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

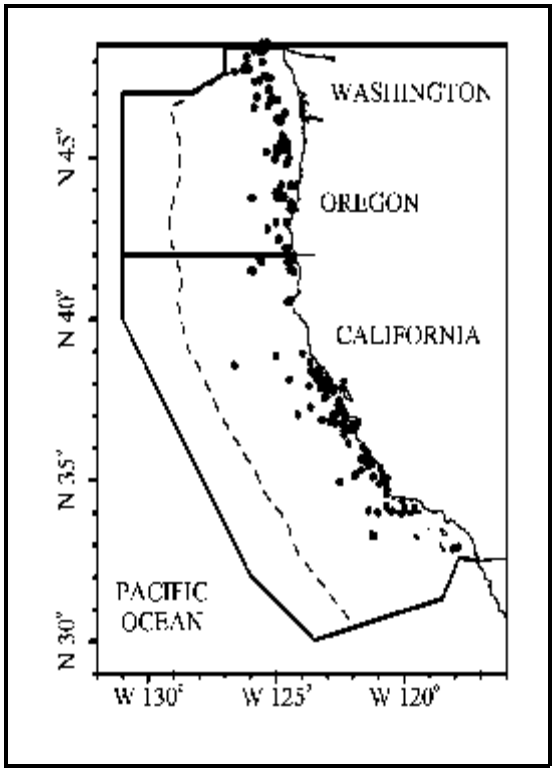

Figure 1. Humpback whale sighting locations based on aerial and shipboard surveys off California, Oregon, and Washington, 1989-96. Dashed line represents the U.S. EEZ, thick line indicates the outer boundary of all surveys combined. Greater effort was conducted off California (south of 42/N) and in the inshore half of the U.S. EEZ. See Appendix 2 of Barlow et al. (1997) and Barlow (1997) for data sources and information on timing and location of survey effort.

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). Aerial, vessel, and photo-identification surveys, and genetic analyses indicate that within the U.S. EEZ, there are at least three relatively separate populations that migrate between their respective summer/fall feeding areas and winter/spring calving and mating areas (Calambokidis et al. 1997, Baker et al. 1998): 1) winter/spring populations in coastal Central America and Mexico which migrate to the coast of California to southern British Columbia in summer/fall (Steiger et al. 1991, Calambokidis et al. 1993) - referred to as the California/ Oregon/Washington - Mexico stock (Figure 1); 2) winter/spring populations of the Hawaiian Islands which migrate to northern British Columbia/Southeast Alaska and Prince William Sound west to Kodiak (Baker et al. 1990, Perry et al. 1990, Calambokidis et al. 1997) - referred to as the Central North Pacific stock; and 3) winter/spring populations of Japan which, based on Discovery Tag information, probably migrate to waters west of the Kodiak Archipelago (the Bering Sea and Aleutian Islands) in summer/fall (Berzin and Rovnin 1966, Nishiwaki 1966, Darling 1991) - referred to as the Western North Pacific stock. Winter/spring populations of humpback whales also occur in Mexico's offshore islands, but the migratory destination of these whales is not well known (Calambokidis et al. 1993, Calambokidis et al. 1997). Significant levels of genetic differences were found between the California and Alaska feeding groups based on analyses of mitochondrial DNA (Baker et al. 1990) and nuclear DNA (Baker et al. 1993). 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). This is substantiated by the observed movement of individually-identified whales between 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.

Until further information becomes available, three management units of humpback whales (as described above) are recognized within the U.S. EEZ of the North Pacific: the California/Oregon/Washington - Mexico stock (this report), the Central North Pacific Stock, and the Western North Pacific Stock. The Central and Western North Pacific stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

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). Dohl et al. (1983) first estimated the central California feeding population to be 338 (CV=0.29) based on aerial surveys in August through November of 1980-83; however, this estimate does not include a correction for submerged animals. More recently, the size of the "California" feeding stock of humpback whales has been estimated by three independent methods. 1) Calambokidis et al. (1998) estimated the number of humpback whales in California-Washington to be 843 (CV=0.06) based on mark-recapture estimates comparing their 1996 and 1997 photo-identification catalogs. 2) Barlow (1997) estimates 1,152 (CV=0.15) humpbacks in California, Oregon and Washington waters based on ship line-transect surveys in summer/autumn of 1991, 1993, and 1996. 3) Forney et al. (1995) estimate 319 (CV=0.41) humpback whales in California coastal waters based on aerial line-transect surveys in winter/spring of 1991 and 1992 (not corrected for diving whales). In addition, Green et al. (1992) report that humpback whales were the second most abundant large whale (after the gray whale) in aerial surveys off Oregon and Washington, but they did not estimate population size. These estimates for the west-coast stock are not significantly different from each other, The shipboard estimates are likely to be the most unbiased, and the aerial surveys are likely to be the most negatively biased because submerged animals are missed. Mark-recapture estimates may also be negatively biased due to heterogeneity in sighting probabilities (Hammond 1986). However, given that the above mark-recapture estimate is based on a large fraction of the entire population (the 1996-97 catalog contained 492 known individuals), this bias is likely to be minimal. Also, in previous mark-recapture analyses on the same population, when methods were used which account for heterogeneity, estimates were comparable or smaller (Calambokidis et al. 1993). The most precise and least biased estimate is likely to be the mark-recapture estimate of 843 (CV=0.06) humpback whales for this population.

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 1996-97 abundance estimated from mark-recapture methods (Calambokidis et al. 1998) or approximately 802.

Current Population Trend

There is some indication that humpback whales increased in abundance in California coastal waters between 1979/80 and 1991 (Barlow 1994) and between 1991 and 1993 (Barlow and Gerrodette 1996), but these trends are not statistically significant. Mark-recapture population estimates increased steadily from 1988/90 to 1992/93 at about 5% per year (Calambokidis and Steiger 1994), and the even higher 1996-97 estimate suggests a continued population increase (Calambokidis et al. 1998). Although the population in the North Pacific is expected to have grown since being given protected status in 1966, the possible effects of continued unauthorized take (Yablokov 1994) and incidental ship strikes and gillnet mortality make this uncertain.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of humpback whale populations in the North Pacific (Best 1993). The proportion of calves in the California/Mexico 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).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (802) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (for an endangered species), resulting in a PBR of 1.6. Because this stock spends approximately half its time in Mexican waters, the PBR allocation for U.S. waters is 0.8 whales per year.

HUMAN-CAUSED MORTALITY

Historic Whaling

The reported take of North Pacific humpback whales by commercial whalers totaled approximately 7,700 between 1947 and 1987 (C. Allison, pers. comm.). In addition, approximately 7,300 were taken along the west coast of North America from 1919 to 1929 (Tonnessen and Johnsen 1982). Total 1910-1965 catches from the California-Washington

stock includes at least the 2,000 taken in Oregon and Washington, the 3,400 taken in California, and the 2,800 taken in Baja California (Rice 1978). 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.

Fishery Information

Humpback whales are known to be killed only in offshore drift gillnets. A summary of known fishery mortality and injury for this stock of humpback whales is given in Table 1. Detailed information on this fishery is provided in Appendix 1 of Barlow et al. (1997). The average fishery mortality and injury is estimated to be 1.4 humpback whales per year for the five most recent years of monitoring (1993-97) based on the observation of one entangled whale (released alive). Some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net. The deaths of two humpback whales that stranded in the Southern California Bight have been attributed to entanglement in fishing gear (Heyning and Lewis 1990). A humpback whale was observed off Ventura, CA in 1993 with a 20 ft section of netting wrapped around and trailing behind. Other unobserved fisheries may also result in injuries or deaths of humpback whales. In 1997, one humpback whale was snagged by a central California salmon troller, and the animal swam away with the hook and many feet of trailing monofilament (NMFS, Southwest Region, unpublished data).

Drift gillnet fisheries for swordfish and sharks exist along the entire Pacific coast of Baja California, Mexico and probably take animals from the same population. Quantitative data are available only for the Mexican swordfish drift gillnet fishery, which has increased from two vessels in 1986 to 29 vessels in 1992 (Sosa-Nishizaki et al. 1993). The total number of sets in this fishery in 1992 can be estimated from data provided by these authors to be approximately 2,700, 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.

Table 1. Summary of available information on the incidental mortality and injury of humpback whales (CA/OR/WA - Mexico stock) for commercial fisheries that might take this species (Julian and Beeson 1998, Julian 1997, Cameron 1998). 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.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality (and Injury)	Estimated Mortality (CV in parentheses)	Mean Annual Takes 1993-97 (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	1993 1994 1995 1996 1997	observer data	13.4% 17.9% 15.6% 12.4% 26.6%	0 0 (1) 0 0 0	Mortality 0,0,0,0,0 Injury 0,6,0,0,0 (0.91)	Mortality 0 Injury 1.2 (0.91)
CA angel shark/halibut and other species large mesh (>3.5") set gillnet fishery	1991-95	observer data	0-15%	0,0,0,0,0	0,0,0,0,0	0
CA salmon troll fishery	1997	incidental report	0%	(1)	n/a	Injury 0.2 (n/a)
Total annual takes						1.4 (0.91)

Ship Strikes

Ship strikes were implicated in the deaths of at least two humpback whales in 1993 and one humpback whale in 1995, and one unidentified whale, which may have been a humpback whale, was struck and injured by a small boat in 1997 (J. Cordaro, pers. comm.). 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 humpback whale deaths by ship strikes from 1993-97 is at least 0.6 per year.

STATUS OF STOCK

Humpback whales in the North Pacific were estimated to have been reduced to 13% of carrying capacity (K) by commercial whaling (Braham 1991). Clearly the North Pacific population was severely depleted. The initial abundance has never been estimated separately for the "California" stock, but this stock was also depleted (probably twice) by whaling (Rice 1974; Clapham et al. 1997). Humpback whales are formally listed as "endangered" under the Endangered Species Act (ESA), 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 (1.4/yr) plus ship strikes (0.6/yr) in California is greater than the PBR allocation of 0.8 for U.S. waters. If none of the injuries from fishing gear entanglement resulted in death, the known mortality due to ship strikes alone would not exceed the PBR. In a review of the severity of injury to the humpback whale entangled in 1994, the Pacific Scientific Review Group determined that it this animal was not seriously injured. Based on strandings and gillnet observations, annual humpback whale mortality and serious injury in California's drift gillnet fishery is probably greater than 10% of the PBR; therefore, total fishery mortality is not approaching zero mortality and serious injury rate. The California stock appears to be increasing in abundance. The increasing levels of anthropogenic noise in the world's oceans, such as those produced by 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.

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