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HUMPBACK WHALE (*Megaptera novaeangliae*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Humpback whales occur throughout the North Pacific, with multiple populations currently recognized based on low-latitude winter breeding areas (Baker et al. 1998, Calambokidis et al. 2001, Calambokidis et al. 2008, Barlow et al. 2011, Fleming and Jackson 2011). North Pacific breeding areas fall broadly into three regions, including the 1) western Pacific (Japan and Philippines); 2) central Pacific (Hawaiian Islands); and 3) eastern Pacific (Central America and Mexico) (Calambokidis et al. 2008). Exchange of animals between breeding areas rarely occurs, based on photo-identification data of individual whales (Calambokidis et al. 2001, Calambokidis et al. 2008). Photo-identification evidence also suggests strong site fidelity to feeding areas, but animals from multiple feeding areas converge on common winter breeding areas (Calambokidis et al. 2008). Baker *et al*. (2008) reported significant differences in mtDNA haplotype frequencies among different breeding and feeding areas in the North Pacific, reflecting strong matrilineal site fidelity to the respective migratory destinations. The most significant differences in haplotype frequencies were found between the California/Oregon feeding area and Russian and Southeastern Alaska feeding areas (Baker et al. 2008). Among breeding areas, the greatest level of differentiation was found between Okinawa and Central America and most other breeding grounds (Baker et al. 2008). Genetic differences between feeding and breeding grounds were also found, even for areas where regular exchange of animals between feeding and breeding grounds is confirmed by photo-identification (Baker et al. 2008).

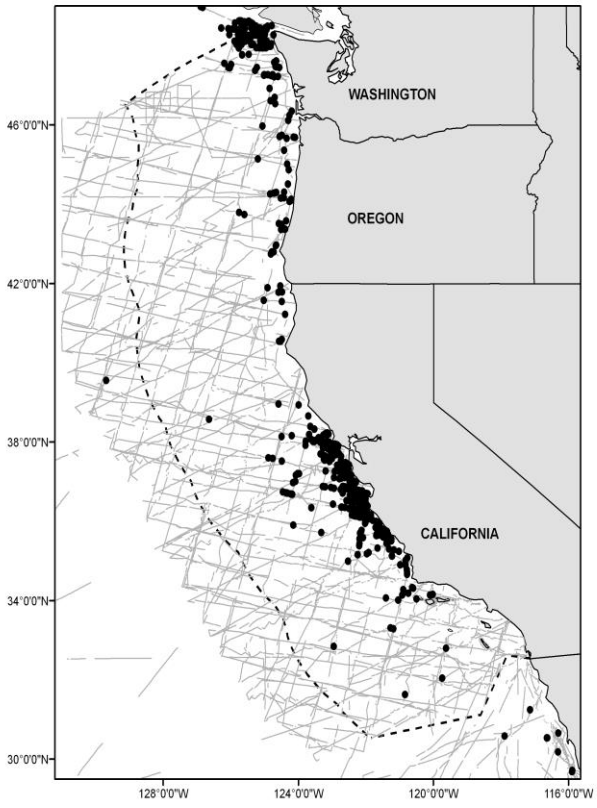

Figure 1. Humpback whale sightings based on shipboard surveys off California, Oregon, and Washington, 1991-2008. Dashed line represents the U.S. EEZ, thin lines indicate completed transect effort of all surveys combined. See Appendix 2 for data sources and information on timing and location of survey effort.

Along the U.S. west coast, one stock is currently recognized, which includes animals that appear to be part of two separate feeding groups, a California and Oregon feeding group and a northern Washington and southern British Columbia feeding group (Calambokidis et al. 2008, Barlow et al. 2011). Very few photographic matches between these feeding groups have been documented (Calambokidis et al. 2008). Humpbacks from both groups have been photographically matched to breeding areas off Central America, mainland Mexico, and Baja California, but whales from the northern Washington and southern British Columbia feeding group also winter near the Hawaiian Islands and the Revillagigedo Islands off Mexico (Barlow et al. 2011).

For the Marine Mammal Protection Act (MMPA) stock assessment reports, the California/Oregon/Washington Stock is defined to include humpback whales that feed off the west coast of the United States, including animals from both the California-Oregon and Washington-southern British Columbia feeding groups (Calambokidis et al. 1996, Calambokidis et al. 2008, Barlow et al. 2011). Three other stocks are recognized in the U.S. MMPA Pacific stock assessment reports: the Central North Pacific Stock (with feeding areas from Southeast Alaska to the Alaska Peninsula), the Western North Pacific Stock (with feeding areas from the

Aleutian Islands, the Bering Sea, and Russia), and the American Samoa Stock in the South Pacific (with largely undocumented feeding areas as far south as the Antarctic Peninsula).

POPULATION SIZE

Based on whaling statistics, the pre-1905 population of humpback whales in the North Pacific was estimated to be 15,000 (Rice 1978), but this population was reduced by whaling to approximately 1,200 by 1966 (Johnson and Wolman 1984). A photo-identification study in 2004-2006 estimated the abundance of humpback whales in the entire Pacific Basin to be 21,808 (CV=0.04) (Barlow et al. 2011). Barlow (2010) recently estimated 1,090 (CV=0.41) humpback whales from a 2008 summer/fall ship line-transect survey of California, Oregon, and Washington waters. Abundance estimates from photographic mark-recapture surveys conducted in California and Oregon waters every year from 1991 through 2011 represent the most current estimates (Calambokidis 2013). These estimates include only animals photographed in California and Oregon waters and not animals that are part of the separate feeding group found off Washington state and southern British Columbia (Calambokidis et al. 2009). California and Oregon estimates range from approximately 1,100 to 2,600 animals, depending on the choice of recapture model and sampling period (Figure 2). The best estimate of abundance for California and Oregon waters is taken as the 2008-2011 Darroch estimate of 1,729 (CV = 0.03) whales, which is also the most precise estimate (Calambokidis 2013).

Calambokidis et al. (2008) reported a range of photographic mark-recapture abundance estimates (145 – 469) for the northern Washington and southern British Columbia feeding group most recently in 2005. The best model estimate from that paper (lowest AIC_c score) was reported as 189 (CV not reported) animals. This estimate is approximately 8 years old and will soon be outdated for use in stock assessments.

Combining abundance estimates from both the California/Oregon and Washington/southern British Columbia feeding groups (1,729 + 189) yields an estimate of 1,918 (CV≈0.03) animals for the California/Oregon/Washington stock. The approximate CV of 0.03 for the combined estimate reflects that a vast majority of the variance is derived from the California and Oregon estimate (CV=0.03) and that no CV was provided for the Washington state and southern British Columbia estimate.

Minimum Population Estimate

The minimum population estimate for humpback whales in the California/Oregon/Washington stock is taken as the lower 20th percentile of the log-normal distribution of the combined mark-recapture estimate for both feeding groups given above, or 1,876 animals.

Current Population Trend

Ship surveys provide some indication that humpback whales increased in abundance in California coastal waters between 1979/80 and 1991 (Barlow 1994) and between 1991 and 2005 (Barlow and Forney 2007; Forney 2007), but this increase was not steady, and estimates showed a slight dip in 2001. Mark-recapture population estimates had shown a long-term increase of approximately 7.5% per year (Calambokidis et al. 2009, Figure 2), but more recent estimates show variable trends (Figure 2), depending on the choice of model and time frame used (Calambokidis 2013). Population estimates for the entire North Pacific have also increased substantially from 1,200 in 1966 to approximately 18,000 - 20,000 whales in 2004 to 2006 (Calambokidis et al. 2008). Although these estimates are based on different methods and the earlier estimate is extremely uncertain, the growth rate implied by these estimates (6-7%) is consistent with growth rate of the California/Oregon/Washington stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

The proportion of calves in the California/Oregon/Washington stock from 1986 to 1994 appeared much lower than previously measured for humpback whales in other areas (Calambokidis and Steiger 1994), but in 1995-97 a greater proportion of calves were identified, and the 1997 reproductive rates for this population are closer to those reported for humpback whale populations in other regions (Calambokidis et al. 1998). Despite the apparently low proportion of calves, two independent lines of evidence indicate that this stock was growing in the 1980s and early 1990s (Barlow 1994; Calambokidis et al. 2003) with a best estimate of 8% growth per year (Calambokidis et al. 1999). The current net productivity rate is unknown.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,855) times one half the estimated population growth rate for this stock of humpback whales (½ of 8%) times a recovery factor of 0.3 (for an endangered species, with $N_{min} > 1,500$ and $CV(N_{min}) < 0.50$), resulting in a PBR of

22. Because this stock spends approximately half its time outside the U.S. EEZ, the PBR allocation for U.S. waters is 11 whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen *et al*. 2008, NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*". Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

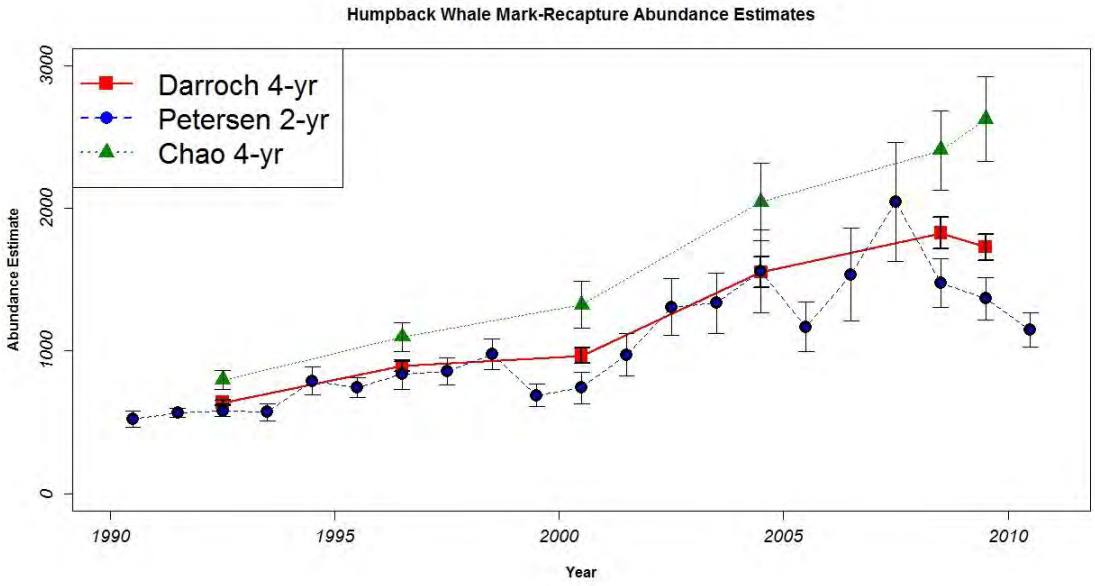

Figure 2. Mark-recapture estimates of humpback whale abundance in California and Oregon, 1991-2011, based on 3 different mark-recapture models and sampling periods (Calambokidis 2013). Vertical bars indicate ±2 standard errors of each abundance estimate. Darroch and Chao models use 4 consecutive non-overlapping sample years, except for the last estimates, which use the four most recent years, but overlap with the next-to-last estimate (Calambokidis 2013).

Fishery Information

Pot and trap fisheries are the most commonly documented source of serious injury and mortality of humpback whales in U.S. west coast waters (Carretta et al. 2013). Between 2007 and 2011, there were 16 documented humpback whale interactions with pot/trap fisheries (Carretta et al. 2013). Of the 16 documented interactions, 10 were identified as generic 'crab pot/trap' and 4 as 'unidentified pot/trap' fishery. Two interactions identified as generic 'crab pot fishery entanglements' in Oregon resulted in the death of whales. An additional 4 serious injuries and 10 prorated serious injuries of humpbacks occurred during this same period (Carretta et al. 2013). Two interactions with serious injuries had gear positively identified: the CA lobster trap fishery and the CA dungeness crab fishery.

Gillnet and unidentified fisheries accounted for 10 interactions with humpback whales between 2007 and 2011 (1 death, 7 serious injuries, and 2 prorated serious injuries). Only one record had a positive identification of the fishery: a self-report of a humpback released with trailing gear from the CA swordfish drift gillnet fishery in 2009. This was designated as a prorated serious injury (prorate value = 0.75), based on a lack of detail regarding the amount of trailing gear or if the gear was constricting in any way. No humpback whales were reported entangled by fishery observers in the California swordfish drift gillnet fishery during 2007-2011 (Carretta and Enriquez 2009a, 2009b, 2010, 2012a, 2012b). The remaining 9 fishery interactions involved humpback whales entangled in ropes and unidentified nets. A summary of human-caused mortality and serious injury of humpback whales from

commercial fisheries during 2007 to 2011 is provided in Table 1. Serious injury designations follow the new NMFS serious injury policy implemented in 2012 (Carretta et al. 2013, NOAA 2012). Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki et al. 1993), but no recent bycatch data from Mexico are available.

Table 1. Summary of available information on the incidental mortality and serious injury of humpback whales (California/Oregon/Washington stock) for commercial fisheries that are likely to take this species (Carretta et al. 2013 Mean annual takes are based on 2007-2011 data unless noted otherwise. Serious injuries may include prorated serious injuries with values less than one (NOAA 2012), thus the sum of serious injury and mortality may not be a whole number.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality (and serious injury)	Estimated mortality	Mean Annual Takes
CA swordfish and thresher shark drift gillnet fishery	2007 2008 2009 2010 2011	observer	16.4% 13.5% 13.3% 11.9% 19.5%	0 0 0 0 0	0 0 0 0 0	0 (n/a)
CA halibut and white seabass and other species large mesh (>3.5") set gillnet fishery	2004 2005 2006 2007 2008	observer	0% 0% ~1% 17.8% 0%	n/a n/a n/a 0 (0) n/a	n/a	0 (n/a)
Pot or trap fisheries (includes identified and unidentified pot/trap interactions)	2007-2011	Strandings & sightings	n/a	2 (11.5)	n/a	≥ 2.7
unidentified fisheries	2007-2011	Strandings & sightings	n/a	1 (7.5)	n/a	≥ 1.7
Total Annual Takes						≥ 4.4

Ship Strikes

Eight humpback whales were reported struck by vessels between 2007 and 2011 (Carretta et al. 2013). Four deaths, two non-serious injuries, one serious injury, and one prorated serious injury (prorate value = 0.36) resulted from vessel strikes during this period (Carretta et al. 2013). In addition, there were four serious injuries to unidentified large whales from ship strikes during this time. The average annual serious injury and mortality attributable to ship strikes during 2007-2011 is 1.1 whales per year (4 deaths, plus one serious injury, plus one prorated serious injury = 5.36 deaths or injuries / 5-yr period).

Other human-caused mortality

The average number of observed humpback deaths from unknown anthropogenic sources is zero during 2007-2011.

STATUS OF STOCK

Approximately 15,000 humpback whales were taken from the North Pacific from 1919 to 1987 (Tonnessen and Johnsen 1982; C. Allison, IWC unpubl. Data), and, of these, approximately 8,000 were taken from the west coast of Baja California, California, Oregon and Washington (Rice 1978), presumably from this stock. Shore-based whaling apparently 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. As a result of commercial whaling, humpback whales were listed as "endangered" under the Endangered Species Conservation Act of 1969. This protection was transferred to the Endangered Species Act (ESA) in 1973. The species is still listed as "endangered", and consequently the California/Oregon/Washington stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The estimated annual mortality and serious injury due to entanglement (4.4/yr), other anthropogenic sources (zero), plus ship strikes (1.1/yr) in California is less than the PBR allocation of 11 for U.S. waters. Based on strandings and at sea observations, annual humpback whale mortality and serious injury in commercial fisheries is greater than 10% of the PBR; therefore, total fishery mortality and serious injury is not approaching zero mortality and serious injury rate.

The California/Oregon/Washington stock underwent a long-term increase from 1990 through approximately 2008 (Figure 2), but more recent estimates have shown variable trends.

Habitat Concerns

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, have been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound. 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). Behavioral changes associated with exposure to simulated mid-frequency sonar, including no change in behavior, cessation of feeding, increased swimming speeds, and movement away from simulated sound sources has been documented in tagged blue whales (Goldbogen et al. 2013), but it is unknown if humpback whales respond in the same manner to such sounds.

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