99 98 91	0 0 1 0 1	0 0 1.0 (0.11) 0 1.1 (0.23)	0.4 (0.13)	HI-NPac	0.36 (0.13)
Southeast Alaska								
Southeast Alaska salmon drift gillnet (Districts 6, 7, 8)	2012 2013	obs data	6.4 6.6	0 1	0 11	5.5 (1.0)	HI-SEAK/NBC	5.37 (1.0)
Minimum total estimated annual mortality						5.9 (0.93)	HI-SEAK/NBC	5.37 (1.0)
							HI-NPac	0.36 (0.13)

Fisheries Summary

The minimum mean annual mortality and serious injury rate due to interactions with all fisheries between 2016 and 2020 is 14.93 Hawai‘i humpback whales (8.39 in U.S. commercial fisheries + 0.29 in recreational fisheries + 0.28 in Alaska subsistence fisheries + 0.34 in Washington tribal treaty fisheries + 4.83 in unknown fisheries + 0.8 in Canadian fisheries). These estimates should be considered minimums. Observers have not been assigned to several fisheries that are known to interact with this stock, making the estimated mortality and serious injury rate an underestimate of actual mortality and serious injury. Further, due to limited Canadian observer program data, mortality and serious injury incidental to Canadian commercial fisheries (i.e., those similar to U.S. fisheries known to interact with humpback whales) is uncertain. Though interactions are thought to be minimal, data regarding the level of humpback whale mortality and serious injury related to commercial fisheries in northern British Columbia are not available, again indicating that the estimated mortality and serious injury incidental to commercial fisheries is underestimated for this stock.

Table 4. Summary of mortality and serious injury of humpback whales, by year and type, reported to the NMFS Alaska Region, West Coast, and Pacific Islands marine mammal stranding networks and by Marine Mammal Authorization Program (MMAP) fisherman self-reports between 2016 and 2020 (Freed et al. 2022; Carretta et al. 2022; Bradford and Lyman 2018, 2019, 2020, 2022, 2023), except for vessel strikes off Washington; see text and Table 5. Total mean annual mortality estimates are prorated to the Hawai‘i - Southeast Alaska / Northern British Columbia (HI-SEAK/NBC) DIP and the Hawai‘i - North Pacific (HI-NPac) unit, which together comprise the Hawai‘i stock, by multiplying by the area-specific movement probabilities in Table 2. Mean annual estimates are rounded but total estimates are based on unrounded estimates.

Cause of injury	2016	2017	2018	2019	2020	Mean annual mortality - total	Mean estimated annual mortality – by DIP/unit	
Bering Sea/Aleutian Islands								
Entangled in Bering Sea/Aleutian Is. commercial Pacific cod pot gear	0	1	0	0	0.75[a]	0.35	HI-NPac	0.18
Entangled in marine debris	1	0	0	0	0	0.2	HI-NPac	0.18
Intentional unauthorized take	1	0	0	0	0	0.2	HI-NPac	0.18
Gulf of Alaska								
Entangled in subsistence crab pot gear	0	0	0	0.75	0	0.15	HI-NPac	0.13
Entangled in shrimp pot gear*	0	0	0	0.75	0	0.15	HI-NPac	0.13
Entangled in unidentified fishing gear*	0	0	1	0	0	0.2	HI-NPac	0.18
Entangled in marine debris	1	0	0	0	0	0.2	HI-NPac	0.18
Vessel strike by AK/WA/OR/CA commercial passenger fishing vessel	0	0.52	0	0	0	0.1	HI-NPac	0.09
Vessel strike by recreational vessel	0.2	0	0	0	0	0.04	HI-NPac	0.04

Cause of injury	2016	2017	2018	2019	2020	Mean annual mortality - total	Mean estimated annual mortality – by DIP/unit	
Southeast Alaska								
Entangled in Southeast Alaska commercial salmon drift gillnet (in ADF&G Districts that were not observed in 2012 and 2013)	2.25	0	1.5	0	1.75 + 0.75[b]	1.25	HI-SEAK/NBC	1.22
Entangled in Southeast Alaska commercial pot gear	0	0	0	0	0.75	0.15	HI-SEAK/NBC	0.15
Entangled in unidentified commercial longline gear	0	0	0	0	0.75	0.15	HI-SEAK/NBC	0.15
Entangled in Southeast Alaska recreational shrimp pot gear	0	0	0.75	0	0	0.15	HI-SEAK/NBC	0.15
Entangled in unidentified recreational pot gear	0	0	0	0.75	0	0.15	HI-SEAK/NBC	0.15
Entangled in unidentified subsistence gillnet	0.75	0	0	0	0	0.15	HI-SEAK/NBC	0.15
Entangled in shrimp pot gear*	0	0	0	0.75	0	0.15	HI-SEAK/NBC	0.15
Entangled in unidentified fishing gear*	0	1	0	0.75	0	0.35	HI-SEAK/NBC	0.34
Entangled in marine debris	2.25	0.75	0	0.75	0	0.75	HI-SEAK/NBC	0.73
Entangled in ADF&G salmon net pen	0.75	0	0	0	0	0.15	HI-SEAK/NBC	0.15
Entangled in mooring gear	0.75	0	0	0	0	0.15	HI-SEAK/NBC	0.15
Vessel strike	1	1.34	3	3	0.4	1.75	HI-SEAK/NBC	1.71
Vessel strike by AK/WA/OR/CA commercial passenger fishing vessel	0	0.2	0	0	0	0. 04	HI-SEAK/NBC	0.04
Washington								
Entangled in commercial Washington Dungeness crab pot gear	0	2	1.75	0.75	1	1.10	HI-SEAK/NBC	0.76
Entangled in Washington tribal gillnet gear	0	0	2.5	0	0	0.50	HI-SEAK/NBC	0.34
Entangled in unidentified fishing gear*	0	0	0	0.75	1.75	0.50	HI-SEAK/NBC	0.34
Entangled in unidentified pot/trap gear*	0	0	2.5	0	0	0.50	HI-SEAK/NBC	0.34

Cause of injury	2016	2017	2018	2019	2020	Mean annual mortality - total	Mean estimated annual mortality – by DIP/unit	
Hawai‘i								
Entangled in commercial Alaska king crab or cod pot gear	0	0	0	1	0	0.20	HI-SEAK/NBC	0.16
							HI-NPac	0.04
Entangled in British Columbia commercial pot gear	0	0	0	1	0	0.20	HI-SEAK/NBC	0.20
							HI-NPac	0.00
Entangled in unidentified British Columbia pot gear*	0	0	3[c]	0	0	0.60	HI-SEAK/NBC	0.60
							HI-NPac	0.00
Entangled in unidentified gillnet*	0	0	1	0	0	0.20	HI-SEAK/NBC	0.16
							HI-NPac	0.04
Entangled in unidentified fishing gear*	2.5	5.25	4	4	0	3.15	HI-SEAK/NBC	2.55
							HI-NPac	0.60
Vessel strike	0.2	1.2	4	2.2	9	3.32	HI-SEAK/NBC	2.69
							HI-NPac	0.63
TOTALS								
Total in U.S. commercial fisheries						3.20	HI-SEAK/NBC	2.43
							HI-NPac	0.22
Total in Canadian fisheries						0.80	HI-SEAK/NBC	0.80
							HI-NPac	0.00
Total in recreational fisheries						0.30	HI-SEAK/NBC	0.29
							HI-NPac	0.00
Total in Alaska subsistence fisheries						0.30	HI-SEAK/NBC	0.15
							HI-NPac	0.13
Total in Washington tribal treaty fisheries						0.50	HI-SEAK/NBC	0.34
							HI-NPac	0.00
*Total in unknown (commercial, recreational, or subsistence) fisheries						5.20	HI-SEAK/NBC	3.88
							HI-NPac	0.95
Total in marine debris						1.15	HI-SEAK/NBC	0.73
							HI-NPac	0.36
Total due to other causes (intentional unauthorized removal, entangled in salmon net pen, entangled in mooring gear, vessel strike)						5.75	HI-SEAK/NBC	4.72
							HI-NPac	0.94

[a] Animal known to be from the Mexico – North Pacific stock based on known wintering and summering areas.

[b] Animal was entangled in both AK SEAK salmon drift gillnet gear and AK salmon troll gear.

[c] Total for 2018 reflects correction of an error in the “Value for PBR” for the serious injury reported 01/27/2018 in Bradford and Lyman (2020).

* Unknown if fishery is commercial, recreational, or subsistence.

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska are not authorized to take humpback whales from this stock. An intentional unauthorized take of a humpback whale by Alaska Natives in Toksook Bay in 2016 resulted in a mean annual mortality and serious injury rate of 0.2 whales between 2016 and 2020 (0.18 prorated to the Hawai‘i stock; Table 4).

Other Mortality

In 2015, increased mortality of large whales was observed along the western Gulf of Alaska (including the areas around Kodiak Island, Afognak Island, Chirikof Island, the Semidi Islands, and the southern shoreline of the Alaska Peninsula) and along the central British Columbia coast (from the northern tip of Haida Gwaii to southern

Vancouver Island). NMFS declared an Unusual Mortality Event (UME) for large whales that occurred from 22 May to 31 December 2015 in the western Gulf of Alaska and from 23 April 2015 to 16 April 2016 in British Columbia (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed May 2023). Forty-six large whale deaths attributed to the UME included 12 fin whales and 22 humpback whales in Alaska and 5 fin whales and 7 humpback whales in British Columbia. Based on the findings from the investigation, the UME was likely caused by ecological factors (i.e., the 2015 El Niño, Warm Water Blob, and Pacific Coast Domoic Acid Bloom).

Entanglements in marine debris, an ADF&G salmon net pen, and mooring gear reported to the NMFS Alaska Region marine mammal stranding network resulted in minimum mean annual mortality and serious injury rates of 1.15, 0.15, and 0.15 humpback whales (prorated as 1.09, 0.15, and 0.15 Hawai'i stock humpback whales), respectively, between 2016 and 2020 (Table 4; Freed et al. 2022).

Vessel strikes

Vessel strikes and other interactions with vessels unrelated to fisheries occur frequently with humpback whales (Tables 4 and 5). The minimum mean annual mortality and serious injury rate due to vessel strikes in Alaska is 1.93, of which 1.87 were prorated to the Hawai'i stock and in Hawai'i is 3.32, all of which were assigned to the Hawai'i stock (Table 4).

Fourteen vessel strike cases involving humpback whales were observed in California, Oregon, and Washington waters during 2016-2020 (8 in California, 1 in Oregon, and 5 in Washington), totaling 13.2 mortalities and serious injuries, or 2.6 whales per year (Carretta et al. 2022). Those occurring off Washington could be prorated to the Hawai'i stock, but because most vessel strikes are likely undetected, we use modeled estimates reported by Rockwood et al. (2017) for these waters. Such analyses are not currently available for other parts of the Hawai'i stock range. The estimated number of annual vessel strike deaths off California, Oregon, and Washington was 22 humpback whales, though this includes only the period July – November when whales are most likely to be present in the U.S. West Coast Exclusive Economic Zone and the season that overlaps with survey effort used in species distribution models (Becker et al. 2016, Rockwood et al. 2017). This estimate is based on an assumption of a moderate level of vessel avoidance by humpback whales, as measured by the behavior of satellite-tagged whales in the presence of vessels (McKenna et al. 2015). Based on estimate of 22 deaths due to vessel strikes annually, the number attributed to the Hawai'i stock during 2016-2020 is 5.4 whales per year (Table 5). The ratio of mean annual observed to estimated vessel strike deaths and serious injuries of humpback whales during 2016-2020 is 2.6 / 22 = 0.11, implying that vessel strike counts from opportunistic observations represent a small fraction of overall incidents.

Combining these estimates results in a total of 10.59 vessel strikes prorated to the Hawai'i stock.

Table 5. Summary of humpback whale vessel strike mortalities and serious injuries (M/SI) during 2016-2020 (Carretta et al. 2022). Estimates are based on prorating annual estimates of humpback vessel strike mortality off the U.S. West Coast (22/year, Rockwood et al. 2017) by the fraction of observed vessel strikes in different feeding areas (Washington vs. California/Oregon), which are then prorated to stock by multiplying by the area-specific movement probabilities in Table 2.

State Detected	Observations	Fraction of Observations	Fraction of Observations *times* 22 M/SI per year estimated by Rockwood et al. (2017)	Mean estimated annual mortality prorated to the Hawai'i stock
Washington	5	0.357	7.86	5.4
California/Oregon	9	0.643	14.14	0
Total	14			5.4

Neilson et al. (2012) summarized 108 large whale vessel-strike events in Alaska from 1978 to 2011, 25 of which are known to have resulted in the whale's death. Eighty-six percent of these reports involved humpback whales. Most vessel strikes of humpback whales are reported from Southeast Alaska; however, there are also reports from the south-central, Kodiak Island, and Prince William Sound areas of Alaska (Freed et al. 2022). Many of the vessel strikes occurring off Hawai'i are reported from waters near Maui (Bradford and Lyman 2018, 2019). It is not known whether the difference in vessel-strike rates between Southeast Alaska and the northern portion of this stock is due to differences in reporting, amount of vessel traffic, densities of animals, or other factors.

Historic whaling

Whaling for humpback whales in the North Pacific occurred for centuries, with known hunting areas including Japan, Russia, Alaska, and the west coast of North America (Reeves and Smith 2006). The great majority of catches were made by modern whaling (after 1900), with most catches of humpback whales occurring during two periods, first from 1906 to 1928, and then during the post-World War II years from 1948 to 1966 (Ivashchenko and Clapham 2016). Until recently, the catch record was incomplete because of extensive illegal takes by the USSR (Ivashchenko et al. 2013), but recent work has allowed for what is thought to be a nearly complete catch record. Approximately 37,000-41,000 humpback whales in total were taken from the North Pacific during whaling from 1656 until 1972, with about 31,000 of those taken during the 20th century (1900-1972) (Ivashchenko and Clapham 2021). Catches of North Pacific humpbacks were prohibited beginning in the 1966 season, but catches were already very low by that time, and it was assumed that North Pacific populations had been greatly over-exploited at that point. Illegal takes of humpbacks in the North Pacific by the USSR continued until 1972 (Ivashchenko and Clapham 2016). Preliminary analyses as part of a Comprehensive Assessment of North Pacific humpback whales by the Scientific Committee of the International Whaling Commission suggest that most breeding populations in the North Pacific were depleted at that time (Ivashchenko et al. 2016), but definitive conclusions cannot be reached until that Comprehensive Assessment is completed.

STATUS OF STOCK

Total annual human-caused serious injury and mortality of the Hawai‘i stock of humpback whales is the sum of U.S. commercial fisheries (8.39/year), Canadian fisheries (0.8/year), recreational fisheries (0.29/year), Alaska subsistence fisheries (0.28/year), Washington tribal treaty fisheries (0.34/year), unknown (commercial, recreational, or subsistence) fisheries (4.83/year), marine debris (1.09/year), and other causes (intentional unauthorized removal, vessel strikes, and entanglement in an Alaska Department of Fish and Game (ADF&G) salmon net pen and in mooring gear) (11.07/year), or 27.09 humpback whales annually. The minimum estimate of the mean annual U.S. commercial fishery-related mortality and serious injury rate for this stock (8.39 whales) is less than 10% of the calculated PBR for the entire stock (10% of PBR = 12.7) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate. There is no estimate of the undocumented fraction of anthropogenic injuries and deaths to humpback whales in Alaska or Hawai‘i. On the U.S. West Coast, a comparison of observed vs. estimated annual vessel strikes suggests that approximately 10% of vessel strikes are documented.

The Hawai‘i stock of humpback whales is equivalent to the Hawai‘i DPS of humpback whales, which is not listed under the ESA (Bettridge et al. 2015, Wade et al. 2021). Humpback whales were previously considered to be depleted species-wide under the MMPA solely on the basis of the species’ ESA listing. After the evaluation of the listing status of DPSs of humpback whales, humpback whale DPSs that are not listed as threatened or endangered were not considered to have depleted status under the MMPA (81 FR 62259, September 8, 2016). However, because the Central North Pacific stock included some whales from the ESA-listed Mexico and Western North Pacific DPSs, the stock was considered to be endangered and depleted, and as a result, was classified as a strategic stock. The newly defined Hawai‘i stock of humpback whales does not include whales from any listed DPSs and, therefore, is not currently considered depleted under the MMPA, and is also not a strategic stock due to its ESA status. It is also not strategic because total annual human-caused mortality and serious injury (27.09) does not exceed the stock’s PBR (127).

As discussed above, it is widely believed that most breeding populations of humpback whales in the North Pacific were over-exploited by whaling and depleted as of ~1966. However, as also discussed above, it is thought that at least some populations in the North Pacific, including humpback whales in Hawai‘i and Alaska, have experienced substantial population growth from when monitoring began (~1980) until recently. The Comprehensive Assessment of North Pacific humpback whales by the Scientific Committee of the International Whaling Commission, when completed, may provide information on whether breeding populations in the North Pacific are currently estimated to be depleted.

One key uncertainty in the assessment of the Hawai‘i stock of humpback whales is that estimates of human-caused mortality and serious injury from stranding data and fisherman self-reports are underestimates because not all animals strand or are self-reported nor are all stranded animals found, reported, or have the cause of death determined.

HABITAT CONCERNS

This stock is the focus of a large whale-watching industry in its wintering grounds (Hawai‘i) and summering grounds (Alaska). Regulations concerning the minimum distance to keep from whales and how to operate vessels when in the vicinity of whales have been developed for Hawai‘i and Alaska waters in an attempt to minimize the

effect of whale watching. In land-based studies in both Hawai‘i and Southeast Alaska, the presence of vessels was shown to induce energetically demanding avoidance behaviors in humpback whales. These include changes such as increases in swim speed and changes in swimming direction as well as several other changes in respiration metrics such as decreases in dive times, increased respiration rate, and decreased inter-breath intervals (Schuler et al. 2019, Currie et al. 2021). Additional concerns have been raised in Hawai‘i about the effect of jet skis and similar fast waterborne tourist-related traffic, notably in nearshore areas inhabited by mothers and calves. In Alaska, NMFS issued regulations in 2001 to prohibit approaches to humpback whales within 100 yards (91.4 m: 66 FR 29502, 31 May 2001). Similarly, in Hawai‘i, NMFS first issued regulations in 1987 that made it unlawful to operate an aircraft within 1,000 feet, approach by any means within 100 yards, cause a vessel or other object to approach within a 100 yards, or disrupt the normal behavior or prior activity of a humpback whale by any other act or omission (52 FR 44912, 23 November 1987). In 2015, NMFS introduced a voluntary responsible viewing program called Whale SENSE to Juneau area whale-watch operators to provide additional protections for whales in Alaska (https://whalesense.org, accessed May 2023). The growth of the whale-watching industry is an ongoing concern as preferred habitats may be abandoned if disturbance levels are too high.

Increasing levels of anthropogenic sound in the world's oceans (Andrew et al. 2002), such as those produced by shipping traffic, or Low Frequency Active sonar, is a habitat concern for whales, as it can reduce acoustic space used for communication (masking) (Clark et al. 2009, NOAA 2016). This can be particularly problematic for baleen whales that may communicate using low-frequency sound (Erbe 2016). Based on vocalizations (Richardson et al. 1995, Au et al. 2006), reactions to sound sources (Lien et al. 1990, 1992; Maybaum 1993), and anatomical studies (Houser et al. 2001), humpback whales also appear to be sensitive to mid-frequency sounds, including those used in active sonar military exercises (U.S. Navy 2007).

Other potential concerns for this stock include harmful algal blooms (Geraci et al. 1989), possible changes in prey distribution with climate change, vessel strikes due to increased vessel traffic (e.g., from increased shipping in higher latitudes), oil and gas activities, and an overlap between humpback whales and high concentrations of marine debris. In a study that quantified the amount and type of marine debris accumulation in Hawai‘i coastal waters from 2013 to 2016, the degree of overlap between marine debris and cetacean distribution was greatest for humpback whales (Currie et al. 2017).

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