6/5/2023 (New SAR)

Humpback Whale (*Megaptera novaeangliae kuzira*) - Western North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

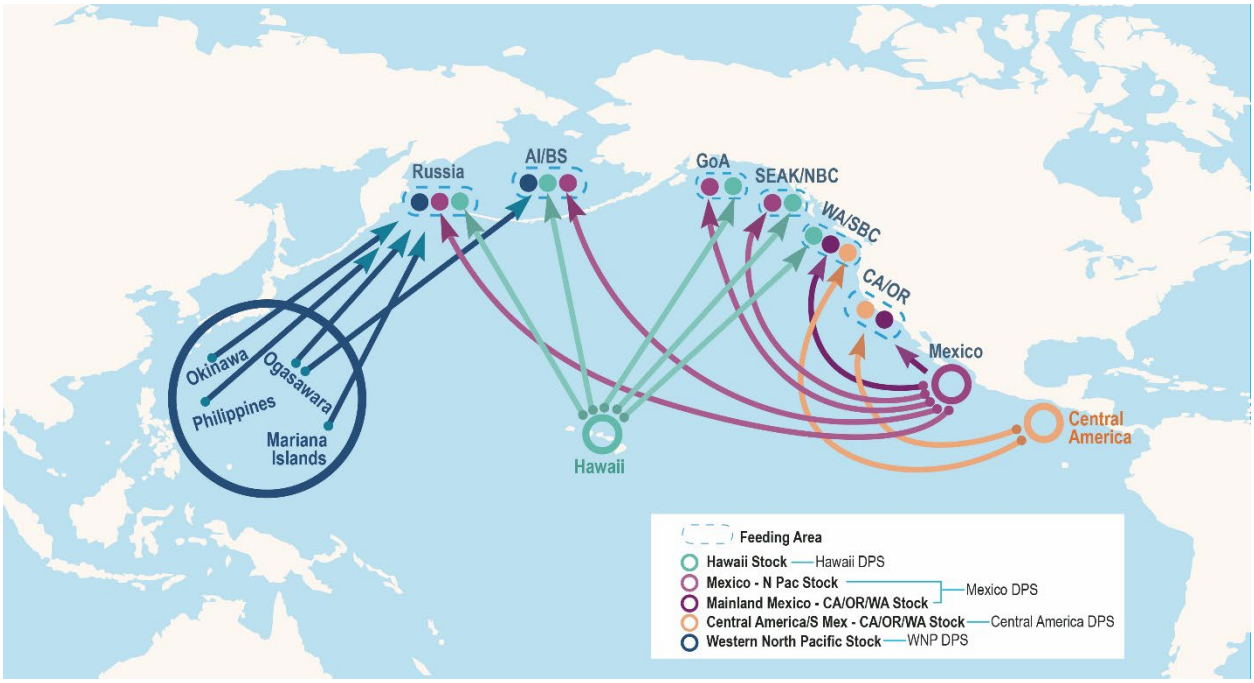

Figure 1. Pacific basin map showing wintering areas of five humpback whale stocks mentioned in this report. Also shown are summering feeding areas mentioned in the text. High-latitude summer feeding areas include Russia, Aleutian Islands / Bering Sea (AI/BS), Gulf of Alaska (GoA), Southeast Alaska / 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 (WNP) 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 in the 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 **Western North Pacific stock**. The stock definition is largely similar to previous marine mammal stock assessments, with two primary changes. The WNP stock is fully aligned with the WNP DPS and the stock range includes humpback whales in the Mariana Archipelago, as they are now known to be part of this DPS based on both photographic identification matches and genetics (Hill et al. 2020a).

POPULATION SIZE

Between 2004 and 2006, a basin-wide study took place on nearly all North Pacific summer and winter areas (Calambokidis et al. 2008, Barlow et al. 2011, Baker et al. 2013, Wade 2021). The study, known as SPLASH (Structure, Population Levels, And Status of Humpbacks), produced substantial photographic and genetic data which form the basis for the only partial range-wide estimates of population size for WNP humpback whales. SPLASH sampling in Asia was limited to the wintering areas in Okinawa and Ogasawara in Japan, and to the Babuyan Islands in the Philippines. Summer surveys in Russia also identified whales from the Kamchatka Peninsula, the Commander Islands, and Gulf of Anadyr, and from U.S. waters across the Aleutians and Bering Sea. A total of 566 unique individuals were seen in the Okinawa, Ogasawara, and Philippines wintering areas during the three winter field seasons of the SPLASH, and a preliminary mark-recapture abundance estimate of ~1,000 was estimated from the SPLASH data for the “Asia” study area using a multi-strata Hilborn model (Calambokidis et al. 2008). A recent comprehensive reanalysis of the SPLASH data using a multi-strata analysis (Wade et al. 2016, Wade 2021) resulted in an estimate for “Asia” of 1,084 (CV = 0.088) for 2004-2006. SPLASH did not include sampling in the Mariana Archipelago, such that this estimate is likely an underestimate of total population size. However, together with the movement probabilities published in Wade (2021), the portion of the stock that uses summering areas in U.S. waters was estimated by multiplying the probability of movement between each feeding area and the Asian wintering area, and then those abundances were added together. This resulted in an estimate of 127 (CV= 0.741) migrating to summering areas in U.S. waters.

Hill et al. (2020b) derived preliminary annual mark-recapture abundance estimates for their study region near Saipan in the Mariana Archipelago. Using an open population mark-recapture model (the POPAN generalization of the Jolly-Seber model), Hill et al. (2020b) estimated yearly abundances that ranged from 34 (CV = 0.56) whales in 2019 to 126 (CV = 0.35) whales in 2017, with an average of 61 (CV = 0.21) whales across all years. The sampling periods in each year were short relative to the length of the winter breeding season; therefore, the annual abundances potentially underestimate the numbers of whales associated with the study area throughout each winter.

Minimum Population Estimate

The minimum population estimate for this stock is the lower 20th percentile of the Asia wintering area estimate of 1,084 (CV = 0.088) derived from Wade’s (2021) multi-strata analysis, which is 1,007 whales, or 75 whales in the U.S. portion of the summer feeding area. The U.S. summer feeding area estimate is not prorated further based on time in U.S. waters given the similarity of this estimate and the preliminary mark-recapture estimates provided for the Mariana Archipelago wintering area. In other words, the U.S summer feeding area estimate is serving as a minimum population estimate for whales in U.S. waters year-round. NMFS’ Guidelines for Assessing Marine

Mammal Stocks suggest that the N_{MIN} estimate of the stock should be adjusted to account for potential abundance changes that may have occurred since the last survey and provide reasonable assurance that the stock size is at least as large as the estimate (NMFS 2023a). While the SPLASH data are more than 15 years old, more recent surveys in portions of the stock's range suggest this is a conservative estimate of total population size given it does not include whales from the Mariana Archipelago, which was not surveyed during SPLASH, nor account for recent increases in the number of whales observed in Russian summer feeding areas (Titova et al. 2018, 2019). The population was also assumed to have increased between 1991-1993 and 2004-2006 (Calambokidis et al. 2008). Additionally, there is no evidence that the apparent declines in humpback whale abundance and calf production following the 2014-2016 marine heatwave in the Gulf of Alaska (Arimitsu et al. 2021, Neilson and Gabriele 2019) affected this stock. For these reasons, the Wade (2021) derived estimate can still be considered a valid minimum population estimate as it provides reasonable assurance that the stock size is at least as large as the estimate (NMFS 2023a).

Current Population Trend

The SPLASH abundance estimate for "Asia" represents a 6.7% annual rate of increase over an abundance estimate from 1991-1993 (Calambokidis et al. 2008), though the 1991-1993 estimate represented only animals photo-identified in Ogasawara and Okinawa, whereas the SPLASH estimate also included effort from the Philippines. Since SPLASH, expanded survey efforts in Russia have yielded a much higher number of whales using some regions, including a sharp increase in the number of whales identified in the Commander Islands, from 17 during SPLASH to 545 in 2010 (Titova et al. 2018). This increase is too great to reflect population growth alone, and may suggest redistribution of whales from other regions, potentially including some not surveyed during SPLASH. The annual rate of increase for the WNP stock is unknown; while it was previously assumed to be increasing, assessments using more recent datasets will be required to assess the current trend.

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. Mobley et al. (2001) estimated a trend of 7% per year for 1993-2000 using data from aerial surveys within the main Hawaiian Islands. Mizroch et al. (2004) estimated survival rates for North Pacific humpback whales using mark-recapture methods, and a Pradel model fit to data from Hawai'i for 1980-1996, resulting in an estimated rate of increase of 10% per year (95% CI: 3-16%). 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% from 1987 to 2003 (95% CI: 5.2-8.6%). The SPLASH abundance estimate for the total North Pacific represents an annual increase of 4.9% over the most complete estimate for the North Pacific for 1991 to 1993. In contrast, Zerbini et al. (2010) used life history data from humpback whale populations globally to produce plausible rates of population growth and determined two ranges, 7.3% (95% CI: 3.5-10.5%) and 8.6% (95% CI: 5.0-11.4%), depending on how juvenile survival was computed. Although there are no current estimates of growth rate for the WNP stock, it is reasonable to assume a growth rate of at least 6.7% (Calambokidis et al. 2008) derived from SPLASH and earlier abundance estimates.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,007) for the Asia wintering area, times one half the estimated population growth rate for this stock of humpback whales (½ of 6.7%), times a recovery factor of 0.1 (for an endangered stock with Nmin < 1,500; Taylor et al. 2003), resulting in a PBR of 3.4. The PBR for the whales that use U.S. waters (minimum population size of 75) is 0.2.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed marine mammals in Alaska 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 prorated 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 WNP stock. Human-caused mortality and serious injury data are also available for some other regions of the WNP stock's range, but the data are incomplete and cannot be considered to be a range-wide estimate. To assess human-caused mortality and serious injury of the

endangered WNP stock in areas where multiple stocks overlap, mortality and serious injury is prorated using the point estimates of the summering to wintering area movement probabilities reported by Wade (2021). These values are 0.020 (CV = 0.466) for mortality and serious injuries in the Aleutian Islands/Bering Sea and 0.003 (CV = 0.771) for mortality and serious injuries in the Gulf of Alaska.

Based on data described in the sections below, the minimum estimated mean annual level of human-caused mortality and serious injury for the WNP stock of humpback whales between 2016 and 2020 is 5.82 whales: 0.012 in U.S. commercial fisheries, 5.8 in non-U.S. commercial fisheries, 0.001 in unknown (commercial, recreational, or subsistence) fisheries, 0.005 in marine debris, and 0.004 due to other causes (intentional unauthorized removal, vessel strikes and intentional unauthorized take) (see text and tables below). However, 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 data, total mortality and serious injury outside of U.S. waters 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.

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 deaths 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 0.008 (CV = 0.49) was prorated to the WNP stock (Table 2; Breiwick 2013; MML, unpubl. data).

Table 2. Summary of incidental mortality and serious injury of humpback whales within the range of the Western North Pacific stock due to observed U.S. commercial fisheries between 2016 and 2020. The mean annual mortality estimate is prorated to the WNP stock by multiplying by the area-specific movement probabilities discussed above. 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 of WNP stock (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)	0.008 (0.49)

Mortality and serious injury in unobserved U.S. commercial fisheries reported to the NMFS Alaska Region marine mammal stranding network 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 0.35 humpback whales between 2016 and 2020, of which 0.004 was prorated to the WNP stock (Table 3; Freed et al. 2022). This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and is a minimum because not all entangled animals strand or are self-reported nor are all stranded animals found, reported, or have the cause of death determined.

In summary, the minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries for the WNP stock between 2016 and 2020 is 0.012 humpback whales, based on observer data from Alaska (Table 2: 0.008) and reports (in which the commercial fishery is confirmed) to the NMFS Alaska Region stranding network (Table 3: 0.004).

Table 3. Summary of mortality and serious injury of humpback whales within the range of the Western North Pacific stock, by year and type, reported to the NMFS Alaska Region marine mammal stranding network and by Marine Mammal Authorization Program (MMAP) fisherman self-reports between 2016 and 2020 (Freed et al. 2022). Injury events lacking detailed injury information are assigned prorated values following injury determination guidelines described in NMFS (2012). 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). Total mean annual mortality estimates are prorated to the WNP stock by multiplying by the area-specific movement probabilities discussed above. 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 of WNP stock
Bering Sea/Aleutian Islands							
Entangled in Bering Sea/Aleutian Is. commercial Pacific cod pot gear	0	1	0	0	0.75†	0.35	0.004
Entangled in marine debris	1	0	0	0	0	0.2	0.004
Intentional unauthorized take	1	0	0	0	0	0.2	0.004
Gulf of Alaska							
Entangled in subsistence crab pot gear	0	0	0	0.75	0	0.15	0.000
Entangled in shrimp pot gear*	0	0	0	0.75	0	0.15	0.000
Entangled in unidentified fishing gear*	0	0	1	0	0	0.2	0.001
Entangled in marine debris	1	0	0	0	0	0.2	0.001
Vessel strike by AK/WA/OR/CA commercial passenger fishing vessel	0	0.52	0	0	0	0.1	0.000
Vessel strike by recreational vessel	0.2	0	0	0	0	0.04	0.000
TOTALS							
Total in commercial fisheries						0.35	0.004
Total in Alaska subsistence fisheries						0.15	0.000
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.35	0.001
Total in marine debris						0.40	0.005
Total due to other causes (intentional unauthorized take, vessel strike)						0.34	0.004

†Stock identification known to be Mexico–North Pacific stock based on known wintering and summering areas.
*Unknown if fishery is commercial, recreational, or subsistence.

Other Fisheries

Reports to the NMFS Alaska Region marine mammal stranding network of swimming, floating, or beachcast humpback whales entangled in fishing gear or with injuries caused by interactions with gear within the range of the WNP stock included: one entanglement in subsistence crab pot gear (with a serious injury prorated at 0.75), resulting in a minimum mean annual mortality and serious injury rate of 0.15 humpback whales, of which 0.000 were prorated to the WNP stock; and two entanglements (one of which was a serious injury prorated at 0.75) in unknown (commercial, recreational, or subsistence) fishing gear, resulting in a minimum mean annual mortality and serious injury rate of 0.35 humpback whales, of which 0.001 were prorated to the WNP stock (Table 3; Freed et al. 2022).

Member nations to the International Whaling Commission (IWC) report fisheries bycatch annually. Such reports are available for Japan and Korea for 2015 to 2019; these data were summarized from the IWC's database of annual progress reports by member nations (https://portal.iwc.int/progressreportspublic, accessed May 2023). China and Russia do not report bycatch to IWC. Japan reported 20 humpback whales died as bycatch in stationary uncovered pound nets from 2015 to 2019. Korea reported two humpback whales killed, one in pot gear and the other in a gillnet. The average mortality rate of humpback whales reported as bycatch in Japanese and Korean fisheries is 5.8 whales per year for 2015 to 2019 (Table 4). All of these are attributed to the WNP stock.

Table 4. Summary of fisheries bycatch (dead and seriously injured) reported to the International Whaling Commission by Japan and Korea for 2015 to 2019, the most recent 5-year period available. Although gear type is reported when known, attribution of bycatch to commercial, recreational, or subsistence fisheries is unknown.

Year	Japan	Gear Type	Korea	Gear Type	Total
2015	18	Stationary uncovered pound net	0		18
2016	3		0		3
2017	3		0		3
2018	3		1	Pot	4
2019	0		1	Gillnet	1
Average 2015-2019					5.8

Fisheries Summary

The minimum estimate of the mean annual mortality and serious injury rate due to interactions with all fisheries between 2016 and 2020 is 5.81 WNP humpback whales (0.012 in U.S. commercial fisheries + 0.001 in unknown fisheries + 5.8 in non-U.S. unknown fisheries). These estimates of mortality and serious injury levels should be considered minimums. Observers have not been assigned to several U.S. fisheries that are known to interact with this stock, and bycatch in foreign fisheries is often unreported or data are not available, making the estimated mortality and serious injury rate an underestimate of actual mortality and serious injury.

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 (0.004 attributed to the WNP stock; Table 3).

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). Humpback whale strandings along the coast of Japan were also higher in 2015 (18) and 2016 (17) than in the recent past (https://portal.iwc.int/progressreportspublic/report, accessed May 2023).

Entanglements in marine debris reported to the NMFS Alaska Region marine mammal stranding network resulted in minimum mean annual mortality and serious injury rates of 0.4 humpback whales within the WNP stock range between 2016 and 2020 (0.005 attributed to the WNP stock, Table 3; Freed et al. 2022). Vessel strikes and other interactions with vessels unrelated to fisheries also occur with humpback whales (Table 3). The minimum mean annual mortality and serious injury rate due to vessel strikes within the range of the WNP stock in Alaska (Table 3) between 2016 and 2020 is 0.14 humpback whales (0.000 attributed to the WNP stock). Most vessel strikes of humpback whales are reported from Southeast Alaska, outside of the range of the WNP stock; however, there are also reports from the south-central, Kodiak Island, and Prince William Sound areas of Alaska (Freed et al. 2022). Vessel collision is also a potential threat to humpback whales in other parts of the WNP stock range. Humpback whales occur off the west side of Saipan where the only harbors on the island are located and vessel traffic is heavy. In 2014, a vessel transporting crew to a Navy ship anchored near the reef was reported to have struck a large whale (Hill et al. 2020c, Pacific Islands Regional Office, unpublished data). No photos were taken of the whale and it was recorded in the report as a possible humpback or sperm whale, but given the shallow-water location it was likely a humpback whale. Personnel from the CNMI Department of Fish and Wildlife responded to the report and found a group of four humpback whales within the immediate area, however none showed signs of recent vessel strike.

Historical 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). A total of 3,277 reported catches occurred in Asia between 1910 and 1964, with 817 catches from Ogasawara between 1924 and 1944 (Nishiwaki 1966, Rice 1998). After World War II, substantial catches occurred in Asia near Okinawa (including 970 between 1958 and 1961), as well as around the main islands of Japan and the Ogasawara Islands. On the feeding grounds, substantial catches occurred around the Commander Islands and western Aleutian Islands, as well as in the Gulf of Anadyr (Springer et al. 2006).

Until recently, the North Pacific-wide catch record was incomplete because of extensive illegal takes by the USSR (Ivashchenko et al. 2013), but recent work has provided 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

The WNP stock of humpback whales is equivalent to the "WNP DPS" of humpback whales listed as endangered under the ESA (Bettridge et al. 2015, Oleson et al. 2022); thus, it is considered a strategic and depleted stock under the MMPA. Total annual human-caused serious injury and mortality of humpback whales is the sum of bycatch reported by foreign nations (5.8/yr) and all takes attributed to this stock in U.S. waters (commercial and unknown fisheries, marine debris, and other causes including intentional unauthorized take and vessel strikes; 0.023/yr) for a total of 5.82 WNP humpback whales annually. The stock-wide PBR (3.4) is exceeded. Total U.S. commercial fishery mortality and serious injury (0.012/yr) is less than the PBR (0.2) for the portion of the stock occurring in U.S. waters. There is no estimate of the undocumented fraction of anthropogenic injuries and deaths to humpback whales on the U.S. summer or winter feeding areas. The Comprehensive Assessment of North Pacific

humpback whales by the Scientific Committee of the IWC, when completed, may provide information on whether breeding populations in the North Pacific are currently estimated to be depleted.

HABITAT CONCERNS

This stock is the focus of a moderate whale-watching industry in the Okinawa and Ogasawara wintering areas. 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).

Increasing levels of anthropogenic sound in the world's oceans (Andrew et al. 2002), such as those produced by shipping traffic, or LFA (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, an overlap between humpback whales and high concentrations of marine debris, and exposure to blast fishing in the Philippines (Acebes et al. 2008). 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).

CITATIONS

Acebes, J. M. V., J. Darling, and E. Q. Aca. 2008. Dynamite blasts in a humpback whale *Megaptera novaeangliae* breeding ground, Babuyan Islands, Philippines. Bioacoustics 17:153-155.

Andrew, R. K., B. M. Howe, J. A. Mercer, and M. A. Dzieciuch. 2002. Ocean ambient sound: comparing the 1960's with the 1990's for a receiver off the California coast. Acoust. Res. Lett. Online 3:65-70.

Arimitsu, M. L., J. F. Piatt, S. Hatch, R. M. Suryan, S. Batten, M. A. Bishop, R. W. Campbell, H. Coletti, D. Cushing, K. Gorman, R. R. Hopcroft, K. J. Kuletz, C. Marsteller, C. McKinstry, D. McGowan, J. Moran, S. Pegau, A. Schaefer, S. Schoen, J. Straley, V. R. von Biela. 2021. Heatwave-induced synchrony within forage fish portfolio disrupts energy flow to top pelagic predators. Glob. Change Biol. 27:1859-1878.

Au, W. W. L., A. A. Pack, M. O. Lammers, L. M. Herman, M. H. Deakos, and K. Andrews. 2006. Acoustic properties of humpback whale songs. J. Acoust. Soc. Am. 120(2):1103-1110.

Baker, C. S., D. Steel, J. Calambokidis, E. Falcone, U. González-Peral, J. Barlow, A. M. Burdin, P. J. Clapham, J. K. Ford, C. M. Gabriele, and D. Mattila. 2013. Strong maternal fidelity and natal philopatry shape genetic structure in North Pacific humpback whales. Mar. Ecol. Prog. Ser. 494:291-306.

Barlow, J., J. Calambokidis, E. A. Falcone, C. S. Baker, A. M. Burdin, P. J. Clapham, J. K. B. Ford, C. M. Gabriele, R. LeDuc, D. K. Mattila, T. J. Quinn II, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., P. Wade, D. Weller, B. H. Witteveen, and M. Yamaguchi. 2011. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. Mar. Mammal Sci. 27:793-818.

Bettridge, S., C. S. Baker, J. Barlow, P. J. Clapham, M. Ford, D. Gouveia, D. K. Mattila, R. M. Pace III, P. E. Rosel, G. K. Silber, and P. R. Wade. 2015. Status review of the humpback whale (*Megaptera novaeangliae*) under the Endangered Species Act. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-540, 240 p.

Breiwick, J. M. 2013. North Pacific marine mammal bycatch estimation methodology and results, 2007-2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-260, 40 p.

Calambokidis, J., G. H. Steiger, J. M. Straley, L. M. Herman, S. Cerchio, D. R. Salden, J. Urbán R., J. K. Jacobsen, O. V. Ziegesar, K. C.Balcomb, and C. M. Gabriele. 2001. Movements and population structure of humpback whales in the North Pacific. Mar. Mammal Sci. 17(4):769-794.

Calambokidis, J., E. A. Falcone, T. J. Quinn, A. M. Burdin, P. J. Clapham, J.K. B. Ford, C. M. Gabriele, R. LeDuc, D. Mattila, L. Rojas-Bracho, J. M. Straley, B. L. Taylor, J. Urbán R., D. Weller, B. H. Witteveen, M. Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of populations, levels of abundance and status of humpback whales in the north Pacific. Cascadia Research. Final report for contract AB133F-03-RP-00078. 57 pp.

Calambokidis, J., J. Barlow, K. Flynn, E. Dobson, and G. H. Steiger. 2017. Update on abundance, trends, and migrations of humpback whales along the US West Coast. International Whaling Commission Report SC/A17/NP/13.

Clark C. W., W. T. Ellison, B. L. Southall, L. T. Hatch, S. M. Van Parijs, A. Frankel, and D. Ponirakis. 2009. Acoustic masking in marine ecosystems: intuitions, analysis and implication. Mar. Ecol. Prog. Ser. 395:201–22.

Clarke, J., K. Stafford, S. E. Moore, B. Rone, L. Aerts, and J. Crance. 2013. Subarctic cetaceans in the southern Chukchi Sea: evidence of recovery or response to a changing ecosystem. Oceanography 26(4):136-149.

Currie, J. J., S. H. Hack, J. A. McCordic, and G. D. Kaufman. 2017. Quantifying the risk that marine debris poses to cetaceans in the coastal waters of the 4-island region of Maui. Mar. Poll. Bull. 121(1-2):69-77.

Currie, J. J., J. A. McCordic, G. L. Olson, A. F. Machernis, and S. H. Stack. 2021. The impact of vessels on humpback whale behavior: the benefit of added whale watching guidelines. Front. Mar. Sci. 8:601433. DOI: dx.doi.org/10.3389/fmars.2021.601433

Erbe, C., C. Reichmuth, K. Cunningham, K. Lucke, and R. Dooling. 2016. Communication masking in marine mammals: A review and research strategy. Mar. Poll. Bull. 103(1–2):15–38.

Fleming, A. and J. Jackson. 2011. Global review of humpback whales (*Megaptera novaeangliae*). U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-474, 206 p.

Freed, J. C., N. C. Young, B. J. Delean, V. T. Helker, M. M. Muto, K. M. Savage, S. S. Teerlink, L. A. Jemison, K. M. Wilkinson, and J. E. Jannot. 2022. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2016-2020. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-442, 116 p.

Geraci, J. R., D. M. Anderson, R. J. Timperi, D. St. Aubin, G. A. Early, J. H. Prescott, and C. A. Mayo. 1989. Humpback whales (*Megaptera novaeangliae*) fatally poisoned by dinoflagellate toxin. Can. J. Fish. Aquat. Sci. 46(11):1895-1898. DOI: dx.doi.org/10.1139/f89-238

Hashagen, K. A., G. A. Green, and B. Adams. 2009. Observations of humpback whales, *Megaptera novaeangliae*, in the Beaufort Sea, Alaska. Northwest. Nat. 90:160-162.

Hill, M. C., A. L. Bradford, D. Steel, C. S. Baker, A. D. Ligon, A. C. Ü, J. V. Acebes, O. A. Filatova, S. Hakala N. Kobayashi, Y. Morimoto, H. Okabe, R. Okamoto, J. Rovers, T. Sato, O. V. Titova, R. K. Uyeyama, and E. M. Oleson. 2020a. Found: A missing breeding ground for endangered western North Pacific humpback whales in the Mariana Archipelago. Endang. Species Res. 41:91-103. DOI: dx.doi.org/10.3354/esr01010

Hill, M. C., A. L. Bradford, and E. M. Oleson. 2020b. Preliminary mark-recapture abundance estimates of humpback whales on a breeding area in the Mariana Archipelago. Pacific Islands Fisheries Science Center Administrative Report H-20-07. DOI: dx.doi.org/10.25923/v3fd-yf59

Hill, M. C., E. M. Oleson, A. L. Bradford, K. K. Martien, D. Steel, and C. S. Baker. 2020c. Assessing cetacean populations in the Mariana Archipelago: A summary of data and analyses arising from Pacific Islands Fisheries Science Center surveys from 2010–2019. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-PIFSC-108, 98p. DOI: dx.doi.org/10.25923/wrye-6h14

Houser, D. S., D. A. Helweg, and P. W. B. Moore. 2001. A bandpass filter-bank model of auditory sensitivity in the humpback whale. Aquat. Mamm. 27:82-91.

Ivashchenko, Y. V. and P. J. Clapham. 2016. A review of humpback whale catches in the North Pacific. International Whaling Commission Report SC/A17/NP/03.

Ivashchenko, Y.V. and P. J. Clapham. 2021. An updated humpback whale catch series for the North Pacific International Whaling Commission Report SC/68C/IA/04.

Ivashchenko, Y. V., R. J. Brownell Jr., and P. J. Clapham. 2013. Soviet whaling in the North Pacific: revised catch totals. J. Cetacean Res. Manage.13:59-71.

Ivashchenko, Y. V., P. J. Clapham, A. E. Punt, P. R. Wade, and A. N. Zerbini. 2016. Assessing the status and pre-exploitation abundance of North Pacific humpback whales: Round II. International Whaling Commission Report SC/66b/IA/19.

Jackson, J.A., D. J. Steel, P. Beerli, B. C. Congdon, C. Olavarría, M. S. Leslie, C. Pomilla, H. Rosenbaum, and C. S. Baker. 2014. Global diversity and oceanic divergence of humpback whales (*Megaptera novaeangliae*). Proc. R. Soc. B 281(1786):20133222.

Lien, J., S. Todd, and J. Guigne. 1990. Inferences about perception in large cetaceans, especially humpback whales, from incidental catches in fixed fishing gear, enhancement of nets by "alarm" devices, and the acoustics of fishing gear. Pp. 347-362 *in* J. A. Thomas, R. A. Kastelein, and A. Ya. Supin (eds.), Marine mammal sensory systems. Plenum, New York.

Lien, J., W. Barney, S. Todd, R. Seton, and J. Guzzwell. 1992. Effects of adding sounds to cod traps on the probability of collisions by humpback whales. Pp. 701-708 *in* J. A. Thomas, R. A. Kastelein, and A. Ya. Supin (eds.), Marine mammal sensory systems. Plenum, New York.

Martien, K. K., A. R. Lang, B. L. Taylor, S. E. Simmons, E. M. Oleson, P. L. Boveng, and M. B. Hanson. 2019. The DIP delineation handbook: a guide to using multiple lines of evidence to delineate demographically independent populations of marine mammals. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-622.

Martien, K. K., B. L. Hancock-Hanser, M. Lauf, B. L. Taylor, F. I. Archer, J. Urbán, D. Steel, C. S. Baker, and J. Calambokidis. 2020. Progress report on genetic assignment of humpback whales from the California-Oregon feeding aggregation to the mainland Mexico and Central America wintering grounds. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-635.

Martien, K. K., B. L. Taylor, F. I. Archer, K. Audley, J. Calambokidis, T. Cheeseman, J. De Weerdt, A. Frisch Jordán, P. Martínez-Loustalot, C. D. Ortega-Ortiz, E. M. Patterson, N. Ransome, P. Ruvelas, J. Urbán Ramírez, and F. Villegas-Zurita. 2021. Evaluation of Mexico Distinct Population Segment of Humpback Whales as units under the Marine Mammal Protection Act. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-658. DOI: dx.doi.org/10.25923/nvw1-mz45

Martien, K. K., B. L. Taylor, A. R. Lang, P. J. Clapham, D. W. Weller, F. I. Archer, and J. Calambokidis. 2023. The migratory whale herd concept: A novel unit to conserve under the ecological paradigm. Mar. Mamm. Sci. DOI: dx.doi.org/10.1111/mms.13026

Maybaum, H. L. 1993. Responses of humpback whales to sonar sounds. J. Acoust. Soc. Am. 94(3, Pt. 2):1848-1849.

Mizroch, S. A., L. M. Herman, J. M. Straley, D. Glockner-Ferrari, C. Jurasz, J. Darling, S. Cerchio, C. Gabriele, D. Salden, and O. von Ziegesar. 2004. Estimating the adult survival rate of central North Pacific humpback whales. J. Mammal. 85(5):963-972.

Mobley, J. M., S. Spitz, R. Grotefendt, P. Forestell, A. Frankel, and G. Bauer. 2001. Abundance of humpback whales in Hawaiian waters: results of 1993-2000 aerial surveys. Report to the Hawaiian Islands Humpback Whale National Marine Sanctuary. 16 p.

Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results, p. 172-191. *In* K. S. Norris (ed.), Whales, Dolphins and Porpoises. University of California Press, Berkeley, CA.

National Marine Fisheries Service (NMFS). 2019. Reviewing and designating stocks and issuing Stock Assessment Reports under the Marine Mammal Protection Act. National Marine Fisheries Service Procedure 02-204-03. Available online: https://media.fisheries.noaa.gov/dam-migration/02-204-03.pdf.

National Marine Fisheries Service (NMFS). 2022a. Evaluation of MMPA Stock Designation for the Central America Distinct Population Segment of humpback whales (*Megaptera novaeangliae*) currently a part of the California/Oregon/Washington humpback whale stock. National Marine Fisheries Service Memorandum for the Record: Management Considerations in Designating Demographically Independent Populations as Stocks under the Marine Mammal Protection Act.

National Marine Fisheries Service (NMFS). 2022b. Evaluation of MMPA Stock Designation for the Mexico Distinct Population Segment of humpback whales (*Megaptera novaeangliae*), currently a part of the California/Oregon/Washington and Central North Pacific (CNP) humpback whale stocks. National Marine Fisheries Service Memorandum for the Record: Management Considerations in Designating Demographically Independent Populations as Stocks under the Marine Mammal Protection Act.

National Marine Fisheries Service (NMFS). 2022c. Evaluation of MMPA Stock Designation for the Hawai'i Distinct Population Segment of humpback whales (*Megaptera novaeangliae*), currently a part of the Central North Pacific humpback whale stock. Memorandum for the Record: Management Considerations in Designating Demographically Independent Populations as Stocks under the Marine Mammal Protection Act.

National Marine Fisheries Service (NMFS). 2022d. Evaluation of MMPA Stock Designation for the Philippines/Okinawa-Northern Pacific and the Mariana/Ogasawara-North Pacific Units within the existing Western North Pacific Stock/Distinct Population Segment of humpback whales (*Megaptera novaeangliae*). Memorandum for the Record: Management Considerations in Designating Demographically Independent Populations as Stocks under the Marine Mammal Protection Act.

National Marine Fisheries Service (NMFS). 2023a. Guidelines for Preparing Stock Assessment Reports Pursuant to the Marine Mammal Protection Act. Protected Resources Policy Directive 02-204-01. Available online: https://www.fisheries.noaa.gov/s3/2023-05/02-204-01-Final-GAMMS-IV-Revisions-clean-1-kdr.pdf. Accessed May 2023.

National Marine Fisheries Service (NMFS). 2023b. Guidelines for Distinguishing Serious from Non-Serious Injury of Marine Mammals Pursuant to the Marine Mammal Protection Act. Protected Resources Policy 02-238-01. Available online: https://www.fisheries.noaa.gov/s3/2023-02/02-238-01%20Final%20SI%20Revisions%20clean_kdr.pdf. Accessed May 2023.

National Oceanic and Atmospheric Administration (NOAA). 2016. Ocean noise strategy roadmap. https://cetsound.noaa.gov/road-map. Accessed May 2023.

Neilson, J. L. and C. M. Gabriele. 2019. Glacier Bay & Icy Strait humpback whale population monitoring: 2018 update. National Park Service Resource Brief.

Oleson, E. M., P. R. Wade, and N. C. Young. 2022. Evaluation of the Western North Pacific Distinct Population Segment of Humpback Whales as units under the Marine Mammal Protection Act. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-PIFSC-124, 27 p.

Reeves, R. R. and T. D. Smith. 2006. A taxonomy of world whaling operations and eras. Pp. 82-101 *in* J. A. Estes, D. P. DeMaster, D. F. Doak, T. M. Williams, and Brownell, R. L. Jr. (eds.), Whales, whaling and Ocean Ecosystems. University of California Press, Berkeley, CA.

Rice, D. W. 1998. Marine Mammals of the World. Systematics and Distribution. Special Publication Number 4. The Society for Marine Mammalogy, Lawrence, Kansas. 231 p.

Richardson, W.J., C.R. Greene, C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press.

Schuler, A. R., S. Piwetz, J. Di Clemente, D. Steckler, F. Mueter, and H. C. Pearson. 2019. Humpback whale movements and behavior in response to whale-watching vessels in Juneau, AK. Front. Mar. Sci. 6: Article 710. DOI: dx.doi.org/10.3389/fmars.2019.00710

Springer, A. M., G. B. van Vliet, J. F. Piatt, and E. M. Danner. 2006. Whales and whaling in the North Pacific Ocean and Bering Sea: oceanographic insights and ecosystem impacts. Pp. 245-261 *in* J. A. Estes, R. L. Brownell, Jr., D. P DeMaster, D. F. Doak, and T. M. Williams (eds.), Whales, Whaling and Ocean Ecosystems. University of California Press.

Taylor, B. L., M. S. Scott, J. Heyning, and J. Barlow. 2003. Suggested guidelines for recovery factors for endangered marine mammals. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-354.

Taylor B. L., K. K. Martien, F. I. Archer, K. Audley, J. Calambokidis, T. Cheeseman, J. De Weerdt, A. Frisch Jordán, P. Martínez-Loustalot, C. D. Ortega-Ortiz, E. M. Patterson, N. Ransome, P. Ruvelas, and J. Urbán Ramírez. 2021. Evaluation of Humpback Whales Wintering in Central America and Southern Mexico as a Demographically Independent Population. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-655.

Titova, O. V., O. A. Filatova, I. D. Fedutin, E. N. Ovsyanikova, H. Okabe, N. Kobayashi, J. M. V. Acebes, A. M. Burdin, and E. Hoyt. 2018. Photo-identification matches of humpback whales (*Megaptera novaeangiae*) from feeding areas in Russian Far East seas and breeding grounds in the North Pacific. Mar. Mammal Sci. 34(1):100-112. DOI: dx.doi.org/10.1111/mms.12444

Titova, O. V., O. A. Filatova, I. D. Fedutin, L. S. Krinova, A. E. Burdin, and E. Hoyt. 2019. Preliminary estimates of the abundance of humpback whales (*Megaptera novaeangliae*) in their two local feeding aggregations off Chukotka in August 2017. Marine Mammals of the Holarctic 1:317-321. DOI: dx.doi.org/10.35267/978-5-9904294-0-6-2019-1-317-321

U.S. Department of the Navy (Navy). 2007. Composite Training Unit Exercises and Joint Task Force Exercises Draft Final Environmental Assessment/Overseas Environmental Assessment. Prepared for the Commander, U.S. Pacific Fleet and Commander, Third Fleet. February 2007.

Wade, P. R. 2021. Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating and calving areas. International Whaling Commission Report SC/68c/IA/03.

Wade, P. R., E. M. Oleson, and N. C. Young. 2021. Evaluation of Hawai‘i distinct population segment of humpback whales as units under the Marine Mammal Protection Act. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-430, 31 p.

Wade, P. R., T. J. Quinn II, J. Barlow, C. S. Baker, A. M. Burdin, J. Calambokidis, P. J. Clapham, E. Falcone, J. K. B. Ford, C. M. Gabriele, R. Leduc, D. K. Mattila, L. Rojas- Bracho, J. Straley, B. L. Taylor, J. Urbán R., D. Weller, B. H. Witteveen, and M. Yamaguchi. 2016. Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating and calving areas. International Whaling Commission Report SC/66b/IA21

Zerbini, A. N., J. M. Waite, and P. R. Wade. 2006. Abundance and Distribution of Fin, Humpback and Minke Whales from the Kenai Fjords to the Central Aleutian Islands, Alaska: Summer 2001-2003. Deep-Sea Res. I 53:1772–1790.

Zerbini, A. N., P. J. Clapham, and P. R. Wade. 2010. Assessing plausible rates of population growth in humpback whales from life-history data. Marine Biology 157:1225–1236. DOI: dx.doi.org/10.1007/s00227-010-1403-y