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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.

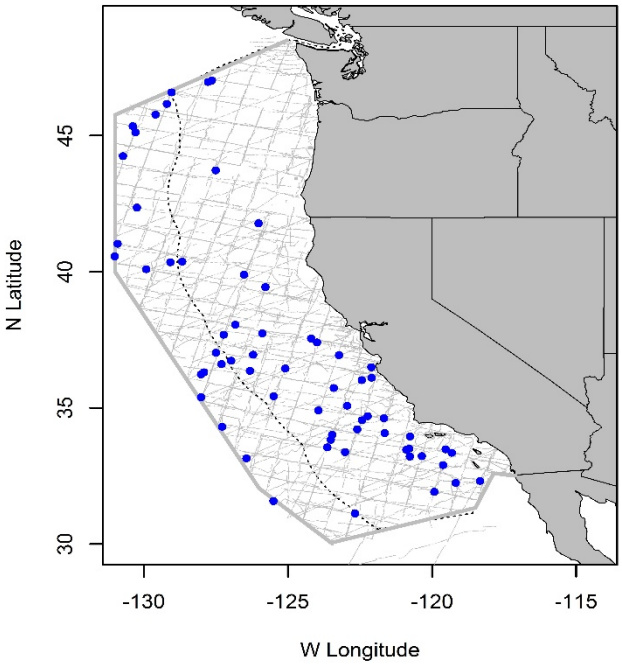

Figure 1. Cuvier's beaked whale sightings based on shipboard surveys off California, Oregon and Washington, 1991-2014 Dashed line represents the U.S. EEZ, thin lines indicate completed transect effort of all surveys combined.

POPULATION SIZE

Although Cuvier's beaked whales have been sighted along the U.S. west coast on several line transect surveys utilizing both aerial and shipboard platforms, the rarity of sightings has historically precluded reliable population estimates. Early abundance estimates were imprecise and negatively-biased by an unknown amount because of the large proportion of time this species spends submerged, and because ship surveys before 1996 covered only California waters, and thus did not include animals off Oregon/Washington. Furthermore, survey data include a large number of unidentified beaked whale sightings that are probably either *Mesoplodon* sp. or Cuvier's beaked whales (*Ziphius cavirostris*). A line-transect survey of U.S. west coast waters in 2014 yielded an abundance estimate of 3,775 (CV=0.68) Cuvier's beaked whales (Barlow 2016). The same analysis also provided estimates for previous years dating back to 1991, but did not evaluate trends in abundance. A trend-based analysis of line-transect data from surveys conducted between 1991 and 2014 provides new estimates of Cuvier's beaked whale abundance (Moore and Barlow 2017). The trend-model analysis incorporates information from the entire 1991-2014 time series for each annual estimate of abundance, and given the strong evidence of a decreasing abundance trend over that time (Moore and Barlow 2013, 2017), the best estimate of abundance is represented by the model-averaged estimate for 2014. Based on this analysis, the best (50^{th} percentile) estimate of abundance for Cuvier's beaked whales in 2014 in waters off California, Oregon and Washington is 3,274 (CV= 0.67) whales, which is similar to the line-transect estimate of 3,775 (CV=0.68) whales in 2014 estimated by Barlow (2016). The lower estimates of Cuvier's beaked whale abundance provided by Moore and Barlow (2017) compared with the Moore and Barlow

(2013) estimates are due to a higher trackline detection probability (*g(0)*) value, based on new Beaufort sea state-specific *g(0)* analysis published by Barlow (2015).

Minimum Population Estimate

Based on the analysis by Moore and Barlow (2017), the minimum population estimate (defined as the log-normal 20th percentile of the abundance estimate) for Cuvier's beaked whales in California, Oregon, and Washington is 2,059 animals.

Current Population Trend

There is substantial evidence, based on line-transect survey data and the historical stranding record off the U.S. west coast, that the abundance of Cuvier's beaked whales in waters off California, Oregon and Washington is lower than in the early 1990s (Moore and Barlow 2013, 2017, Figure 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 fairly stable. 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).

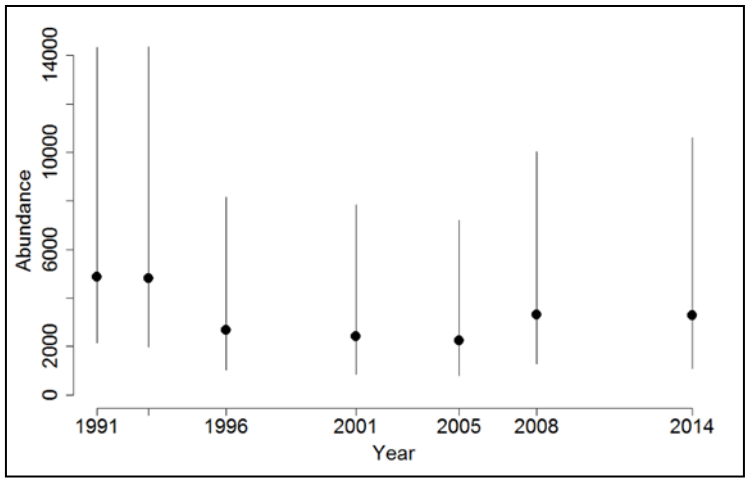

Figure 2. Abundance estimates for Cuvier's beaked whales in the California Current, 1991-2014 (Moore and Barlow 2017). For each year, the Bayesian posterior median (●) abundance estimates are shown, along with 95% CRIs.

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 (2,059) 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 21 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 Cuvier's beaked

whales have been observed entangled in over 5,400 observed fishing sets (Barlow and Cameron 2003, Carretta *et al.* 2008, Carretta and Barlow 2011, Carretta *et al.* 2017). New model-based estimates of bycatch based on regression trees identify the use of acoustic pingers and longitude as two variables influencing the bycatch of Cuvier's beaked whales in the fishery (Carretta *et al.* 2017). Mean annual takes in Table 1 are based only on 2011-2015 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 0.1 (CV=2.8) whales. This results in an average estimated annual mortality of 0.02 (CV=2.8) 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 2011-2015 data unless noted otherwise.

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	2011 2012 2013 2014 2015	20% 19% 37% 24% 20%	0 0 0 0 0		
		2011-2015	**24%**	**0**	**0.1 (2.8)**	**0.02 (2.8)**
Minimum total annual takes						0.02 (2.8)

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).

STATUS OF STOCK

The status of Cuvier's beaked whales in California, Oregon and Washington waters relative to OSP is not known, 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 (most recent survey) 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 known human-caused mortality between 2011 and 2015 is negligible (0.02 whales annually in the drift gillnet fishery) and reflects a small probability that true bycatch in this fishery may be greater than the zero observed from approximately 5,400 fishing sets since 1996 (Carretta *et al.* 2017). 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).

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