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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Although the International Whaling Commission (IWC) only considered one stock (Donovan 1991), there is now good evidence for multiple populations of humpback whales in the North Pacific (Johnson and Wolman 1984; Baker et al. 1990). Humpback whales in the North Pacific feed in coastal waters from California to Russia and in the Bering Sea. They migrate south to wintering destinations off Mexico, Central America, Hawaii, southern Japan, and the Philippines. Mitochondrial and nuclear genetic markers show that considerable structure exists in humpback whale populations in the North Pacific (Baker et al. 1998). Significant levels of mitochondrial and nuclear genetic differences were found between central California and Southeast Alaska feeding areas (Baker et al. 1998). Mitochondrial genetic differences are also found between feeding area in the Atlantic (Palsboll et al. 1995). The genetic exchange rate between California and Alaska is estimated to be less than 1 female per generation (Baker 1992). Two breeding areas (Hawaii and coastal Mexico) showed fewer genetic differences than did the two feeding areas (Baker 1992). Individually identified whales have been found to move between winter breeding areas in Hawaii and Mexico (Baker et al. 1990). There have been no individual matches between 597 humpbacks photographed in California and 617 humpbacks photographed in Alaska (Calambokidis et al. 1996). Only two of the 81 whales photographed in British Columbia have matched with a California catalog (Calambokidis et al. 1996), indicating that the U.S./Canada border is an approximate geographic boundary between feeding populations. Waters off northern Washington may be an area of mixing between the California/Oregon/Washington stock and a southern British Columbia stock. For humpback whales, maternally directed fidelity to specific feeding areas within an ocean basin appears to be so strong that genetic differences have evolved in both the Atlantic, where there is a single breeding area, and in the Pacific, where there are multiple breeding areas. Because fidelity appears to be greater in feeding areas than in breeding areas, the stock structure of humpback whales is defined based on feeding areas.

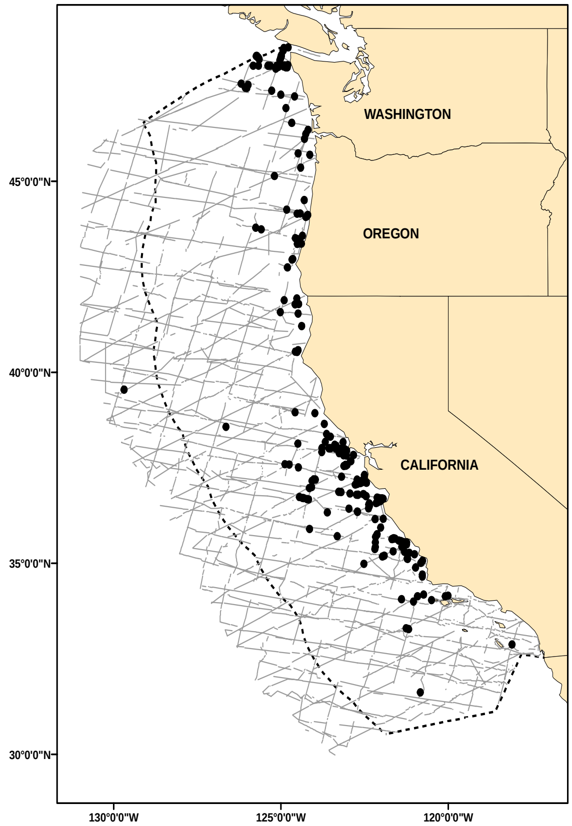

Figure 1. Humpback whale sightings based on shipboard surveys off California, Oregon, and Washington, 1991-2005. Dashed line represents the U.S. EEZ, thin lines indicate completed transect effort of all surveys combined. See Appendix 2 for data sources and information on timing and location of survey effort.

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. The winter migratory destination of this stock is primarily in coastal waters of Mexico and Central America. Two other stocks are recognized in the U.S. MMPA stock assessment reports: the Central North Pacific Stock (with feeding areas from Southeast Alaska to the Alaska Peninsula) and the Western North Pacific Stock (with feeding areas from the Aleutian Islands, the Bering Sea, and Russia).

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). The North Pacific total now almost certainly exceeds 6,000 humpback whales (Calambokidis et al. 1997). Barlow and Forney (2007) estimated 1,096 (CV= 0.22) humpbacks in California, Oregon, and Washington waters based on summer/fall ship line-transect surveys in 2001. Forney (2007) estimated 1,769 (CV=0.16) humpbacks in the same region based on a 2005 summer/fall ship line-transect survey, which included additional fine-scale coastal strata not included in the 2001 survey. The combined 2001 and 2005 line-transect estimate of abundance is the geometric mean of the two annual estimates, or 1,392 (CV=0.13). Calambokidis et al. (2004) estimated humpback whale abundance in these feeding areas from 1991 to 2003 using Petersen mark-recapture estimates based on photo-identification collections in adjacent pairs of years (Figure 2). These data show a general upward trend in abundance followed by a large (but not statistically significant) drop in the 1999/2000 and 2000/2001 estimates. The 2002/2003 mark-recapture population estimate (1,391, CV=0.22) is higher than any previous mark-recapture estimates and may indicate that the apparent decline in the previous two estimates exaggerates any real decline that might have occurred (Calambokidis et al. 2003) or that a real decline was followed by an influx of new whales from another area (Calambokidis et al. 2004). This latter view is substantiated by the greater fraction of new whales seen for the first time in 2003 (Calambokidis et al. 2004). In general, mark-recapture estimates are negatively biased due to heterogeneity in sighting probabilities (Hammond 1986); however, this bias is likely to be minimal because the above mark-recapture estimate is based on data from nearly half of the entire population (the 2002/2003 data contained 542 known individuals). The best estimate of abundance is the unweighted geometric mean of 2002/2003 mark-recapture and 2001-2005 line transect estimates, or 1,391 (CV=0.13) whales.

Minimum Population Estimate

The minimum population estimate for humpback whales in the California/Mexico stock is taken as the lower 20th percentile of the log-normal distribution of the unweighted mean estimate or approximately 1,250.

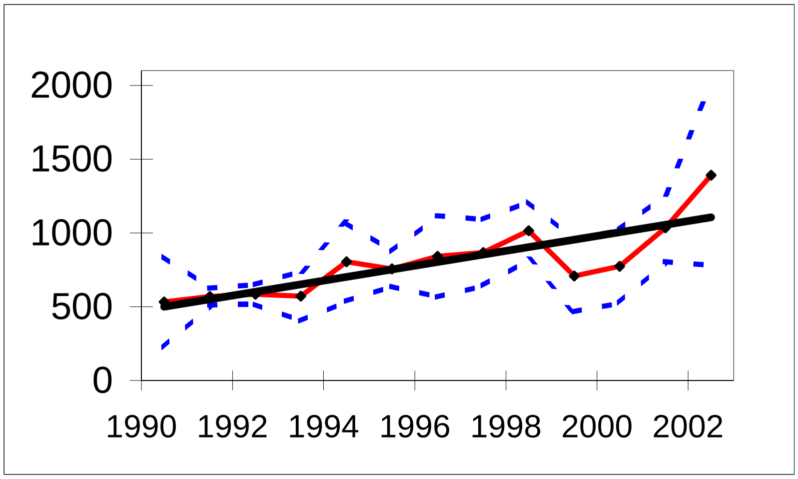

Figure 2. Mark-recapture estimates of the abundance of humpback whales feeding off California, Oregon, and Washington, based on photo-identification studies (Calambokidis et al. 2004). Dotted lines indicate +/- 2 standard errors for each estimate. Straight, bold line indicates linear regression.

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 increased steadily from 1988/90 to 1997-98 at about 8% per year (Calambokidis et al. 1999), showed a decrease around 1999-2001, and then increased again in 2002-2003 (Figure 2, Calambokidis et al. 2004) The observed decrease in abundance between 1999-2001 may have been related to prevailing oceanographic conditions off the U.S. west coast. The apparent dip in the 1999/2000 and 2000/2001 estimates may indicate that population growth is slowing, but the subsequent increases in 2001/2002 and 2002/2003 casts some doubt on this explanation. Population estimates for the entire North Pacific have also increased substantially from 1,200 in 1966 to 6,000-8,000 circa 1992. 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 the recently observed 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 (1,250) <u>times</u> one half the estimated population growth rate for this stock of humpback whales (½ of 8%) <u>times</u> a recovery factor of 0.1 (for an endangered species with $N_{min} < 1,500$), resulting in a PBR of 5. Because this stock spends approximately half its time outside the U.S. EEZ, the PBR allocation for U.S. waters is 2.5 whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information on historic whaling has been moved to the Status of Stock section.

Fishery Information

A summary of known fishery mortality and injury for this stock of humpback whales for 2002-2006 is given in Table 1. A total of 14 humpback whales were observed entangled in fishing gear from 2002-2006 in California and Oregon. No entanglements were reported from the observer program that monitors the large-mesh swordfish and thresher shark drift gillnet fishery (Carretta and Chivers 2004, Carretta et al. 2005a, 2005b, Carretta and Enriquez 2006, 2007); however, a free-swimming humpback was observed entangled in gillnet gear of unknown origin in 2006 (NMFS, Southwest Regional Stranding Program, unpublished data). Ten humpbacks were reported entangled at sea in trap/pot fishery gear off California and Oregon during 2002-2006, including one animal that was later found dead in Oregon (Northwest Regional Stranding Program, unpublished data). One whale was entangled in sablefish trap gear and another in spot prawn trap gear (NMFS, Southwest Regional Stranding Program, unpublished data). The whale entangled in sablefish trap gear was successfully disentangled by divers who removed all the gear, and the animal swam away immediately following disentanglement. The remaining seven entanglements were attributed to unknown trap/pot gear or crab pot line. Two of the sightings involving crab pot gear were cow/calf pairs where the cow was entangled. Three additional whales were observed entangled in net/rope or other gear of unknown origin during this same period. Other unobserved fisheries may also result in injuries or deaths of humpback whales. Other than the humpback that died off Oregon in 2006 and the whale disentangled from the sablefish trap gear, the final status of the 12 remaining entangled whales is unknown. Due to the trailing gear, they are considered as serious injuries in Table 1. Including the 12 serious injuries and 1 mortality, total mean annual serious injury and mortality for the commercial fisheries listed in Table 1 is 2.6 per year for the period 2002-2006.

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and may take animals from the same population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which uses vessels, gear, and operational procedures similar to those in the U.S. drift gillnet fishery, although nets may be up to 4.5 km long (Holts and Sosa-Nishizaki 1998). The fleet increased from two vessels in 1986 to 31 vessels in 1993 (Holts and Sosa-Nishizaki 1998). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2700, with an observed rate of marine mammal bycatch of 0.13 animals per set (10 marine mammals in 77 observed sets; Sosa-Nishizaki et al. 1993). This overall mortality rate is similar to that observed in California driftnet fisheries during 1990-95 (0.14 marine mammals per set; Julian and Beeson, 1998), but species-specific information is not available for the Mexican fisheries. Previous efforts to convert the Mexican swordfish driftnet fishery to a longline fishery have resulted in a mixed-fishery, with 20 vessels alternately using longlines or driftnets, 23 using driftnets only, 22 using longlines only, and seven with unknown gear type (Berdegué 2002).

Table 1. Summary of available information on the incidental mortality and injury of humpback whales (eastern North Pacific stock) for commercial fisheries that might take this species (Carretta and Chivers 2004, Carretta et al. 2005a, 2005b). Injury includes any entanglement that does not result in immediate death and may include serious injury resulting in death. n/a indicates that data are not available. Mean annual takes are based on 2002-2006 data unless noted otherwise.

Fishery Name	**Year(s)**	**Data Type**	**Percent Observer Coverage**	**Observed Mortality (and injury)**	**Estimated mortality**	**Mean Annual Takes**
CA/OR thresher shark/swordfish drift gillnet fishery	2002 2003 2004 2005 2006	Observer	22.1% 20.2% 20.6% 20.9% 18.5%	0 0 0 0 0	0 0 0 0 0	0 (n/a)
CA angel shark/halibut and other species large mesh (>3.5”) set gillnet fishery	1990-94 2002 2003 2004 2005 2006	No fishery-wide observer program since 1994	10-15% 0% 0% 0% 0% 0%	0,0,0,0,0 n/a	0,0,0,0,0 n/a	n/a
Pot or trap fisheries	2002-2006	Strandings & sightings	n/a	1 (9)	n/a	≥2.0
unidentified fisheries	2002-2006	Strandings& sightings	n/a	0 (3)	n/a	≥ 0.6
Total Annual Takes						≥2.6

Ship Strikes

Ship strikes were implicated in the deaths of at least two humpback whales in 1993, one in 1995, and one in 2000 (NMFS, Southwest Regional Office, unpubl. data). One humpback was reported injured as the result of a ship strike in 2005, but the fate of that animal is unknown and details are lacking to determine if it was a serious injury. During 2002-2006, there were an additional seven injuries and one mortality of unidentified large whales attributed to ship strikes. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not have obvious signs of trauma. Several humpback whales have been photographed in California with large gashes in their dorsal surface that appear to be from ship strikes (J. Calambokidis, pers. comm.). The average number of documented humpback whale deaths by ship strikes for 2002-2006 is zero per year, but it is apparent that animals struck by ships are unlikely to be reported.

Other human-caused mortality

There was no humpback whale mortality reported from non-commercial fishery sources for the period 2002-2006. The average number of humpback deaths from unknown anthropogenic sources is zero per year from 2002-2006.

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 formally listed as "endangered" under the Endangered Species Act (ESA) in 1973. The species is still listed as “endangered”, and consequently the California/Mexico stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The estimated annual mortality and injury due to entanglement (2.6/yr), other anthropogenic sources (zero), plus ship strikes (zero) in California exceeds the PBR allocation of 2.5 for U.S. waters. The 12 humpbacks that were entangled at sea and whose final status are unknown were either trailing pot or trap gear, buoys, or had netting wrapped around one or more body parts, and are considered seriously injured. 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 eastern North Pacific stock appears to be increasing in abundance.

Habitat Concerns

Increasing levels of anthropogenic sound in the world’s oceans (Andrew et al. 2002), such as those produced by shipping traffic, ATOC (Acoustic Thermometry of Ocean Climate) 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 (Navy 2007).

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