Revised 5/30/2023 (New SAR)

Humpback Whale (*Megaptera novaeangliae kuzira*)
Central America / Southern Mexico - California-Oregon-Washington Stock

Stock Definition and Geographic Range

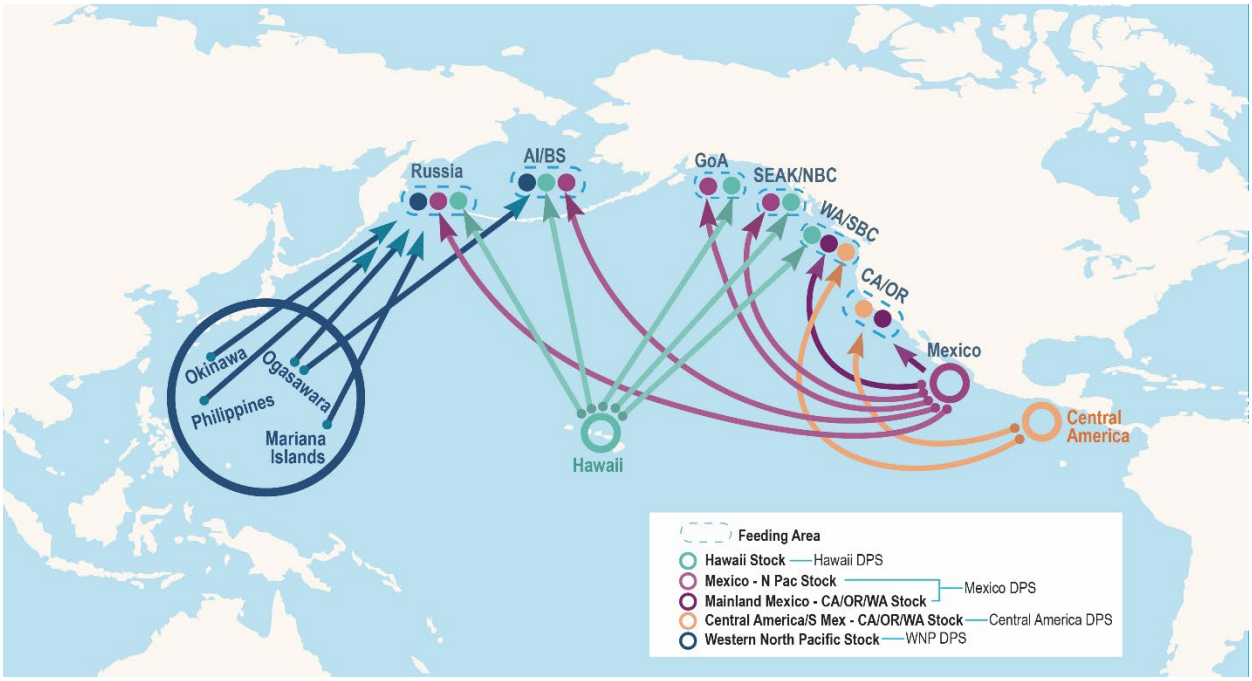

Figure 1. Pacific basin map showing wintering areas of five humpback whale stocks mentioned in this report. Also shown are summer feeding areas mentioned in the text. High-latitude summer feeding areas include Russia, Aleutian Islands / Bering Sea (AI/BS), Gulf of Alaska (GoA), Southeast Alaska / Northern 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 2023). 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.

<table>
<tr><th>DPS</th><th>ESA Status</th><th>DIPs / units</th><th>Stocks</th></tr>
<tr><td>Central America</td><td>Endangered</td><td>Central America - CA-OR-WA DIP</td><td>Central America / Southern Mexico - CA-OR-WA stock</td></tr>
<tr><td rowspan="2">Mexico</td><td rowspan="2">Threatened</td><td>Mainland Mexico - CA-OR-WA DIP</td><td>Mainland Mexico - CA-OR-WA stock</td></tr>
<tr><td>Mexico - North Pacific unit</td><td>Mexico - North Pacific stock</td></tr>
<tr><td rowspan="2">Hawai‘i</td><td rowspan="2">Not Listed</td><td>Hawai‘i - North Pacific unit</td><td rowspan="2">Hawai‘i stock</td></tr>
<tr><td>Hawai‘i - Southeast Alaska / Northern British Columbia DIP</td></tr>
</table>

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 2019, NMFS 2022a, NMFS 2023). 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 2019, NMFS 2022b, NMFS 2023). 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 2019, NMFS 2022b, NMFS 2023). 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 2019, NMFS 2022c, NMFS 2023). 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 2019, NMFS 2022d, NMFS 2023). 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 **Central America/Southern Mexico – California-Oregon-Washington stock** (Figure 2). In previous marine mammal stock assessments, humpback whales that summer and feed off California, Oregon, and Washington were treated as a single stock ("California-Oregon-Washington"), that included whales from three DPSs (Central America, Mexico, Hawai‘i), defined by separate wintering areas. Some Hawai'i stock whales occur in Washington state and Southern British Columbia waters during

summer (Calambokidis and Barlow 2020, Wade 2021), but the proportions using Washington vs Southern British Columbia waters during summer is unknown. The previous "California-Oregon-Washington" stock included animals from multiple DIPs (Central America – California-Oregon-Washington DIP, Mainland Mexico – California-Oregon-Washington DIP, and Hawai'i), which is inconsistent with management goals under the MMPA (NMFS 2019).

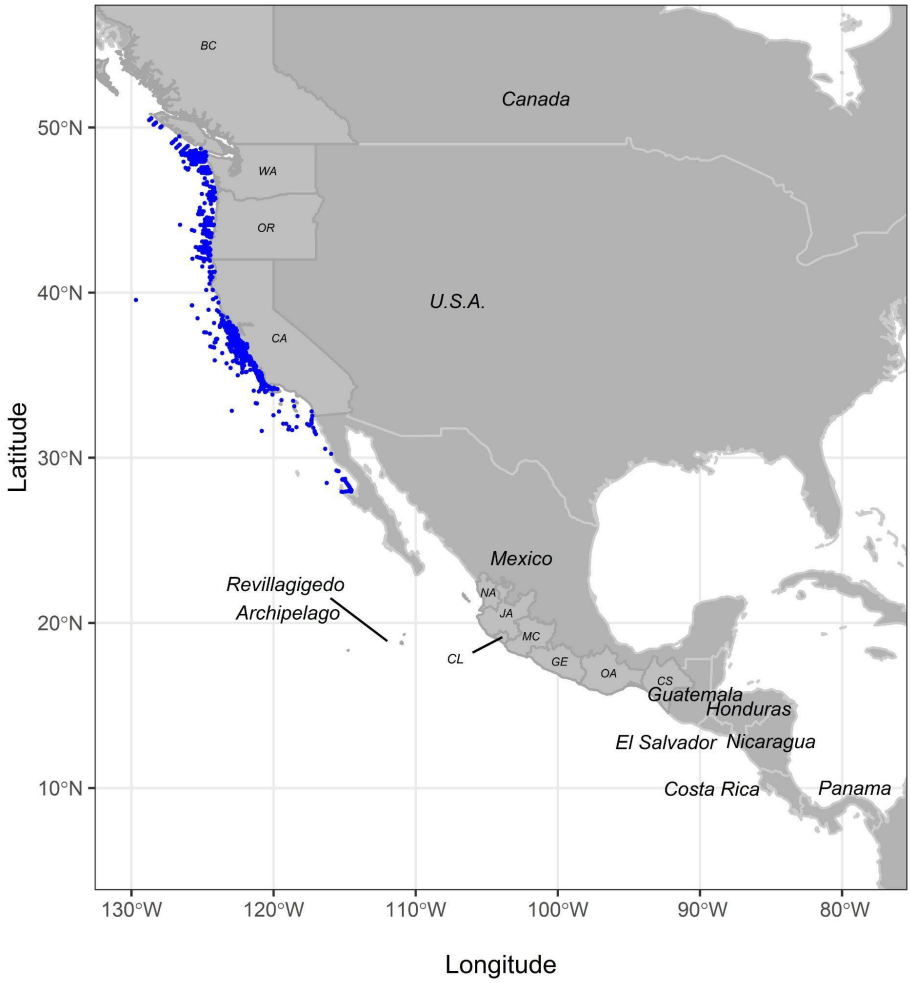

Figure 2. Wintering and summering areas for the Central America / Southern Mexico - CA-OR-WA stock of humpback whales. The primary wintering areas of the Central America / Southern Mexico - CA-OR-WA stock include the Pacific coasts of Nicaragua, Honduras, El Salvador, Guatemala, Panama, Costa Rica, with animals sometimes sighted as far north as Michoacán and Colima. Primary summering areas of whales from this stock include California and Oregon, with only a few individuals identified in the northern Washington/southern British Columbia feeding areas. Summering area sightings from 1991 - 2018 NMFS/SWFSC research vessel line-transect surveys are shown as blue dots and primarily represent whales from two stocks: the Central America / Southern Mexico - CA-OR-WA stock and Mainland Mexico - CA-OR-WA stock, although small numbers of whales from the Hawai'i stock also have been matched to WA and Southern British Columbia (Wade 2021). Country and state names abbreviations from north to south are: BC = British Columbia, WA = Washington state, OR = Oregon, CA = California, U.S.A. = United States of America, NA = Nayarit, JA = Jalisco, CL = Colima, MC = Michoacán, GE = Guerrero, OA = Oaxaca, and CS = Chiapas.

Population Size

Curtis *et al.* (2022) estimated the population size of whales wintering in southern Mexico and Central America using spatial capture-recapture methods based on photographic data collected between 2019 and 2021. Their

estimate of abundance is 1,496 (CV=0.171) whales and this represents the best estimate of abundance for the Central America / Southern Mexico - CA-OR-WA stock of humpback whales.

Minimum Population Estimate

The minimum population estimate for this stock is taken as the lower 20th percentile of the capture-recapture estimate from Curtis *et al.* (2022), or 1,284 whales.

Current Population Trend

The 2019-2021 abundance estimate for the Central America / Southern Mexico - CA/OR/WA stock (1,496, CV=0.171) is almost double the 2004-2006 estimate that excludes whales from southern Mexico (755 whales, CV=0.242) (Wade 2021). Given the time elapsed between the two estimates, if the increase were due purely to population growth, it would suggest an annual growth rate of approximately 4.7% (Curtis *et al.* 2022), which is lower than the 8.2% annual increase observed for the U.S. West Coast since 1989 (Calambokidis and Barlow 2020). Given inclusion of whales from southern Mexico in the current estimate, Curtis *et al.* (2022) derived a population growth rate for Central America / Southern Mexico whales based on differences between 2004-2006 estimates and the current estimate by excluding whales from southern Mexico, yielding an annual growth rate of 1.6% (SD = 2.0%) for this stock of humpback whales. However, the estimate has high uncertainty (Curtis *et al.* 2022).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Calambokidis and Barlow (2020) reported humpback whale abundance increased 8.2% annually in the California Current since 1989, based on mark-recapture estimates largely restricted to whales summering in California and Oregon waters. However, these estimates include whales from the Central America / Southern Mexico - CA/OR/WA stock and the Mainland Mexico - CA/OR/WA stocks. The maximum net productivity rate for the Central America / Southern Mexico - CA/OR/WA stock is unknown. However, the maximum net productivity rate can be taken to be at least as high as the maximum observed for the combined stocks, or 8.2% annually, though it could be higher if one of the stocks is growing faster than another.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,284), times one-half the estimated population growth rate for this stock of humpback whales (½ of 8.2%) times a recovery factor of 0.1 (for an endangered stock with N_{min}<1,500; NMFS 2023), resulting in a PBR of 5.2. Ryan *et al.* (2019) summarizes sighting and acoustic data, noting that humpbacks are present in central California waters at least 8 months annually, with December and April representing 'transition months', where whales are moving out of / into the region. Counting December and April each as one-half month of residency time during migration, plus the 7 months of May through November when whales are abundant, yields 8 months of residency time, or ⅔ of the year. This may be considered a minimum residency time, as some whales are still in U.S. waters from December to April. Therefore, the total PBR for this stock (5.2) is prorated by ⅔, to yield a PBR in U.S. waters of 3.5 whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Human-caused mortality and serious injury (MSI) of humpback whales in CA-OR-WA summer feeding areas includes whales from three stocks: **Central America / Southern Mexico – CA-OR-WA**; **Mainland Mexico – CA-OR-WA**; and **Hawai'i**. Where multiple stocks share a summer feeding area, total human-caused MSI for the mixed-stock area may be prorated to each stock using point estimates of summer to winter area movement probabilities in Wade (2021) (Table 2). Human-caused MSI from CA-OR-WA waters for the Hawai'i stock is summarized in the Alaska stock assessments (Young *et al*. 2023).

Table 2. Summer to winter area movement probabilities from Wade (2021) used for prorating human-caused MSI to stocks of humpback whales using CA/OR/WA waters in summer.

	Location of MSI	
Stock	**California or Oregon**	**Washington**
Central America/Southern Mexico - CA/OR/WA	0.423 (CV=0.23)	0.059 (CV=0.935)
Hawai'i	0.00	0.688 (CV=0.13)
Mainland Mexico – CA/OR/WA	0.577 (CV=0.169)	0.254 (CV=0.278)

Fishery Information

U.S. Commercial Fisheries

Table 3. Sources of humpback whale MSI in California (CA), Oregon (OR), and Washington (WA) commercial fisheries from 2016-2020, unless noted otherwise (Carretta 2022, Carretta *et al.* 2022, Jannot *et al.* 2021). Records include entanglements detected outside of U.S. waters, but confirmed to involve U.S. fisheries. Most cases represent strandings and at-sea sightings of entangled whales. Cases of entangled *unidentified whales* are prorated to humpback whale based on location, depth, and time of year (Carretta 2018). Sources derived from observer programs with statistical estimates of bycatch and uncertainty are shown with coefficients of variation (CV) where available. Totals for the Central America / Southern Mexico – CA-OR-WA stock are based on prorating CA-OR-WA cases by summer to winter area movement probabilities in Table 2. In 2017, there was one non-serious injury of a humpback involving two gear types: CA Coonstripe Shrimp Pot and WA/OR/CA Sablefish Pot.

Fishery	Cases	All CA-OR-WA Humpback Stocks ∑ MSI	Central America/Southern Mexico – CA-OR-WA Stock ∑ MSI	Central America/Southern Mexico – CA-OR-WA Stock Mean Annual MSI
CA Spot Prawn Trap	5	3.25	1.37	0.275
CA Dungeness Crab Pot	34	23.75	10.05	2.01
Dungeness Crab Pot (Commercial, state unknown)	2	2	0.846	0.169
OR Dungeness Crab Pot	2	1.75	0.740	0.148
WA Coastal Dungeness Crab Pot	7	5.5	0.324	0.065
Gillnet Fishery	6	2	0.846	0.169
Unidentified Fishery Interaction (whales identified as humpback)	58	43.75	17.60	3.52
Unidentified Fishery Interaction (unidentified whales prorated to humpback)	7	5.25	2.22	0.44
Unidentified Pot/Trap Fishery Entanglement	13	9.5	3.11	0.622
WA/OR/CA Sablefish Pot[1]	2	7.82 (CV>0.8)	3.31 (CV>0.8)	0.661 (CV>0.8)
CA Swordfish and Thresher Shark Drift Gillnet (Observer Program)[2]	0	0.1 (CV>0.8)	0.042 (CV>0.8)	≈0.01 (CV>0.8)
Totals	**136**	**104.7**	**40.45**	**8.1**

Other human-caused mortality and serious injury

Non-commercial sources of human-caused MSI, including tribal fisheries, recreational fisheries, marine debris (including research buoys) and vessel strikes are also responsible for a fraction of reported cases annually (Carretta *et al.* 2022). These sources and case totals are summarized in Tables 4 and 5.

[1] Estimates are based on 2015-2019 data (Jannot et al. 2021) 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 CA + OR waters. Other sablefish pot cases opportunistically reported (at-sea sightings of entangled whales, strandings) also occurred in CA/OR waters (Carretta et al. 2022). Estimates from Jannot et al. (2021) are used in this stock assessment report because annual MSI totals are higher than those reported based on opportunistic sightings (Carretta et al. 2022). Annual observer coverage varies between 14% and 72% for the LE fleet and between 2% and 12% for the OA fleet (Somers et al., 2020).

[2] There were no observed entanglements during 2016-2020 with 21% observer coverage, however the model-based estimate of bycatch is based on pooling 1990-2000 data, resulting in a small positive estimate (Carretta 2022).

Marine Debris, Recreational and Tribal Fisheries

Table 4. Sources of MSI from marine debris, recreational, and tribal fisheries from 2016-2020 summarized in Carretta *et al*. (2022).

Source	Cases	All CA-OR-WA Humpback Stocks ∑ MSI	Central America/Southern Mexico – CA-OR-WA Stock ∑ MSI	Central America/Southern Mexico – CA-OR-WA Stock Mean Annual MSI
Dungeness Crab Pot Fishery (Recreational)	2	1	0.423	0.085
Gillnet Fishery, Tribal	3	2.5	0.148	0.0295
Hook And Line Fishery	1	0.75	0.317	0.063
Marine Debris	1	1	0.423	0.085
Pot Fishery, Tribal	1	1	0.423	0.085
Spot Prawn Trap/Pot Fishery (Recreational)	1	0	0	0
Totals	**9**	**6.25**	**1.73**	**0.35**

Vessel Strikes

Fourteen vessel strike cases involving humpback whales were observed in CA-OR-WA waters during 2016-2020 (8 in CA, 1 in OR, and 5 in WA), totaling 13.2 MSI, or 2.6 whales per year (Carretta *et al.* 2022). Most vessel strikes are likely undetected and thus, we use estimates of vessel strike mortality reported by Rockwood *et al.* (2017) for this region. The estimated number of annual vessel strike deaths 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 EEZ 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 estimates of 22 deaths due to vessel strikes annually, the number attributed to the Central America / Southern Mexico - CA-OR-WA stock during 2016-2020 is 6.45 whales per year (Table 5). The estimated mortality of 6.45 humpback whales annually due to vessel strikes represents approximately 0.4% of the stock's estimated population size (6.45 deaths / 1,496 whales). 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.

Table 5. Summary of humpback whale vessel strike MSI during 2016-2020 (Carretta *et al*. 2022). Estimates are based on prorating annual estimates of humpback vessel strike mortality in this region (22/yr, Rockwood *et al*. 2017) by the fraction of observed vessel strikes in different feeding areas (WA vs CA/OR), which are then prorated to stock by summer to winter area movement probabilities from Wade (2021).

State Detected	Observations	Fraction of Observations	Fraction of Observations *times* 22 MSI/yr estimated by Rockwood et al. (2017)	Central America/Southern Mexico – CA-OR-WA stock prorated ∑ MSI based on summer to winter area movement probabilities (Wade 2021)
WA	5	0.357	7.86	0.463
CA/OR	9	0.643	14.14	5.98
Total	**14**			**6.45**

Vessel strikes in U.S. West Coast EEZ waters continue to impact large whales (Redfern *et al.* 2013; 2019; Moore *et al.* 2018). A complex of diverse vessel types, speeds, and destination ports all contribute to variability in vessel traffic and these factors may be influenced by economic and regulatory changes. For example, Moore *et al.*

(2018) found that primary routes traveled by vessels changed when emission control areas (ECAs) were established off the U.S. West Coast. They also found that large vessels typically reduced their speed by 3-6 kts in ECAs between 2008 and 2015. The speed reductions are thought to be a strategy to reduce operating costs associated with more expensive, cleaner burning fuels required within the ECAs. In contrast, Moore *et al.* (2018) noted that some vessels increased speed when transiting longer routes to avoid the ECAs. Further research is ongoing to understand how variability in vessel traffic affects vessel strike risk and mitigation strategies, though Redfern *et al.* (2019) note that a combination of vessel speed reductions and expansion of areas to be avoided should be considered. Rockwood *et al.* (2017) note that 82% of humpback whale vessel strike mortalities occur within 10% of the region, implying that vessel strike mitigation measures may be effective if applied over relatively small regions.

Historic whaling

Approximately 15,000 humpback whales were taken from the North Pacific from 1919 to 1987 (Tonnessen and Johnsen 1982), of these, approximately 8,000 were from the west coast of Baja California, California, Oregon and Washington (Rice 1978). Shore-based whaling depleted the humpback whale stock off California twice: once prior to 1925 (Clapham *et al.* 1997) and again between 1956 and 1965 (Rice 1974). There has been a prohibition on taking humpback whales since 1966.

Habitat Concerns

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 2016c). 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 (Hauser *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).

Seven important feeding areas for humpback whales are identified off the U.S. west coast by Calambokidis *et al.* (2015), including five in California, one in Oregon, and one in Washington. Humpback whales have increasingly reoccupied areas inside of Puget Sound (the 'Salish Sea'), a region where they were historically abundant prior to whaling (Calambokidis *et al.* 2017).

STATUS OF STOCK

The Central America / Southern Mexico - CA-OR-WA stock of humpback whales is a DIP delineated from the 'Central America DPS' of humpback whales listed as endangered under the ESA (Bettridge *et al.* 2015, Taylor *et al.* 2021), and is therefore considered 'depleted' and 'strategic' under the MMPA. Total annual human-caused serious injury and mortality of humpback whales is the sum of commercial fishery MSI (8.1/yr) + vessel strikes (6.45/yr), + non-commercial sources of MSI (0.35/yr), or 14.9 humpback whales annually. Total commercial fishery MSI (8.1/yr) is greater than the calculated PBR (3.5) for this stock, thus, it is not approaching zero mortality and serious injury rate. There is no estimate of the undocumented fraction of anthropogenic injuries and deaths to humpback whales on the U.S. West Coast, but for vessel strikes, a comparison of observed vs. estimated annual vessel strikes suggests that approximately 10% of vessel strikes are documented. The stock is estimated to have grown at 1.6% annually (SD = 2.0%) between 2004-2006 and 2019-2021 Curtis *et al.* (2022), but this estimate has high uncertainty. Habitat concerns include sensitivity to anthropogenic sound sources.

REFERENCES

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. Acoustic Research Letters Online 3:65-70.

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

Baker, C.S., Steel, D., Calambokidis, J., Falcone, E., González-Peral, U., Barlow, J., Burdin, A.M., Clapham, P.J., Ford, J.K., Gabriele, C.M. and Mattila, D., 2013. Strong maternal fidelity and natal philopatry shape genetic structure in North Pacific humpback whales. *Marine Ecology Progress Series*, *494*, pp.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.

Becker, E.A., Forney, K.A., Fiedler, P.C., Barlow, J., Chivers, S.J., Edwards, C.A., Moore, A.M. and Redfern, J.V., 2016. Moving Towards Dynamic Ocean Management: How Well Do Modeled Ocean Products Predict Species Distributions? Remote Sensing, 8(2), p.149.

Becker, E. A., K. A. Forney, E. M. Oleson, A. L. Bradford, R. Hoopes, J. E. Moore, and J. Barlow. 2022. Abundance, distribution, and seasonality of cetaceans within the U.S. Exclusive Economic Zone around the Hawaiian Archipelago based on species distribution models. U.S. Dept. of Commer., NOAA Tech. Memo. NMFSPIFSC-131, 45 p.

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

Calambokidis, J., Steiger, G.H., Straley, J.M., Herman, L.M., Cerchio, S., Salden, D.R., Jorge, U.R., Jacobsen, J.K., Ziegesar, O.V., Balcomb, K.C. and Gabriele, C.M., 2001. Movements and population structure of humpback whales in the North Pacific. *Marine mammal science*, *17*(4), pp.769-794.

Calambokidis, J., E.A. Falcone, T.J. Quinn*, et al.* 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., G.H. Steiger, C. Curtice, J. Harrison, M.C. Ferguson, E. Becker, M. DeAngelis, and S.M. Van Parijs. 2015. Biologically Important Areas for Selected Cetaceans Within U.S. Waters – West Coast Region. Aquatic Mammals 41(1):39-53.

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.

Calambokidis, J. and J. Barlow. 2020. Updated abundance estimates for blue and humpback whales along the U.S. West Coast using data through 2018, U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-634. https://repository.library.noaa.gov/view/noaa/27104

Carretta, J.V. 2018. A machine-learning approach to assign species to 'unidentified' entangled whales. Endangered Species Research Vol. 36: 89–98. DOI: https://doi.org/10.3354/esr00894

Carretta, J.V. 2022. Estimates of marine mammal, sea turtle, and seabird bycatch in the California large-mesh drift gillnet fishery: 1990-2020. NOAA Technical Memorandum NMFS-SWFSC-666. https://doi.org/10.25923/9z2t-4829

Carretta, J.V., J. Greenman, K. Wilkinson, L. Saez, D. Lawson, and J. Viezbicke. 2022. Sources of human-related injury and mortality for U.S. Pacific West Coast Marine Mammal Stock Assessments, 2016-2020. NOAA Technical Memorandum NMFS-SWFSC-670. 246 pp. https://doi.org/10.25923/d79a-kg51

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.

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

Curtis, K. Alexandra, John Calambokidis, Katherina Audley, Melvin G. Castaneda, Joëlle De Weerdt, Andrea Jacqueline García Chávez, Frank Garita, Pamela Martínez-Loustalot, Jose D. Palacios-Alfaro, Betzi Pérez, Ester Quintana-Rizzo, Raúl Ramírez Barragan, Nicola Ransome, Kristin Rasmussen, Jorge Urbán R., Francisco Villegas Zurita, Kiirsten Flynn, Ted Cheeseman, Jay Barlow, Debbie Steel, and Jeffrey Moore. 2022. Abundance of humpback whales (*Megaptera novaeangliae*) wintering in Central America and southern Mexico from a one-dimensional spatial capture-recapture model. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-661. https://doi.org/10.25923/9cq1-rx80

Erbe, C., Reichmuth C., Cunningham K., Lucke K., Dooling R. (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

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.

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

Jackson, J.A., Steel, D.J., Beerli, P., Congdon, B.C., Olavarría, C., Leslie, M.S., Pomilla, C., Rosenbaum, H. and Baker, C.S., 2014. Global diversity and oceanic divergence of humpback whales (Megaptera novaeangliae). *Proceedings of the Royal Society B: Biological Sciences*, *281*(1786), p.20133222.

Jannot J.E., Ward E.J., Somers K.A., Feist B.E., Good T.P., Lawson D. and Carretta J.V. 2021. Using Bayesian Models to Estimate Humpback Whale Entanglements in the United States West Coast Sablefish Pot Fishery. Front. Mar. Sci. 8:775187. doi: 10.3389/fmars.2021.775187

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. P. 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. P. 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. NOAA-TM-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. NOAA-TM-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. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-658. https://doi.org/10.25923/nvw1-mz45

Martien, K.K., Taylor, B.L., Lang, A.R., Clapham, P.J., Weller, D.W., Archer, F.I. and Calambokidis, J., 2023. The migratory whale herd concept: A novel unit to conserve under the ecological paradigm. Marine Mammal Science. https://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.

McKenna M., Calambokidis J., Oleson E., Laist D., Goldbogen J. 2015. Simultaneous tracking of blue whales and large ships demonstrates limited behavioral responses for avoiding collision. Endangered Species Research 27: 219-232. https://doi.org/10.3354/esr00666

Moore, T.J, J.V. Redfern, M. Carver, S. Hastings, J.D. Adams, and G.K. Silber. Exploring ship traffic variability off California. 2018. Ocean and Coastal Management 163:515-527.

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 at: https://media.fisheries.noaa.gov/dam-migration/02-204-03.pdf

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.

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.

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.

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.

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

NOAA. 2016. Ocean noise strategy roadmap. https://cetsound.noaa.gov/road-map

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-TM-NMFS-PIFSC-124, 27 p.

Redfern, J. V., M. F. McKenna, T. J. Moore, J. Calambokidis, M. L. DeAngelis, E. A. Becker, J. Barlow, K. A. Forney, P. C. Fiedler, and S. J. Chivers. 2013. Assessing the risk of ships striking large whales in marine spatial planning. Conservation Biology, 27:292-302.

Redfern, J.V., T.J. Moore, E.A. Becker, J. Calambokidis, S.P. Hastings, L.M. Irvine, B.R. Mate, D.M. Palacios. 2019. Evaluating stakeholder-derived strategies to reduce the risk of ships striking whales. Diversity and Distributions.

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

Rockwood, R.C., Calambokidis, J. and Jahncke, J., 2017. High mortality of blue, humpback and fin whales from modeling of vessel collisions on the US West Coast suggests population impacts and insufficient protection. *PLoS One*, *12*(8), p.e0183052.

Ryan J.P., Cline D.E., Joseph J.E., Margolina, T., Santora J.A., Kudela R.M., et al. (2019) Humpback whale song occurrence reflects ecosystem variability in feeding and migratory habitat of the northeast Pacific. PLoS ONE 14(9): e0222456.

Somers, K. A., Whitmire, C. E., Richerson, K., Jannot, J. E., Tuttle, V. J., and Mcveigh, J. 2020. Fishing Effort in the 2002-17 Pacific Coast Groundfish Fisheries. NOAA Technical Memorandum NMFS-NWFSC-153. Seattle, WA.

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, J. Urbán Ramírez. 2021. Evaluation of Humpback Whales Wintering in Central America and Southern Mexico as a Demographically Independent Population. NOAA Technical Memorandum, NOAA-NMFS-SWFSC-655.

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.

Young, N.C., Muto, M. M., V. T. Helker, B. J. Delean, J. C. Freed, R. P. Angliss, N. A. Friday, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, J. L. Crance, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, K. T. Goetz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R.

Wade, J. M. Waite, and A. N. Zerbini. 2022. Alaska marine mammal stock assessments, 2023. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-xxx, xxx p.