Revised 10/15/2009

HARBOR PORPOISE (*Phocoena phocoena*): Morro Bay Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the Pacific, harbor porpoise are found in coastal and inland waters from Point Conception, California to Alaska and across to Kamchatka and Japan (Gaskin 1984). Harbor porpoise appear to have more restricted movements along the western coast of the continental U.S. than along the eastern coast. Regional differences in pollutant residues in harbor porpoise indicate that they do not move extensively between California, Oregon, and Washington (Calambokidis and Barlow 1991). That study also showed some regional differences within California (although the sample size was small). This pattern stands as a sharp contrast to the eastern coast of the U.S. and Canada where harbor porpoise are believed to migrate seasonally from as far south as the Carolinas to the Gulf of Maine and Bay of Fundy (Polacheck et al. 1995). A phylogeographic analysis of genetic data from northeast Pacific harbor porpoise did not show complete concordance between DNA sequence types and geographic location (Rosel 1992). However, an analysis of molecular variance (AMOVA) of the same data with additional samples found significant genetic differences for four of the six pair-wise comparisons between the four areas investigated: California, Washington, British Columbia, and Alaska (Rosel et al. 1995). These results demonstrate that harbor porpoise along the west coast of North America are not panmictic or migratory, and movement is sufficiently restricted that genetic differences have evolved. Recent preliminary genetic analyses of samples ranging from Monterey Bay, California to Vancouver Island, British Columbia indicate that there is small-scale subdivision within the U.S. portion of this range (Chivers *et al.*, 2002, 2007).

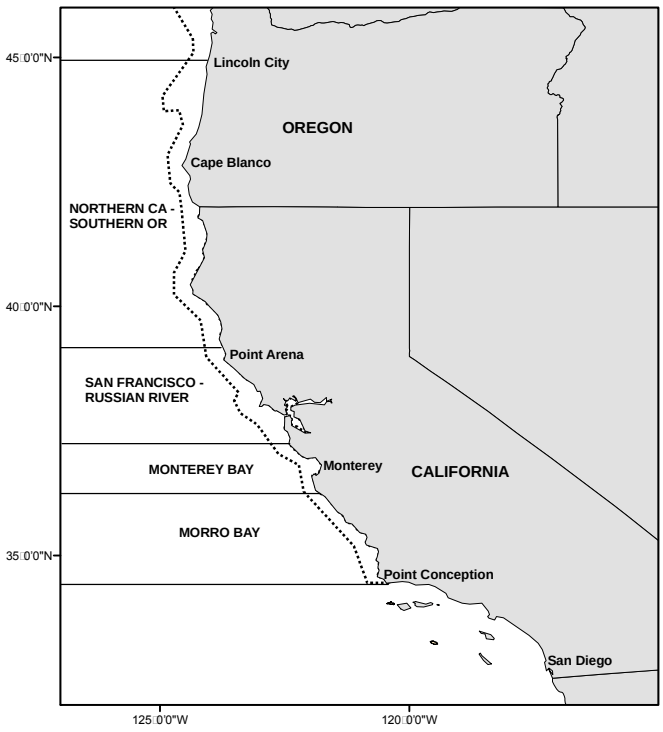

Figure 1. Stock boundaries and distributional range of harbor porpoise along the California and southern Oregon coasts. Dashed line represents harbor porpoise habitat (0-200 m) in this region.

In their assessment of harbor porpoise, Barlow and Hanan (1995) recommended that the animals inhabiting central California (defined to be from Point Conception to the Russian River) be treated as a separate stock. Their justifications for this were: 1) fishery mortality of harbor porpoise is limited to central California, 2) movement of individual animals appears to be restricted within California, and consequently 3) fishery mortality could cause the local depletion of harbor porpoise if central California is not managed separately. Although geographic structure exists along an almost continuous distribution of harbor porpoise from California to Alaska, stock boundaries are difficult to draw because any rigid line is (to a greater or lesser extent) arbitrary from a biological perspective. Nonetheless, failure to recognize geographic structure by defining management stocks can lead to depletion of local populations. Based on recent genetic findings (Chivers *et al.*, 2002, 2007), California coast stocks were re-evaluated, and significant genetic differences were found among 4 identified sampling sites. Revised stock boundaries are presented here based on these genetic data and density discontinuities identified from aerial surveys, resulting in six California/Oregon/Washington stocks where previously there had been four (Carretta *et al.* 2001a). The stock boundaries for animals that occur in California/southern Oregon waters are shown in

Figure 1. For the 2009 Marine Mammal Protection Act (MMPA) Stock Assessment Reports, other Pacific coast harbor porpoise stocks include: 1) a Monterey Bay stock, 2) a San Francisco-Russian River stock, 3) a northern California/southern Oregon stock, 4) an Oregon/Washington coast stock, 5) an Inland Washington stock, 6) a Southeast Alaska stock, 7) a Gulf of Alaska stock, and 8) a Bering Sea stock. Stock assessment reports for Monterey Bay, San Francisco-Russian River, northern California/southern Oregon, Northern Oregon/Washington coast, and Inland Washington waters harbor porpoise appear in this volume. The three Alaska harbor porpoise stocks are reported separately in the Stock Assessment Reports for the Alaska Region.

POPULATION SIZE

Previous estimates of abundance for California harbor porpoise were based on aerial surveys conducted between the coast and the 50-fm isobath during 1988-95 (Barlow and Forney 1994, Forney 1999a). These estimates did not include an unknown number of animals found in deeper waters. Barlow (1988) found that the vast majority of harbor porpoise in California were within the 0-50-fm depth range; however, Green et al. (1992) found that 24% of harbor porpoise seen during aerial surveys of Oregon and Washington were between the 100m and 200m isobaths (55 to 109 fathoms). A systematic ship survey of depth strata out to 90 m in northern California showed that porpoise abundance declined significantly in waters deeper than 60 m (Carretta *et al.* 2001b). A recent analysis of harbor porpoise trends including oceanographic data suggests that the proportion of California harbor porpoise in deeper waters may vary between years (Forney 1999b). Since 1999 aerial surveys have extended farther offshore (to the 200m depth contour or a minimum of 10 nmi from shore in the region of the Morro Bay stock) to provide a more complete abundance estimate. Based on 2002-2007 aerial surveys conducted under good survey conditions (Beaufort $\leq$2, cloud cover $\leq$25%) the estimate of abundance for this stock is 2,044 animals (CV = 0.40) (Carretta et al., 2009.).

Minimum Population Estimate

The minimum population estimate for the Morro Bay harbor porpoise stock is taken as the lower 20th percentile of the log-normal distribution of the abundance estimated from the 2002-2007 aerial surveys, or 1,478 animals.

Current Population Trend

There has been an increasing trend in porpoise abundance in the Morro Bay stock since 1988, which is statistically significant ($p < 0.002$), Figure 2. The observed increase in abundance estimates for this stock since 1988 implies an annual population growth rate of approximately 13%, which is consistent with the median growth rate of 10% reported by Caswell et al. (1998) for Atlantic harbor porpoise and high reproductive rates reported for this species by Read and Hohn (1995). It is possible that some of the observed growth of the Morro Bay stock is partly due to emigration of animals from the Monterey Bay stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Based on what are argued to be biological limits of the species (i.e. females give birth first at age 4 and produce one calf per year until death), the theoretical, maximum-conceivable growth rate of a closed harbor porpoise population was estimated as 9.4% per year (Barlow and Boveng 1991). This maximum theoretical rate may not be achievable for any real population. [Woodley and Read (1991) calculate a maximum growth rate of approximately 5% per year, but their argument for this being a maximum (i.e. that porpoise survival rates cannot exceed those of Himalayan thar) is not well justified.] Population growth rates have not actually been measured for any harbor porpoise population. Because a reliable estimate of the maximum net productivity rate is not available for Morro Bay harbor porpoise, we use the default maximum net productivity rate (R_{MAX}) of 4% for cetaceans (Wade and Angliss 1997).

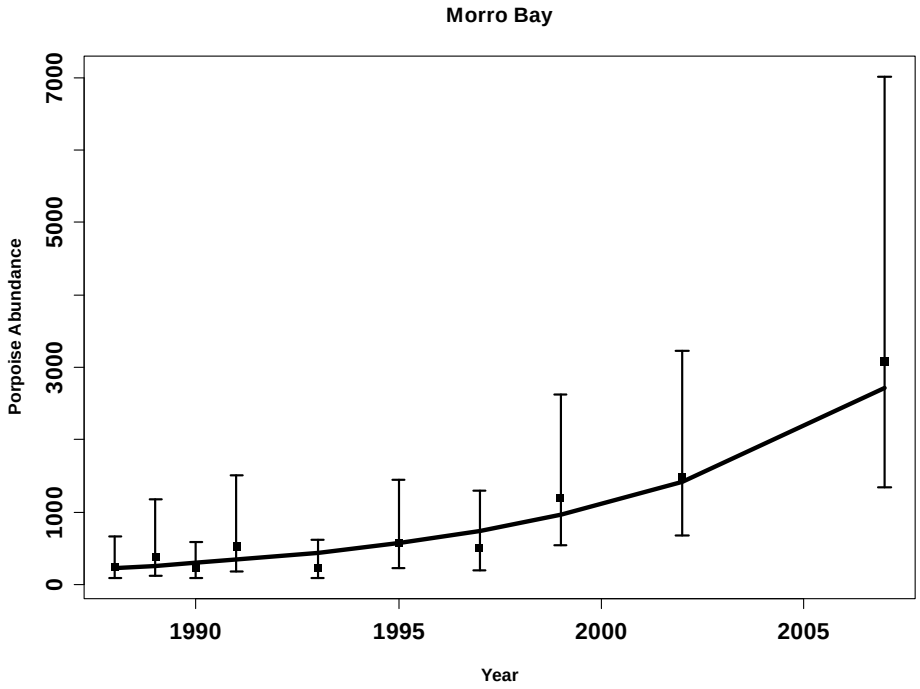

Figure 2. Aerial survey annual estimates of abundance for the Morro Bay stock of harbor porpoise (inshore stratum only), 1988-2007. Error bars represent lower and upper 95% confidence intervals. Solid line represents a linear regression on the natural logarithm of abundance over time. The slope of this regression is statistically significant ($p < 0.002$, $r^2 = 0.83$).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,478) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for a stock of unknown status ; Wade and Angliss 1997), resulting in a PBR of 15.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Gillnet fisheries for halibut and white seabass that historically operated in the vicinity of Morro Bay were eliminated in this stock's range in 2002 by a ban on gillnets inshore of 60 fathoms (~110 m) from Point Arguello to Point Reyes, California. The large-mesh drift gillnet fishery for swordfish and thresher shark operates too far offshore to interact with harbor porpoise in this region. Since 2002, fishery-related strandings of harbor porpoise have been recorded north of this stock's range. The responsible fisheries have not been identified and the locations of the strandings indicate that the animals are from stocks to the north (see Monterey Bay, San Francisco – Russian River, and Northern California/Southern Oregon stock assessments).

STATUS OF STOCK

Harbor porpoise in California are not listed as threatened or endangered under the Endangered Species Act nor as depleted under the Marine Mammal Protection Act. Barlow and Hanan (1995) calculate the status of harbor porpoise relative to historic carrying capacity (K) using a technique called back-projection. They calculate that the central California population (including Morro Bay, Monterey Bay, and San Francisco-Russian River stocks) could have been reduced to between 30% and 97% of K by incidental fishing mortality, depending on the choice of input parameters. They conclude that there is no practical way to reduce the range of this estimate. New information does not change this conclusion, and the status

of central California harbor porpoise populations relative to their Optimum Sustainable Population (OSP) levels must be treated as unknown.

No fishery-related mortality of harbor porpoise has been documented within this stock's range between 2003 and 2007. Current fishery mortality is zero and can be considered insignificant and approaching zero mortality rate. The stock is considered non-strategic and the population appears to have grown at approximately 11% annually since surveys began in the late 1980s. There are no known habitat issues that are of particular concern for this stock.

REFERENCES

Barlow, J. 1988. Harbor porpoise (*Phocoena phocoena*) abundance estimation in California, Oregon and Washington: I. Ship surveys. Fish. Bull. 86:417-432.

Barlow, J. and P. Boveng. 1991. Modeling age-specific mortality for marine mammal populations. Mar. Mamm. Sci. 7(1):84-119.

Barlow, J. and K. A. Forney. 1994. An assessment of the 1994 status of harbor porpoise in California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-205. 17 pp.

Barlow, J. and D. Hanan. 1995. An assessment of the status of harbor porpoise in central California. Rept. Int. Whal., Special Issue 16:123-140.

Calambokidis, J. and J. Barlow. 1991. Chlorinated hydrocarbon concentrations and their use for describing population discreteness in harbor porpoises from Washington, Oregon, and California. pp. 101-110 In: J. E. Reynolds III and D. K. Odell (eds.) Marine mammal strandings in the United States. NOAA Tech. Rep. NMFS 98.

Carretta, J.V., K.A. Forney, and S.R. Benson. 2009. Preliminary estimates of harbor porpoise abundance in California waters from 2002 to 2007. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-435. 10 p.

Carretta, J.V. 2001. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2000. Paper SC/53/SM9 presented to the International Whaling Commission (unpublished). 21pp.

Carretta, J.V., J. Barlow, K.A. Forney, M.M. Muto, and J. Baker. 2001a. U.S. Pacific Marine Mammal Stock Assessments: 2001. U.S. Dep. Commer. NOAA Technical Memorandum NMFS-SWFSC-317. 280pp.

Carretta, J.V., B.L. Taylor, and S.J. Chivers. 2001b. Abundance and depth distribution of harbor porpoise (*Phocoena phocoena*) in northern California determined from a 1995 ship survey. U.S. Fishery Bulletin 99:29-39.

Carretta, J.V. 2002. Preliminary estimates of cetacean mortality in California gillnet fisheries for 2001. Paper SC/54/SM12 presented to the International Whaling Commission (unpublished). 22pp.

Carretta, J.V. 2003. Preliminary estimates of harbor porpoise abundance in California from 1997 and 1999 aerial surveys. Southwest Fisheries Science Center Administrative Report LJ-03-04. 12 p.

Carretta, J.V. and S.J. Chivers. 2003. Preliminary estimates of marine mammal mortality and biological sampling of cetaceans in California gillnet fisheries for 2002. Paper SC/55/SM3 presented to the International Whaling Commission (unpublished). 21pp.

Carretta, J.V. and K.A. Forney. 2004. Preliminary estimates of harbor porpoise abundance in California from 1999 and 2002 aerial surveys. SWFSC Administrative Report LJ-04-01, available from Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA, USA. 13pp.

Caswell, H., S. Brault, A. Read, and T. Smith. 1998. Harbor porpoise and fisheries: an uncertainty analysis of incidental mortality. Ecological Applications 84(4):1226-1238.

Chivers, S.J., A.E. Dizon, P.J. Gearin, and K.M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbour porpoises, (Phocoena phocoena), indicated by molecular genetic analyses. Journal of Cetacean Research and Management 4(2):111-122.

Chivers, S.J., B. Hanson, J. Laake, P. Gearin, M.M. Muto, J. Calambokidis, D. Duffield, T. McGuire, J. Hodder, D. Greig, E. Wheeler, J. Harvey, K.M. Robertson, and B. Hancock. 2007. Additional genetic evidence for population structure of Phocoena phocoena off the coasts of California, Oregon, and Washington. Southwest Fisheries Science Center Administrative Report LJ-07-08. 16pp.

Forney, K. A. 1999a. The abundance of California harbor porpoise estimated from 1993-97 aerial line-transect surveys. Admin. Rep. LJ-99-02. Southwest Fisheries Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 16 pp.

Forney, K. A. 1999b. Trends in harbor porpoise abundance off central California, 1986-95: Evidence for interannual changes in distribution? J. Cetacean Res. Manage. 1:73-80.

Gaskin, D. E. 1984. The harbour porpoise (*Phocoena phocoena* L.): regional populations, status, and information on direct and indirect catches. Rep. int. Whal. Commn 34:569_586.

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and 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 prepared for the Pacific OCS Region.

Julian, F. and M. Beeson. 1998. Estimates of mammal, turtle, and bird mortality for two California gillnet fisheries: 1990-1995. U.S. Fishery Bulletin 96:271-284.

Laake, J. L., J. C. Calambokidis, S. D. Osmek, and D. J. Rugh. 1997. Probability of detecting harbor porpoise from aerial surveys: estimating g(0). J. Wildl. Manag. 61:63-75.

NMFS, Southwest Fisheries Science Center, P.O. Box 271, La Jolla, CA 92038-0271.

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

Norris, K.S. and J.H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. Univ. Calif. Publ. Zool. 63(4):291-402.

Polacheck, T., F. W. Wenzel, and G. Early. 1995. What do stranding data say about harbor porpoise (*Phocoena phocoena*). Rep. Int. Whal. Comm., Special Issue 16:169-179.

Read, A.J. and A.A. Hohn. 1995. Life in the fast lane: the life history of harbor porpoises from the Gulf of Maine. Marine Mammal Science 11(4):423-440.

Rosel, P. E. 1992. Genetic population structure and systematic relationships of some small cetaceans inferred from mitochondrial DNA sequence variation. Ph.D. Dissertation, Univ. Calif. San Diego. 191pp.

Rosel, P. E., A. E. Dizon, and M. G. Haygood. 1995. Variability of the mitochondrial control region in populations of the harbour porpoise, Phocoena phocoena, on inter-oceanic and regional scales. Can. J. Fish. and Aquat. Sci. 52:1210-1219.

Wade, P. R. and R. P. Angliss. 1997. Guidelines for Assessing Marine Mammal Stocks: Report of the GAMMS Workshop April 3-5, 1996, Seattle, Washington. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12. 93 pp.

Woodley, T. H. and A. J. Read. 1991. Potential rates of increase of a harbour porpoise (*Phocoena phocoena*) population subjected to incidental mortality in commercial fisheries. Can. J. Fish. Aquat. Sci. 48:2429-2435.