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CUVIER'S BEAKED WHALE (*Ziphius cavirostris*): Hawaii Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Cuvier's beaked whales occur in all oceans and major seas (Heyning 1989). Summer/fall shipboard surveys of the waters within the U.S. Exclusive Economic Zone (EEZ) of the Hawaiian Islands, resulted in 4 sightings in 2002, 22 in 2010, and 11 in 2017 including markedly higher sighting rates during nearshore surveys in the Northwestern Hawaiian Islands. (Figure 1; Barlow 2006, Bradford *et al.* 2017, Yano *et al.* 2018).

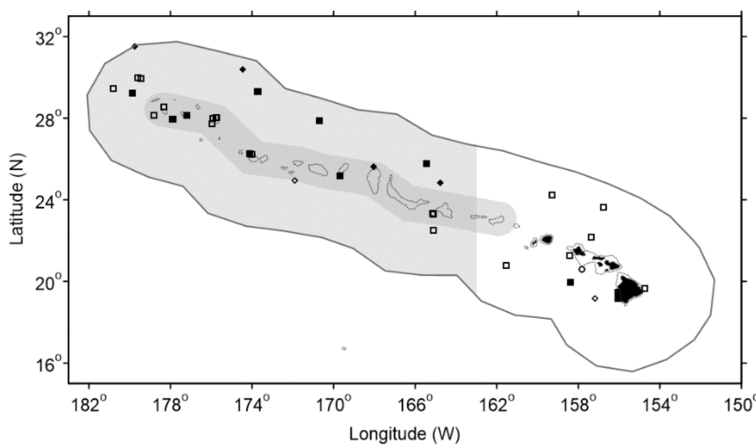

Figure 1. Cuvier's beaked whale sighting locations during the 2002 (diamonds), 2010 (circle), and 2017 (square) shipboard surveys, as well as sightings of unidentified *Ziphiid* during 2002 (open diamond), 2010 (open circle), and 2017 (open square) shipboard surveys of U.S. EEZ waters surrounding the Hawaiian Islands (Barlow 2006, Bradford *et al.* 2017, Yano *et al.* 2018). Outer line represents approximate boundary of survey area and U.S. EEZ. Dark gray shading indicates of the original Papahanaumokuakea Marine National Monument, with the lighter gray shading denoting the full 2016 Expansion area. Dotted line represents the 1000 m isobath.

Resighting and movement data of individual Cuvier's beaked whales suggest the existence of insular and offshore populations of this species in Hawaiian waters (Baird 2019). A 21-yr study off Hawaii Island suggests long-term site fidelity and year round occurrence (McSweeney *et al.* 2007). Ten Cuvier's beaked whales have been tagged off Hawaii Island since 2006, with all remaining close to the island of Hawaii or to Maui for the duration of tag data received (Baird *et al.* 2013, Baird 2019). Approximately 95% of all locations were within 45 km of shore and the farthest offshore an individual was documented was 67 km (Baird *et al.* 2013). The available satellite data suggest that a resident population may occur near Hawaii Island, distinct from offshore, pelagic Cuvier's beaked whales. This conclusion is further supported by the long-term site fidelity evident from photo-identification data (McSweeney *et al.* 2007). The available movement, social structure, and habitat data suggest there is likely a separate island-associated population of Cuvier's beaked whales within the main Hawaiian Islands (Baird 2019). Formal assessment of demographic-independence has not been completed, but division of this population into a separate island-associated stock may be warranted in the future.

For the Marine Mammal Protection Act (MMPA) stock assessment reports, Cuvier's beaked whales within the Pacific U.S. EEZ are divided into three discrete, non-contiguous areas: 1) Hawaiian waters (this report), 2) Alaskan waters, and 3) waters off California, Oregon and Washington. The Hawaii stock includes animals found both within the Hawaiian Islands EEZ and in adjacent high seas waters. Because data on abundance, distribution, and human-caused impacts are largely lacking for high seas waters, the status of this stock is evaluated based on data from U.S. EEZ waters of the Hawaiian Islands (NMFS 2005).

POPULATION SIZE

Encounter data from shipboard line-transect surveys of the entire Hawaiian Islands EEZ were recently reevaluated for each survey year, resulting in updated abundance estimates of Cuvier's beaked whale in the Hawaii EEZ (Bradford *et al.*2021; Table 1).

Table 1. Line-transect abundance estimates for Cuvier's beaked whale derived from surveys of the entire Hawaii EEZ in 2002, 2010, and 2017 (Bradford *et al.* 2021).

Year	Abundance	CV	95% Confidence Limits
2017	4,431	0.41	2,036-9,644
2010	338	1.02	65-1,771
2002	1,216	0.77	319-4,633

The updated design-based abundance estimates use sighting data from throughout the central Pacific to estimate the detection function and use Beaufort sea-state-specific trackline detection probabilities for Cuvier's beaked whale from Barlow *et al.* (2015). Although previous estimates from the Hawaii EEZ have been published using subsets of this data, Bradford *et al.* (2021), uses a consistent approach for estimating all abundance parameters and the resulting estimates are considered the best available for each survey year. Wade and Gerrodette (1993) estimated population size for Cuvier's beaked whales in the eastern tropical Pacific, but it is not known whether any of these animals are part of the same population that occurs around the Hawaiian Islands.

Minimum Population Estimate

Minimum population size is calculated as the lower 20th percentile of the log-normal distribution (Barlow *et al.* 1995) of the 2010 abundance estimate, or 3,180 Cuvier's beaked whales.

Current Population Trend

The three available abundance estimates for this stock have very broad confidence intervals, and for 2010 and 2017, they do not overlap. Annual encounter rate variation may have a large impact on abundance estimates for species with low density and patchy distribution. Bradford *et al.* (2021) indicate that the high sighting rate, and correspondingly higher abundance estimate, may be the result of extreme encounter rate variability for this species, though animal movement in response to environmental conditions or the influence of sightings of island-associated groups during systematic survey in 2017 cannot be discounted.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the pelagic stock of Cuvier's beaked whales is calculated as the minimum population estimate for the U.S. EEZ of the Hawaiian Islands (3,180) 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 within the Hawaiian Islands EEZ; Wade and Angliss 1997), resulting in a PBR of 32 Cuvier's beaked whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Information on fishery-related mortality of cetaceans in Hawaiian waters is limited, but the gear types used in Hawaiian fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. No estimates of human-caused mortality or serious injury are currently available for nearshore hook and line fisheries because these fisheries are not observed or monitored for protected species bycatch.

There are currently two distinct longline fisheries based in Hawaii: a deep-set longline (DSLL) fishery that targets primarily tunas, and a shallow-set longline fishery (SSLL) that targets swordfish. Both fisheries operate within U.S. waters and on the high seas. Between 2014 and 2018, no Cuvier's beaked whales were observed hooked or entangled in the SSLL fishery (100% observer coverage) or the DSLL fishery (18-22% observer coverage) (Bradford 2018a, 2018b, 2020, Bradford and Forney 2017, McCracken 2019). One unidentified beaked whale was taken, but not seriously injured, within the Hawaiian EEZ in the DSLL fishery (Bradford 2018a). Average 5-yr estimates of annual mortality and serious injury for 2014-2018 are zero Cuvier's beaked whales within or outside of the U.S. EEZs, and 0.5 (CV = 1.2) unidentified beaked whales within the U.S. EEZs (Table 2).

Table 2. Summary of available information on incidental mortality and serious injury of Cuvier's beaked whales (Hawaii stock) in commercial longline fisheries, within and outside of the Hawaiian Islands EEZ (McCracken 2019). Mean annual takes are based on 2014-2018 data unless otherwise indicated. Information on all observed takes (T) and

combined mortality events & serious injuries (MSI) is included. Total takes were prorated to deaths, serious injuries, and non-serious injuries based on the observed proportions of each outcome.

Fishery Name	Year	Data Type	Percent Observer Coverage	Observed total interactions (T) and mortality events, and serious injuries (MSI), and total estimated mortality and serious injury (M&SI) of Cuvier's beaked whales (ZI),and unidentified beaked whales (ZU)			
				Outside U.S. EEZs		Hawaiian EEZ	
				Obs. ZI T/MSI Obs. ZU T/MSI	Estimated ZI M&SI (CV) Estimated ZU MSI (CV)	Obs. ZI T/MSI Obs. ZU T/MSI	Estimated ZI M&SI (CV) Estimated ZU MSI (CV)
Hawaii-based deep-set longline fishery	2014	Observer data	21%	0	0 (-)	0	0 (-)
	2015		21%	0	0 (-)	0	0 (-)
	2016		20%	0	0	0 1/0	0 3 (0.9)
	2017		20%	0	0	0	0
	2018		18%	0	0	0	0
Mean Estimated Annual ZI Take (CV)					**0 (-)**		**0 (-)**
Mean Estimated Annual ZU Take (CV)					**0 (-)**		**0.5 (1.2)**
Hawaii-based shallow-set longline fishery	2014	Observer data	100%	0	0	0	0
	2015		100%	0	0	0	0
	2016		100%	0	0	0	0
	2017		100%	0	0	0	0
	2018		100%	0	0	0	0
Mean Annual ZI Takes (100% coverage)					**0**		**0**
Mean Annual ZU Takes (100% coverage)					**0.6**		**0**
Minimum total annual ZI takes within U.S. EEZ							**0 (-)**

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. Similarly, Simonis *et al.* (2020) reported a statistically significant correlation between sonar use and single and mass stranding events of beaked whales in the Mariana Archipelago. In Hawaiian waters, Faerber and 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). The impact of sonar exercises on resident versus offshore beaked whales may be significantly different with offshore animals less frequently exposed, and possibly subject to more extreme reactions

(Baird *et al.* 2009). No estimates of potential mortality or serious injury are available for U.S. waters.

STATUS OF STOCK

The Hawaii stock of Cuvier's beaked whales is not considered strategic under the 1994 amendments to the MMPA. The status of Cuvier's beaked whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Cuvier's beaked whales are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor designated as "depleted" under the MMPA. There have been no reported fishery related mortality or injuries within the Hawaiian Islands EEZ, such that the total mortality and serious injury can be considered to be insignificant and approaching zero. The impacts of anthropogenic sound on beaked whales remain a concern (Barlow and Gisiner 2006, Cox *et al.* 2006, Hildebrand *et al.* 2005, Weilgart 2007). One Cuvier's beaked whale found stranded on the main Hawaiian Islands tested positive for *Morbillivirus* (Jacob *et al.* 2016). The presence of *morbillivirus* in all 3 known species of beaked whales in Hawaiian waters (Jacob *et al*. 2016), raises concerns about the history and prevalence of this disease in Hawaii and the potential population impacts, including the cumulative impacts of disease with other stressors.

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