Revised 05/30/2022

CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Cuvier's beaked whales are distributed widely throughout deep waters of all oceans (MacLeod *et al.* 2006). Off the U.S. west coast, this species is the most commonly encountered beaked whale (Figure 1). No seasonal changes in distribution are apparent from stranding records, and morphological evidence is consistent with the existence of a single eastern North Pacific population from Alaska to Baja California, Mexico (Mitchell 1968). For the Marine Mammal Protection Act (MMPA) stock assessment reports, Cuvier's beaked whales within the Pacific U.S. Exclusive Economic Zone are divided into three discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), 2) Alaskan waters, and 3) Hawaiian waters.

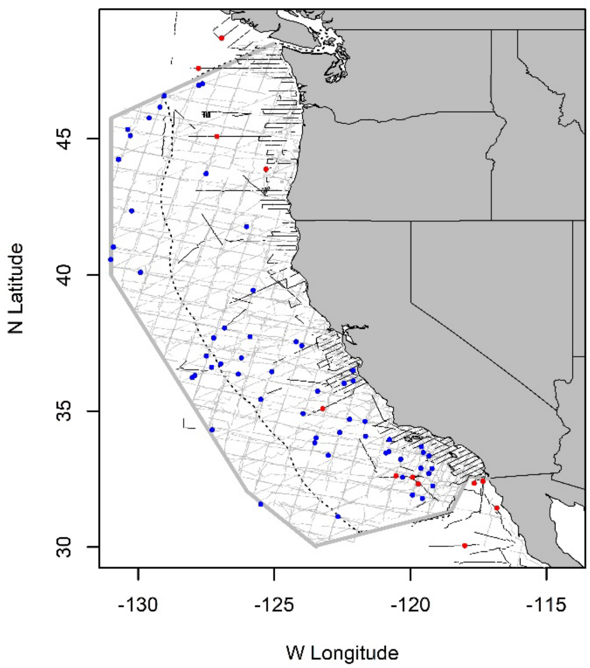

Figure 1. Cuvier's beaked whale sightings based on shipboard surveys off California, Oregon, and Washington, 1991-2018. Dashed line represents U.S. EEZ, thin lines indicate completed transect effort (gray = 1991-2014, black = 2018). Sightings from the 2018 survey are shown in red.

POPULATION SIZE

Although Cuvier's beaked whales are sighted along the U.S. west coast on most vessel-based line transect surveys, the rarity of sightings results in imprecise abundance estimates (Barlow 2016, Moore and Barlow 2017). Furthermore, survey data includes a large number of unidentified beaked whale sightings that are probably either *Mesoplodon* sp. or Cuvier's beaked whales (*Ziphius cavirostris*). A trend-based analysis of line-transect data from surveys conducted between 1991 and 2014 provided a range of estimates from 2,242 to 4,860 Cuvier's beaked whales with coefficients of variation between 0.59 and 0.67 (Moore and Barlow 2017). Barlow *et al*. (2021) developed a new method for estimating Cuvier's beaked whale density and abundance, using a modified point-transect distance sampling framework applied to passive acoustic data collected on drifting hydrophone arrays. They estimated the abundance of Cuvier's beaked whales in 2016 to be 5,454 whales (CV=0.27, 95% CI = 3,151 – 8,907), which is higher than any previous line-transect estimate, with better precision. Barlow *et al*. (2021) note that the largest source of uncertainty in their estimates is estimation of the effective area surveyed by floating hydrophones.

Minimum Population Estimate

The minimum population estimate is based on the lower 20th percentile of the posterior distribution reported in Barlow *et al*. (2021), or 4,214 whales.

Current Population Trend

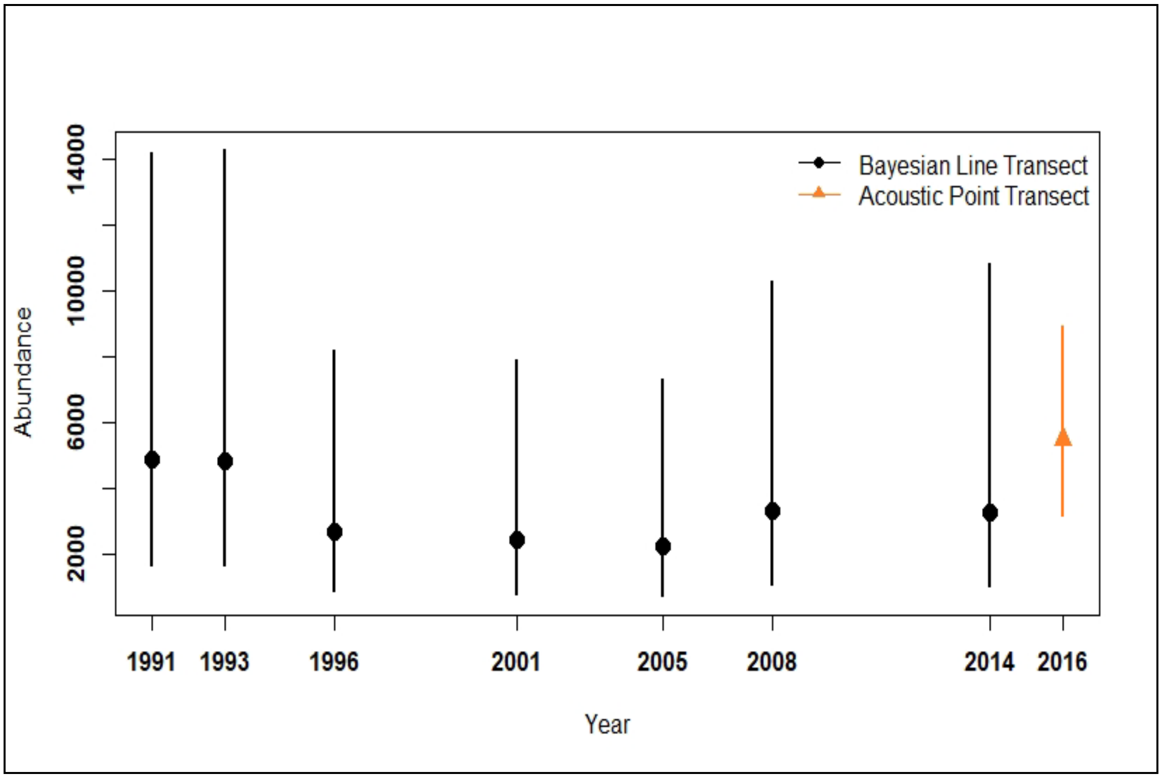

Figure 2. Abundance estimates for Cuvier's beaked whales in the California Current, 1991-2016 (Moore and Barlow 2017, Barlow *et al*. 2021). For each year, the Bayesian posterior median (●) and mean (▲) abundance estimates are shown, along with 95% CRIs.

There is substantial evidence, based on line-transect survey data and the historical stranding record off the U.S. west coast, that the estimated abundance of Cuvier's beaked whales in waters off California, Oregon and Washington was lower between 2001 and 2014 than in the early 1990s (Moore and Barlow 2013, 2017, Fig. 2). Statistical analysis of line-transect survey data from 1991 - 2014 indicates a 0.85 probability of decline during this period (Moore and Barlow 2017), with the mean annual rate of population change estimated to have been -3.0% per year (95% CRI: -10% to +3%, regression model results), although abundance throughout the 2000s appears stable, and estimates have not been updated following the 2018 survey. The 2016 acoustic based estimate represents the highest point estimate of the time series (Fig. 2), but it is unknown if this reflects differences in methodology between line transect and acoustic methods, a true increase in abundance, or both. Patterns in the historical stranding record alone provide limited information about beaked whale abundance trends, but the stranding record appears generally consistent rather than at-odds with results of the line-transect survey analysis. Regional stranding networks along the Pacific coast of the U.S. and Canada originated during the 1980s, and beach coverage and reporting rates are thought to have increased throughout the 1990s and in to the early 2000s. Therefore, for a stable or increasing population, an overall increasing trend in stranding reports between the 1980s and 2000s would be expected. Patterns of Cuvier's beaked whale strandings data are highly variable across stranding network regions, but an overall increasing trend from the 1980s through 2000s is not evident within the California Current area, contrary to patterns for Baird's beaked whales (Moore and Barlow 2013) and for cetaceans in general (e.g., Norman *et al.* 2004, Danil *et al.* 2010). Taylor *et al*. (2007) highlighted difficulties in assessing trends in abundance for beaked whales from visual surveys due to the rarity of sightings and relative imprecision of estimates. The addition of a new acoustically-derived abundance estimate for 2016 that is higher than all previous line-transect estimates (Barlow *et al*. 2021) does not aid in the assessment of trends for this stock, as there are no comparable acoustic estimates that overlap with the line-transect estimates. Barlow *et al*. (2021) note the great potential to estimate trends in abundance with greater precision using acoustic methods, based on documenting changes in acoustic encounter rates through time.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for this species.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (4,214), times one half the default maximum net growth rate for cetaceans (½ of 4%), times a recovery factor of 0.50 (for a species of unknown status with no known fishery mortality; Wade and Angliss 1997), resulting in a PBR of 42 Cuvier's beaked whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The California swordfish drift gillnet fishery has been the only fishery historically known to interact with this stock. Prior to the introduction of acoustic pingers into the fishery in 1996, there were 21 Cuvier's beaked whales observed entangled in approximately 3,300 drift gillnet fishery sets: 1992 (six animals), 1993 (three), 1994 (six) and 1995 (six) (Julian and Beeson 1998). Since acoustic pinger use, no observed Cuvier's beaked whale entanglements have been observed in over 5,900 observed fishing sets (Barlow and Cameron 2003, Carretta *et al.* 2008, Carretta and Barlow 2011, Carretta 2021). New model-based estimates of bycatch based on regression trees identify the use of acoustic pingers, latitude, and sea surface temperature as three variables influencing the bycatch of Cuvier's beaked whales in the fishery (Carretta 2021). Mean annual takes in Table 1 are based on 2015-2019 data. Although no Cuvier's beaked whales were observed entangled in the most recent 5-year time period, bycatch models produced a negligible estimate of bycatch for this 5-year period of 0.3 (CV=1.4) whales. This results in an average estimated annual mortality of 0.06 (CV= 1.4) Cuvier's beaked whales.

Table 1. Summary of available information on the incidental mortality and serious injury of Cuvier's beaked whales (California/ Oregon/Washington Stock) in commercial fisheries that might take this species. Mean annual takes are based on 2016-2020 data.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality + ReleasedAlive	Estimated Annual Mortality / Mortality + Entanglements	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	2016-2020	21%	0	0.3 (1.4)	0.06 (1.4)
Minimum total annual takes						0.06 (1.4)

Gillnets have been documented to entangle marine mammals off Baja California (Sosa-Nishizaki *et al.* 1993), but no recent bycatch data from Mexico are available.

Other mortality

Anthropogenic sound sources, such as military sonar and seismic testing have been implicated in the mass strandings of beaked whales, including atypical events involving multiple beaked whale species (Simmonds and Lopez-Jurado 1991, Frantiz 1998, Anon. 2001, Jepson *et al.* 2003, Cox *et al.* 2006). While D'Amico *et al.* (2009) note that most mass strandings of beaked whales are unassociated with documented sonar activities, lethal or sub-lethal effects of such activities would rarely be documented, due to the remote nature of such activities and the low probability that an injured or dead beaked whale would strand. Filadelpho *et al.* (2009) reported statistically significant correlations between military sonar use and mass strandings of beaked whales in the Mediterranean and Caribbean Seas, but not in Japanese and Southern California waters, and hypothesized that regions with steep bathymetry adjacent to coastlines are more conducive to stranding events in the presence of sonar use. In Hawaiian waters, Faerber & Baird (2010) suggest that the probability of stranding is lower than in some other regions due to nearshore currents carrying animals away from beaches, and that stranded animals are less likely to be detected due to low human population density near many of Hawaii's beaches. Actual and simulated sonar are known to interrupt the foraging dives and echolocation activities of tagged beaked whales (Tyack *et al.* 2011, DeRuiter *et al.* 2013). Cuvier's beaked whales tagged and tracked during simulated mid-frequency sonar exposure showed avoidance reactions, including prolonged diving, cessation of echolocation click production associated with foraging, and directional travel away from the simulated sonar source (DeRuiter *et al.* 2013). Blainville's beaked whale presence was monitored on hydrophone arrays before, during, and after sonar activities on a Caribbean military range, with evidence of avoidance behavior: whales were detected throughout the range prior to sonar exposure, not detected in the center of the range coincident with highest sonar use, and gradually returned to the range center after the cessation of sonar activity (Tyack *et al.* 2011). Fernández *et al.* (2013) report that there have been no mass strandings of beaked whales in the Canary Islands following a 2004 ban on sonar activities in that region. The absence of beaked whale bycatch in California drift gillnets following the introduction of acoustic pingers into the fishery implies additional sensitivity of beaked whales to anthropogenic sound (Carretta *et al.* 2008, Carretta and Barlow 2011, Carretta 2022).

STATUS OF STOCK

The status of Cuvier's beaked whales in California, Oregon and Washington waters relative to OSP is unknown, but Moore and Barlow (2013) indicated a substantial likelihood of population decline in the California Current since the early 1990s, at a mean rate of -2.9% per year, which corresponds to trend-fitted abundance levels in 2008 being at 61% of 1991 levels. New trend estimates also indicate evidence of a population decline between 1990 and 2014, with an 85% probability of a decline at a mean rate of -3.0% per year (Moore and Barlow 2017). Cuvier's beaked whales are not listed as "threatened" or "endangered" under the Endangered Species Act, nor designated as "depleted" under the MMPA. However, the long-term decline in Cuvier's beaked whale abundance in the California Current reported by Moore and Barlow (2013, 2017), and the degree of decline (trend-fitted 2014 abundance at approximately 67% of 1991 levels) suggest that this stock may be below its carrying capacity. Assessing changes in abundance for any species may also be confounded by distributional shifts within the California Current related to ocean-warming (Cavole *et al.* 2015). Given that the stock is not currently ESA listed or designated as depleted, and human-caused mortality is below PBR, it is not strategic. Moore and Barlow (2013) ruled out bycatch as a cause of the decline in Cuvier's beaked whale abundance and suggest that impacts from anthropogenic sounds such as naval sonar and deepwater ecosystem changes within the California Current are plausible hypotheses warranting further investigation. The average annual estimated human-caused mortality between 2016 and 2020 is negligible (0.06 whales annually) and reflects a small probability that true bycatch in this fishery may be greater than the zero observed from approximately 5,900 fishing sets since 1996 (Carretta 2021). The total fishery mortality and serious injury for this stock is less than 10% of the PBR and thus is considered to be insignificant and approaching zero. The impacts of anthropogenic sound on beaked whales remains a concern (Barlow and Gisiner 2006, Cox *et al.* 2006, Hildebrand *et al.* 2005, Weilgart 2007).

REFERENCES

Barlow, J. 2010. Cetacean abundance in the California Current from a 2008 ship-based line-transect survey. NOAA Technical Memorandum, NMFS, NOAA-TM-NMFS-SWFSC-456.

Barlow, J. 1999. Trackline detection probability for long-diving whales. p. 209-224 *In*: G. W. Garner, S. C. Amstrup, J. L. Laake, B. F. J. Manly, L. L. McDonald, and D. G. Robertson (eds.) Marine Mammal Survey and Assessment Methods. A. A. Balkema, Rotterdam. 287 pp.

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.

Barlow, J. and R. Gisiner. 2006. Mitigating, monitoring, and assessing the effects of anthropogenic sound on beaked whales. J. Cet. Res. Manage. 7(3):239-249.

Barlow, J. and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105:509-526.

Barlow, J. 2016. Cetacean abundance in the California current estimated from ship-based line-transect surveys in 1991-2014. Southwest Fisheries Science Center, Administrative Report, LJ-2016-01. 63 p.

Barlow, J., J.E. Moore, J.L.K. McCullough, and E.T. Griffiths. 2021. Acoustic-based estimates of Cuvier's beaked whale (Ziphius cavirostris) density and abundance along the U.S. West Coast from drifting hydrophone recorders. Marine Mammal Science 2021:1-22.

Carretta, J.V. 2022. Estimates of marine mammal, sea turtle, and seabird bycatch in the California large-mesh drift gillnet fishery: 1990-2020. NOAA Technical Memorandum NMFS-SWFSC-666. https://doi.org/10.25923/9z2t-4829

Carretta, J.V. and J. Barlow. 2011. Long-term effectiveness, failure rates, and “dinner bell” properties of acoustic pingers in a gillnet fishery. Marine Technology Society Journal 45:7-19.

Carretta, J.V., J. Barlow, and L. Enriquez. 2008. Acoustic pingers eliminate beaked whale bycatch in a gill net fishery. Marine Mammal Science 24(4):956-961.

Cavole, L.M., Demko, A.M., Diner, R.E., Giddings, A., Koester, I., Pagniello, C.M., Paulsen, M.L., Ramirez-Valdez, A., Schwenck, S.M., Yen, N.K. and Zill, M.E., 2016. Biological impacts of the 2013–2015 warm-water anomaly in the Northeast Pacific: Winners, losers, and the future. Oceanography, 29(2), pp.273-285.

Cox T.M., Ragen T.J., Read A.J., Vos E., Baird R.W., *et al.* 2006. Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management 7:177-187.

Danil K., Chivers S.J., Henshaw M.D., Thieleking J.L., Daniels R., *et al.* 2010. Cetacean strandings in San Diego County, California, USA: 1851–2008. Journal of Cetacean Research and Management 11:163–184.

DeRuiter, S.L., Southall B.L.,Calambokidis J., Zimmer W.M.X., Sadykova D., Falcone E.A., Friedlaender A.S., Joseph J.E., Moretti D., Schorr G.S., Thomas L., Tyack P.L. 2013. First direct measurements of behavioural responses by Cuvier’s beaked whales to mid-frequency active sonar. Biol Lett 9: 20130223.

Fernández, A., Arbelo, M. and Martín, V. 2013. No mass strandings since sonar ban. Nature 497:317.

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. 27p.

Hildebrand J.A. 2005. Impacts of anthropogenic sound. In: Reynolds III JE, Perrin WF, Reeves RR, Montgomery S, Ragen TJ, editors. Marine mammal research: conservation beyond crisis. Baltimore: Johns Hopkins University. pp. 101-123.

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

MacLeod C.D., Perrin W.F., Pitman R., Barlow J., Ballance L., D’Amico A., Gerrodette T., Joyce G., Mullin K.D., Palka D.L., Waring G.T. 2006. Known and inferred distributions of beaked whale species (Cetacea: Ziphiidae). Journal of Cetacean Research and Management 7:271-286.

Mitchell, E. 1968. Northeast Pacific stranding distribution and seasonality of Cuvier's beaked whale, *Ziphius cavirostris*. Can. J. Zool. 46:265-279.

Moore, J.E. and Barlow, J.P. 2017. Population abundance and trend estimates for beaked whales and sperm whales in the California Current based on ship-based visual line-transect survey data, 1991 – 2014. U.S. Department of Commerce, NOAA Technical Memorandum, NOAA-TM-SWFSC-585. 16 p.Moore J.E. and Barlow J.P. 2013. Declining Abundance of Beaked Whales (Family Ziphiidae) in the California Current Large Marine Ecosystem. PLoS ONE 8(1):e52770. doi:10.1371/journal.pone.0052770

Norman S.A., Bowlby C.E., Brancato M.S., Calambokidis J., Duffield D., *et al.* (2004) Cetacean strandings in Oregon and Washington between 1930 and 2002. Journal of Cetacean Research and Management 6:87-99.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thompson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 p.

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.

Taylor, B. L., Martinez, M., Gerrodette, T., Barlow, J., & Hrovat, Y. N. (2007). Lessons from monitoring trends in abundance of marine mammals. Marine Mammal Science, 23(1), 157–175. https://doi.org/10.1111/j.1748-7692.2006.00092.x

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.

Weilgart, L.S. 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology 85:1091-1116.