Revised 04/15/2020

HARBOR PORPOISE (*Phocoena phocoena*): San Francisco-Russian River 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 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. Subsequent 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).

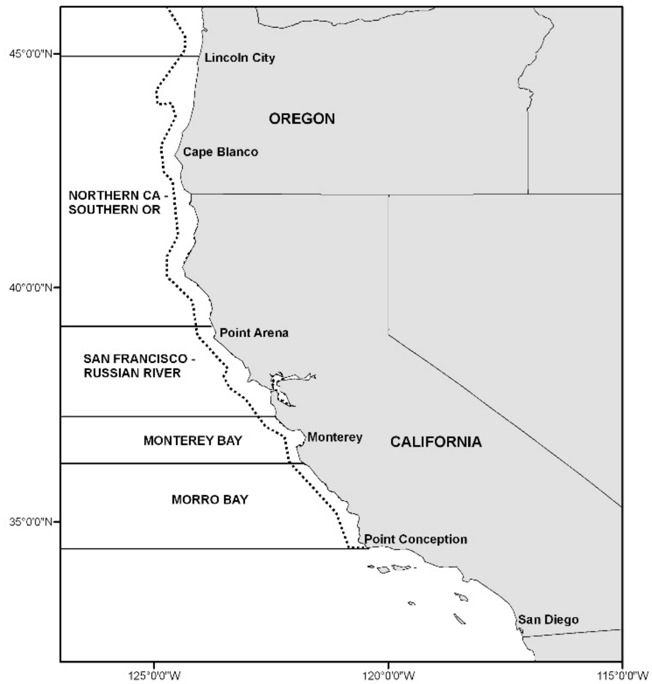

Figure 1. Stock boundaries and distributional range of harbor porpoise along the California and southern Oregon coasts. Dashed line represents harbor porpoise habitat (0-200 m) along the U.S. west coast.

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 was 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 more 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 Marine Mammal Protection Act (MMPA) Stock Assessment Reports, Pacific coast harbor porpoise stocks include: 1) a Morro Bay stock, 2) a Monterey Bay stock, 3) a northern California/southern Oregon stock, 4) a northern 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 harbor porpoise stocks within waters of California, Oregon, and Washington 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 1999). 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). Since 1999, aerial surveys extended farther offshore (to the 200m depth contour or a minimum of 15 nmi from shore in the region of the San Francisco-Russian River stock) to provide a more complete abundance estimate (Forney *et al.* 2014). A recent analysis of long-term trends in the San Francisco-Russian River harbor porpoise stock (Forney *et al.* 2019) between 1986 and 2017 estimated a population size of 7,524 (CV=0.574) porpoises during 2017. This estimate includes a correction factor of 3.42 (1/g(0); g(0)=0.292, CV=0.366) (Laake *et al*. 1997) to adjust for groups missed by aerial observers, and it is the most recent estimate available for this stock.

Minimum Population Estimate

The minimum population estimate for the San Francisco-Russian River harbor porpoise stock is taken as the lower 20th percentile of the log-normal distribution of the abundance estimated from 1986 to 2017 aerial surveys, or 4,801 animals.

Current Population Trend

A hierarchical Bayesian analysis of harbor porpoise trends between 1986 and 2017 (Forney *et al.* 2019) showed an increase in population size following the elimination of gillnets from the range of the San Francisco – Russian River stock in 1987 (Forney *et al.* 2019). The population size peaked in 2005 at about 14,500 porpoises, and subsequently appeared to drop, leveling off at about 7,000-8,000 porpoises during 2010-2017 (Figure 2). There are no known causes of this apparent decline, and Forney *et al.* (2019) suggested that a shift in the distribution of harbor porpoise in this region, including a re-colonization of waters inside San Francisco Bay documented in 2009 (Stern *et al.* 2017), might have reduced their detectability during aerial surveys along the outer coast.

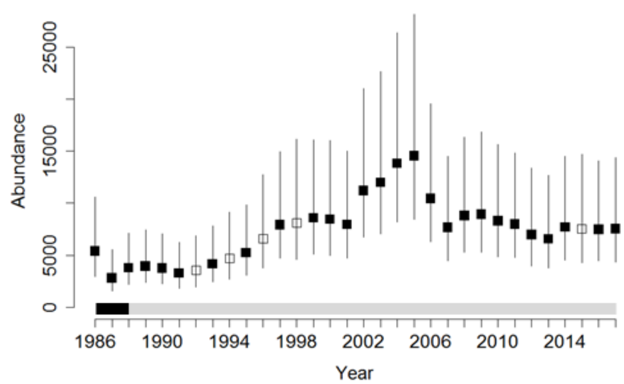

Figure 2. Population trends for the San Francisco-Russian River harbor porpoise stock, 1986-2017 (from Forney *et al.* 2019). Estimates represent median abundance (with 95% credible intervals) for years with survey effort (solid symbols) and without survey effort (open symbols). Shaded bars along the X-axis reflect the relative level of gillnet bycatch: high (black), or none (light gray).

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 based on a human survivorship curve (Barlow and Boveng 1991). This maximum theoretical rate represents maximum survival in a protected environment and may not be achievable for any wild population (Barlow and Boveng 1991). 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. Forney *et al.* (2019) estimated a growth rate of 2.4% per year (95% credible interval: 0.1% - 4.8%) for the San Francisco – Russian River harbor porpoise stock after gillnet fisheries were eliminated in 1987, but this cannot be considered a maximum net productivity rate because it includes periods of apparent decline as well as increase. Because a reliable estimate of the maximum net productivity rate is not available for this harbor porpoise stock, we use the default maximum net productivity rate (R_{MAX}) of 4% for cetaceans (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (4,801) 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 48.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Although coastal gillnets are prohibited throughout this stock's range, there have been fishery-related strandings in past years. In the most recent five-year period (2013-2017), three fishery-related strandings of harbor porpoise were documented within the range of the San Francisco-Russian River stock (in 2013, 2014, and 2015; Table 1, Carretta *et al.* 2019). Unidentified net fisheries were considered responsible for all three porpoise deaths.

Table 1. Summary of available information on incidental mortality and injury of harbor porpoise (San Francisco-Russian River stock) in commercial fisheries that might take this species. No fishery takes or fishery-related strandings were reported in this region between 2013 and 2017, Carretta *et al.* (2019). n/a indicates that data are not available.

Fishery Name	Year(s)	Data Type	Percent Observer Coverage	Observed Mortality	Kill/Day	Estimated Mortality (CV in parentheses)	Mean Annual Takes (CV in parentheses)
Unknown net fishery	2013-2017	stranding	n/a	3	n/a	≥3 (n/a)	≥ 0.6(n/a)
Minimum total annual takes							≥ 0.6 (n/a)

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. Although Forney *et al.* (2019) documented a population increase in the San Francisco – Russian River harbor porpoise stock, the carrying capacity of this stock is not known, and the population status relative to Optimum Sustainable Population (OSP) levels must be treated as unknown. Because the known human-caused mortality or serious injury (≥ 0.6 harbor porpoise per year) is less than the PBR (48), this stock is not considered a "strategic" stock under the MMPA, and fishery mortality can be considered insignificant and approaching zero mortality and serious injury rate. Harbor porpoises are sensitive to disturbance by a variety of anthropogenic sound sources, and the limited range of several U.S. West Coast harbor porpoise stocks makes them particularly vulnerable to potential impacts (see overview in Forney *et al*. 2017). A recent habitat concern along the U.S. West coast includes the use of acoustic deterrent devices ('seal bombs') that are used in commercial fishing activities off California (Simonis *et al*. 2020), especially in the Monterey Bay region.

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., 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, NOAA-TM-NMFS-SWFSC-317. 280 p.

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., V. Helker, M.M. Muto, J. Greenman, K.Wilkinson, D. Lawson, J. Viezbicke, and J. Jannot. 2019. Sources of Human-related Injury and Mortality for U.S. Pacific West Coast Marine Mammal Stock Assessments, 2013-2017. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-616. 150 p.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. 1999. 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., J.V. Carretta, S.R. Benson. 2014. Preliminary estimates of harbor porpoise abundance in Pacific Coast waters of California, Oregon and Washington, 2007-2012. U.S. Dep. Commer., NOAA Tech Memo NMFS-SWFSC-537. 21 p.

Forney, K.A., Southall, B.L., Slooten, E., Dawson, S., Read, A.J., Baird, R.W. and Brownell Jr, R.L., 2017. Nowhere to go: noise impact assessments for marine mammal populations with high site fidelity. Endangered species research, 32, pp. 391-413.

Forney, K.A., J.E. Moore, J. Barlow, J.V. Carretta and S.R. Benson. 2019. A multi-decadal Bayesian trend analysis of harbor porpoise (*Phocoena phocoena*) populations off California relative to past fishery bycatch. Draft Document PSRG-2019-08 presented to the Pacific Scientific Review Group, 5-7 March 2019, Olympia, WA. 22 p.

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.

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.

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.

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.

Simonis, A.E., Forney, K.A., Rankin, S., Ryan, J., Zhang, Y., DeVogelaere, A., Joseph, J., Margolina, T., Krumpel, A. and Baumann-Pickering, S., 2020. Seal Bomb Noise as a Potential Threat to Monterey Bay Harbor Porpoise. Frontiers in Marine Science, 7, p.142

Stern S.J., W. Keener, I.D. Szczepaniak, M.A. Webber. 2017. Return of harbor porpoises (*Phocoena phocoen*a) to San Francisco Bay. Aquatic Mammals 2017, 43(6), 691-702, DOI 10.1578/AM.43.6.2017.691

Teilmann, J. and J. Carstensen. 2012. Negative long term effects on harbour porpoises from a large scale offshore wind farm in the Baltic—evidence of slow recovery. Environ. Res. Lett. 7 (2012) 045101, doi:10.1088/1748-9326/7/4/045101.

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.