Revised 10/15/2009

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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Although the International Whaling Commission (IWC) only considered one stock in the North Pacific (Donovan 1991), there is now good evidence for multiple populations of humpback whales (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 to feeding areas than to breeding areas, the stock structure of humpback whales is defined based on feeding areas.

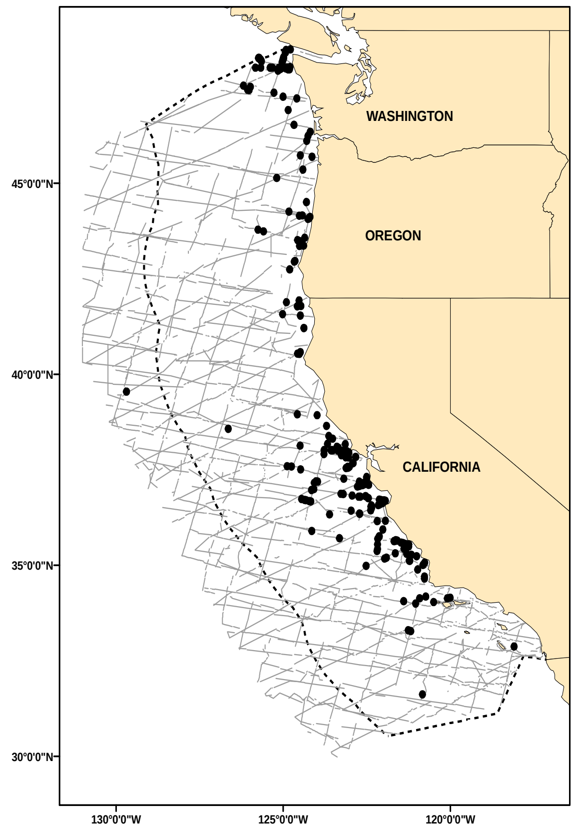

Figure 1. Humpback whale sightings based on shipboard surveys off California, Oregon, and Washington, 1991-2005. Dashed line represents the U.S. EEZ, thin lines indicate completed transect effort of all surveys combined. See Appendix 2 for data sources and information on timing and location of survey 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). A photo-identification study in 2004-2006 estimated the abundance of humpback whales in the entire Pacific Basin to be approximately 18,000-20,000 (Calambokidis et al. 2008). Estimates of regional abundance in the California/Oregon stratum from that study (1,702) are less precise than estimates from dedicated west-coast studies. 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.

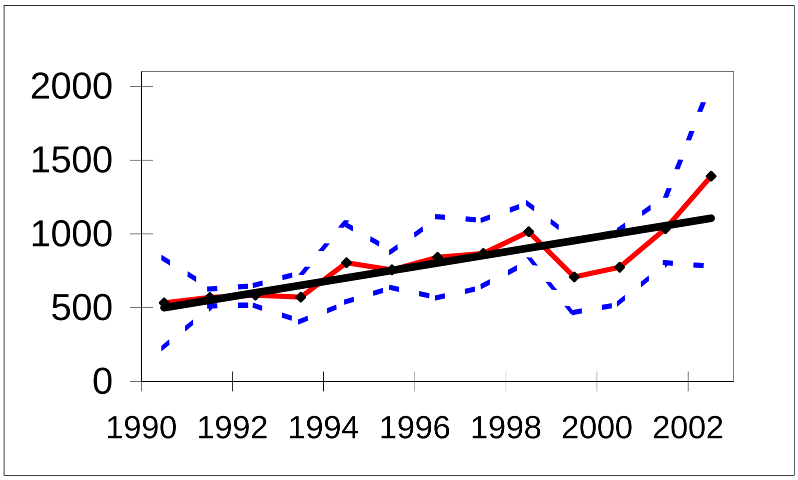

Figure 2. Mark-recapture estimates of the abundance of humpback whales feeding off California, Oregon, and Washington, based on photo-identification studies (Calambokidis et al. 2004). Dotted lines indicate +/- 2 standard errors for each estimate. Straight, bold line indicates linear regression.

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 and 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) times one half the estimated population growth rate for this stock of humpback whales (½ of 8%) times 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 2003-2007 is given in Table 1. A total of 19 humpback whales were observed entangled in fishing gear during 2003-2007 in California and Oregon (Table 1). 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). Of the 19 humpbacks entangled in fishing gear, 13 were reported entangled at sea in trap/pot fishery gear off California and Oregon, including one animal that was later found dead in Oregon (Northwest Regional Stranding Program, unpublished data). Six humpbacks were reported entangled in unknown gillnet or other gear, including lines and buoys of unknown origin. Two of the 13 pot/trap gear entanglements could be attributed to specific fisheries: 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. Two of the sightings involving crab pot gear were cow/calf pairs where the cow was entangled. Due to the trailing gear, 17 of the humpbacks are considered as serious injuries in Table 1 (the released animal is not considered seriously injured). Including the 17 serious injuries and one death, total mean annual serious injury and mortality for the commercial fisheries listed in Table 1 is 3.6 per year for the period 2003-2007. In addition to the humpback entanglements, there were five unidentified whales observed entangled in pot or trap gear and two unidentified whales entangled in unknown gillnet gear during 2003-2007. It is likely that some of these whales were humpbacks.

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 (California/Oregon/Washington 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 2003-2007 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	2003		20.2%	0	0	
	2004		20.6%	0	0	
	2005	Observer	20.9%	0	0	0 (n/a)
	2006		18.5%	0	0	
	2007		16.4%	0	0	
CA halibut and white seabass and other species large mesh (>3.5”) set gillnet fishery	2003		0%	n/a	n/a	
	2004	observer	0%	n/a		
	2005		0%	n/a		
	2006		0%	n/a		0 (n/a)
	2007		17.8%	0 (0)		
Pot or trap fisheries	2003	Strandings & sightings		0 (5)		
	2004			0 (0)		
	2005		n/a	0 (3)	n/a	≥2.4
	2006			1 (1)		
	2007			0 (2)		
unidentified fisheries	2003	Strandings& sightings		0 (0)	n/a	≥ 1.2
	2004			0 (1)		
	2005			0 (0)		
	2006			0 (2)		
	2007			0 (3)		
Total Annual Takes						≥3.6

Ship Strikes

One humpback was reported injured as the result of a ship strike in 2005, and another in 2007, but the fate of both animals is unknown and details are lacking to determine if these were serious injuries. During 2003-2007, there were an additional six injuries 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 2003-2007 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 2003-2007. The average number of humpback deaths from unknown anthropogenic sources is zero per year from 2003-2007.

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/Mexico stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The estimated annual mortality and serious injury due to entanglement (3.6/yr), other anthropogenic sources (zero), plus ship strikes (zero) in

California exceeds the PBR allocation of 2.5 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 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).

REFERENCES

Allison, C. International Whaling Commission. The Red House, 135 Station Road, Impington, Cambridge, UK CB4 9NP.

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. 1992. Genetic variability and stock identity of humpback whales, world-wide. Final Contract Report to Int. Whal. Commn. 45pp.

Baker, C. S., L. Medrano-Gonzalez, J. Calambokidis, A. Perry, F. Pichler, H. Rosenbaum, J. M. Straley, J. Urban-Ramirez, M. Yamaguchi, and O. von Ziegesar. 1998. Population structure of nuclear and mitochondrial DNA variation among humpback whales in the North Pacific. Mol. Ecol. 7:695-708.

Baker, C. S., S. R. Palumbi, R. H. Lambertsen, M. T. Weinrich, J. Calambokidis, and S. J. O'Brien. 1990. Influence of seasonal migration on geographic distribution of mitochondrial DNA haplotypes in humpback whales. Nature 344(15):238-240.

Barlow, J. 1994. Abundance of large whales in California coastal waters: a comparison of ship surveys in 1979/80 and in 1991. Rept. Int. Whal. Commn. 44:399-406.

Barlow, J. and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105:509-526.Berdegué, J. 2002. Depredación de las especies pelágicas reservadas a la pesca deportiva y especies en peligro de extinción con uso indiscriminado de artes de pesca no selectivas (palangres, FAD's, trampas para peces y redes de agallar fijas y a la deriva) por la flota palangrera Mexicana. Fundación para la conservación de los picudos. A.C. Mazatlán, Sinaloa, 21 de septiembre.

Barlow, J. and G. A. Cameron. 2003. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Marine Mammal Science 19(2):265-283.

Berzin, A. A., and A. A. Rovnin. 1966. The distribution and migrations of whales in the northeastern part of the Pacific, Chukchi and Bering Seas. Izvestiya Tikhookeanskogo Nauchno-Issledovatel'skogo Institut Rybnogo Khozyaistva I Okeanografii 58:179-207. (Translated by Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Seattle, 1968, pp. 103-136 *In:* K. I. Panin (ed.), Soviet Research on Marine Mammals of the Far East).

Braham, H. W. 1991. Endangered whales: status update. A Report on the 5-year status of stocks review under the 1978 amendments to the U.S. Endangered Species Act. NMFS Unpublished Report.

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. Urban, 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. Final report for Contract AB133F-03-RP-00078. 58 p. Available from Cascadia Research (www.cascadiaresearch.org) and NMFS, Southwest Fisheries Science Center (http://swfsc.noaa.gov).

Calambokidis, J., T. Chandler, E. Falcone, and A. Douglas. 2004. Research on large whales off California, Oregon and Washington in 2003. Contract Report to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 48p.

Calambokidis, J., T. Chandler, K. Rasmussen, G. H. Steiger, L. Schlender. 1998. Humpback and blue whale photographic identification: Report on research in 1997. Contract Report to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 41pp.

Calambokidis, J., T. Chandler, K. Rasmussen, G. H. Steiger, and L. Schlender. 1999. Humpback and blue whale photo-identification research off California, Oregon and Washington in 1998. Final Contract Report to Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 35 pp.

Calambokidis, J., T. Chandler, L. Schlender, G. H. Steiger, and A. Douglas. 2003. Research on humpback and blue whale off California, Oregon and Washington in 2002. Final Contract Report to Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 49 pp.

Calambokidis, J., and G. H. Steiger. 1994. Population assessment of humpback and blue whales using photo-identification from 1993 surveys off California. Final Contract Report to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 31pp.

Calambokidis, J., G. H. Steiger, J. R. Evenson, K. R. Flynn, K. C. Balcomb, D. E. Claridge, P. Bloedel, J. M. Straley, C. S. Baker, O. von Ziegesar, M. E. Dahlheim, J. M. Waite, J. D. Darling, G. Ellis, and G. A. Green. 1996. Interchange and isolation of humpback whales in California and other North Pacific feeding grounds. Mar. Mamm. Sci. 12(2):215-226.

Calambokidis, J., G. H. Steiger, J. M. Straley, T. J. Quinn, II, L. M. Herman, S. Cerchio, D. R. Salden, M. Yamaguchi, F. Sato, J. Urbán R., J. Jacobsen, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, N. Higashi, S. Uchida, J. K. B. Ford, Y. Miyamura, P. Ladrón de Guevara P., S. A. Mizroch, L. Schlender and K. Rasmussen. 1997. Abundance and population structure of humpback whales in the North Pacific Basin. Final Contract Report 50ABNF500113 to Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038. 72p.

Calambokidis, J., G. H. Steiger, J. M. Straley, L. M. Herman, S. Cerchio, D. R. Salden, J. Urbán-R., J. K. Jacobsen, O. von Ziegesar, K. C. Balcomb, C. M. Gabriele, M. E. Dahlheim, S. Uchida, G. Ellis, Y. Miyamura, P. Ladrón de Guevara-P., M. Yamaguchi, F. Sata, S. A. Mizroch, L. Schlender, K. Rasmussen, J. Barlow, and T. J. Quinn II. 2001. Movements and population structure of humpback whales in the North Pacific. Mar. Mamm. Sci. 17(4):769-794.

Carretta, J.V. and L. Enriquez. In prep. Marine mammal and seabird bycatch in observed California commercial fisheries in 2007.

Carretta, J.V. and L. Enriquez. 2007. Marine mammal and sea turtle bycatch in the California/Oregon thresher shark and swordfish drift gillnet fishery in 2006. Administrative Report LJ-07-06, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037. 9p.

Carretta, J.V. and L. Enriquez. 2006. Marine mammal bycatch and estimated mortality in California commercial fisheries during 2005. Administrative Report LJ-06-07, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA 92037. 14p.

Carretta, J.V. and S.J. Chivers. 2004. Preliminary estimates of marine mammal mortality and biological sampling of cetaceans in California gillnet fisheries for 2003. Paper SC/56/SM1 presented to the IWC Scientific Committee, June 2004 (unpublished). [Available from Southwest Fisheries Science Center, National Marine Fisheries Service, 8604 La Jolla Shores Drive, La Jolla, CA 92037, USA] 21p.

Carretta, J.V., S.J. Chivers, and K. Danil. 2005a. Preliminary estimates of marine mammal bycatch, mortality, and biological sampling of cetaceans in California gillnet fisheries for 2004. Administrative Report LJ-05-10, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, California, 92037. 17 p.

Carretta, J.V., T. Price, D. Petersen, and R. Read. 2005b. Estimates of marine mammal, sea turtle, and seabird mortality in the California drift gillnet fishery for swordfish and thresher shark, 1996-2002. Marine Fisheries Review 66(2):21-30.

Clapham, P. J., S. Leatherwood, I. Szczepaniak, and R. L. Brownell, Jr. 1997. Catches of humpback and other whales from shore stations at Moss Landing and Trinidad, California, 1919-1926. Marine Mammal Science 13(3):368-394.

Cordaro, J. Southwest Region, NMFS, 501 West Ocean Blvd, Long Beach, CA 90802_4213.

Darling, J. D. 1991. Humpback whales in Japanese waters. Ogasawara and Okinawa. Fluke identification catalog 1987-1990. Final Contract Report, World Wildlife Fund for Nature, Japan. 22 pp.

Dohl, T. P., R. C. Guess, M. L. Duman, and R. C. Helm. 1983. Cetaceans of central and northern California, 1980-83: Status, abundance, and distribution. Final Report to the Minerals Management Service, Contract No. 14-12-0001-29090. 284p.

Donovan, G. P. 1991. A review of IWC stock boundaries. Rept. Int. Whal. Commn., Special Issue 13:39-68.

Forney, K. A., J. Barlow, and J. V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. Fish. Bull. 93:15-26.

Forney, K.A. 2007. Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-406. 27 p.

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, K. C. Balcomb, III. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Ch. 1 In: J. J. Brueggeman (ed.). Oregon and Washington Marine Mammal and Seabird Surveys. Minerals Management Service Contract Report 14-12-0001-30426.

Hammond, P. S. 1986. Estimating the size of naturally marked whale populations using capture-recapture techniques. Rept. Int. Whal. Commn., Special Issue 8:253-282.

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.

Heyning, J. E., and T. D. Lewis. 1990. Fisheries interactions involving baleen whales off southern California. Rep. int. Whal. Commn. 40:427-431.

Holts, D. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038.

Holts, D. and O. Sosa-Nishizaki. 1998. Swordfish, *Xiphias gladius*, fisheries of the eastern North Pacific Ocean. *In*: I. Barrett, O. Sosa-Nishizaki and N. Bartoo (eds.). Biology and fisheries of swordfish, *Xiphias gladius*. Papers from the International Symposium on Pacific Swordfish, Ensenada Mexico, 11-14 December 1994. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 142, 276 p.

Johnson, J. H., and A. A. Wolman. 1984. The humpback whale, Megaptera novaeangliae. Mar. Fish. Rev. 46(4):30-37.

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.

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

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

Norris, T. F., M. McDonald, and J. Barlow. 1999. Acoustic detections of singing humpback whales (Megaptera novaeangliae) in the eastern North Pacific during their northbound migration. J. Acoust. Soc. Am. 106(1):506-514.

Perry, A., C. S. Baker, L. M. Herman. 1990. Population characteristics of individually identified humpback whales in the central and eastern North Pacific: a summary and critique. Rep. Int. Whal. Commn. (Special Issue 12):307-317.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. pp. 170-195 In: W. E. Schevill (ed.). The Whale Problem: A Status Report. Harvard Press, Cambridge, MA.

Rice, D. W. 1978. The humpback whale in the North Pacific: distribution, exploitation, and numbers. pp. 29-44 In: K. S. Norris and R. R. Reeves (eds.). Report on a Workshop on Problems Related to Humpback Whales (Megaptera novaeangliae) in Hawaii. Contr. Rept. to U. S. Marine Mammal Commn. NTIS PB-280-794. 90pp.

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

Sosa-Nishizaki, O., R. De la Rosa Pacheco, R. Castro Longoria, M. Grijalva Chon, and J. De la Rosa Velez. 1993. Estudio biologico pesquero del pez (*Xiphias gladius*) y otras especies de picudos (marlins y pez vela). Rep. Int. CICESE, CTECT9306.

Steiger, G. H., J. Calambokidis, R. Sears, K. C. Balcomb, and J. C. Cubbage. 1991. Movement of humpback whales between California and Costa Rica. Mar. Mamm. Sci. 7:306-310.

Tonnessen, J. N., and A. O. Johnsen. 1982. The History of Modern Whaling. Univ. Calif. Press, Berkeley and Los Angeles. 798pp.7:306-310.

Urbán R., J., C. Alverez F., M. Salinas Z., J. Jacobson, K. C. Balcomb III, A. Jaramillo L., P. L. de Guevara P., and A. Aguayo L. 1999. Population size of humpback whale, *Megaptera novaeangliae*, in waters off the Pacific coast of Mexico.

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.