

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 four sightings in 2002 and 22 in 2010, including markedly higher sighting rates during nearshore surveys in the Northwestern Hawaiian Islands. (Figure 1; Barlow 2006, Bradford *et al.* 2017).

Resighting and movement data of individual Cuvier's beaked whales suggest the existence of insular and offshore populations of this species in Hawaiian waters. A 21-yr study off Hawaii Island suggests long-term site fidelity and year round occurrence (McSweeney *et al.* 2007). Eight Cuvier's beaked whales have been tagged off Hawaii Island since 2006, with all remaining close to the island of Hawaii for the duration of tag data received (Baird *et al.* 2013). 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). 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 a 2010 shipboard line-transect survey of the entire Hawaiian Islands EEZ was recently reevaluated using Beaufort sea-state-specific trackline detection probabilities for beaked whales. The new $g(0)$ values allow for use of all on-effort survey data, and resulted in an abundance estimate of 723 (CV = 0.69) Cuvier's beaked whales (Bradford *et al.* 2017) in the Hawaii stock. A 2002 shipboard line-transect survey of the same region resulted in an abundance estimate of 15,242 (CV=1.43) Cuvier's beaked whales (Barlow 2006). Species abundances estimated from the 2002 HICEAS survey used species-specific $g(0)$ values (Barlow 1999) (the probability of sighting and recording an animal directly on the track line) and limited the encounter data to Beaufort 0-2 (Barlow 2006). Since then, Barlow (2015) developed a more robust method for estimating species-specific $g(0)$ values that are adjusted for the Beaufort sea states that are encountered during a survey. This new method was used for analyzing the data from the 2010 survey, but has not yet been used to analyze the 2002 data. Wade and Gerrodette (1993) estimated population

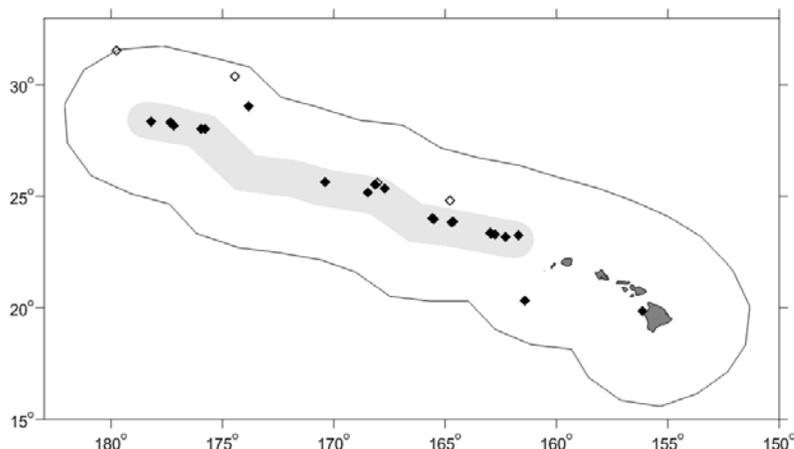


Figure 1. Cuvier's beaked whale sighting locations during the 2002 (open diamonds) and 2010 (black diamonds) shipboard surveys of U.S. EEZ waters surrounding the Hawaiian Islands (Barlow 2006, Bradford *et al.* 2017; see Appendix 2 for details on timing and location of survey effort). Outer line represents approximate boundary of survey area and U.S. EEZ. Gray shading indicates area of Papahānaumokuākea Marine National Monument.

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 428 Cuvier's beaked whales.

Current Population Trend

The significant decrease in abundance estimates between the 2002 and 2010 surveys is attributed to the use of higher sea states (beaufort 0-6) in estimating the trackline detection probability for the 2010 survey, compared to the 2002 survey, which utilized only beaufort sea state data 0 through 2 (Bradford *et al.* 2017). This change in analysis methodology resulted in far less extrapolation over the survey area, resulting in a more representative estimate of abundance. The 2002 survey data have not been reanalyzed using this method. . Assessment of population trend will likely require additional survey data and reanalysis of all datasets using comparable methods.

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 (428) times one half the default maximum net growth rate for cetaceans ($\frac{1}{2}$ 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 4.3 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. In 1998, a Cuvier's beaked whale stranded possibly entangled, with scars and cuts from fishing gear along its body (Bradford & Lyman 2013). The gear was not described. No other interactions between nearshore fisheries and Cuvier's beaked whales have been reported in Hawaiian 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 (DSL) fishery that targets primarily tunas, and a shallow-set longline fishery (SSL) that targets swordfish. Both fisheries operate within U.S. waters and on the high seas. Between 2011 and 2015, no Cuvier's beaked whales were observed hooked or entangled in the SSL fishery (100% observer coverage) or the DSL fishery (20-22% observer coverage) (Bradford 2017, Bradford and Forney 2017, McCracken 2017). Two unidentified beaked whales was taken in the SSL fishery and considered seriously. Average 5-yr estimates of annual mortality and serious injury for 2011-2015 are zero Cuvier's beaked whales within or outside of the U.S. EEZs, and 0.4 unidentified beaked whales outside the U.S. EEZs (Table 1). Four unidentified cetaceans were taken in the DSL fishery, and one unidentified cetacean was taken in the SSL fishery, some of which could have been Cuvier's beaked whales (Bradford 2017, Bradford and Forney 2017).

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). 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.

REFERENCES

- Anon. 2001. Joint Interim Report, Bahamas Marine Mammal Stranding Event of 15_16 March 2000. Available from NOAA, NMFS, Office of Protected Resources, Silver Spring, MD.
- Baird, R.W., G.S. Schorr, D.L. Webster, S.D. Mahaffy, D.J. McSweeney, M.B. Hanson, and K.D. Andrews. 2009. Movements of satellite-tagged Cuvier's and Blainville's beaked whales in Hawaii: Evidence for an offshore population of Blainville's beaked whales. Report to Southwest Fisheries Science Center, 15p.
- Baird, R.W., G.S. Schorr, M.B. Hanson, D.L. Webster, S.D. Mahaffy, D.J. McSweeney, and R.D. Andrews. 2013. Niche partitioning of beaked whales: Comparing diving behavior and habitat use of Cuvier's and Blainville's beaked whales off the Island of Hawaii. Draft document PSRG-2013-XX presented to the Pacific Scientific Review Group, April 2-4, 2013. Del Mar, CA.
- Barlow 1999. Trackline detection probability for long diving whales. *In* Marine mammal survey and assessment methods (G. W. Garner, S. C. Amstrup, J. L. Laake, B. F.J. Manly, L. L. McDonald, and D. G. Robertson, eds.
- Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. *Marine Mammal Science* 22: 446–464.
- Barlow 2015. Inferring trackline detection probabilities, $g(0)$, for cetaceans from apparent densities in different survey conditions. *Mar. Mamm. Sci.* 31:923–943.
- 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., S.L. Swartz, T.C. Eagle, and P.R. Wade. 1995. U.S. Marine Mammal Stock Assessments: Guidelines for Preparation, Background, and a Summary of the 1995 Assessments. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-6, 73 p.
- Bradford, A.L. 2017. Injury Determinations for Marine Mammals Observed Interacting with Hawaii and American Samoa Longline Fisheries During 2015–2016. NOAA Tech Memo NMFS-PIFSC-xxx.
- Bradford, A.L. and K.A. Forney. In press. Injury determinations for cetaceans observed interacting with Hawaii and

- American Samoa longline fisheries during 2010-2014. NOAA-TM-NMFS-PIFSC-62, doi:10.7289/V5/TM-PIFSC-62
- Bradford, A.L., K.A. Forney, J. E.M. Oleson, J. Barlow. 2017. Abundance estimates of cetaceans from a line-transect survey within the U.S Hawaiian Islands Exclusive Economic Zone. *Fishery Bulletin* 115: 129-142.
- Bradford, A.L. and E. Lyman. 2013. Injury determinations for humpback whales and other cetaceans reported to the Hawaiian Islands Disentanglement and Pacific Islands Marine Mammal Response Networks during 2007-2011. PIFSC Working Paper WP-13-005.
- Carretta, J., J. Barlow, and L. Enriquez. 2008. Acoustic pingers eliminate beaked whale bycatch in a gillnet fishery. *Marine Mammal Science* 24(4): 956-961.
- 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(5): 7-19.
- Cox, T.M., T.J. Ragen, A.J. Read, E. Vos, R.W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D’Amico, G. D’Spain, A. Fernandez, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J.A. Hildebrand, D. Houser, T. Hullar, P.D. Jepson, D. Ketten, C.D. Macleod, P. Miller, S. Moore, D. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead, and L. Brenner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. *J.Cetacean Res. Manag.* 7: 177-187.
- D’Amico A., Gisiner R.C., Ketten D.R., Hammock J.A., Johnson C., *et al.* 2009. Beaked whale strandings and naval exercises. *Aquat. Mamm.* 34: 452–472.
- 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. <http://dx.doi.org/10.1098/rsbl.2013.0223>
- Faerber, M.M. and R.W. Baird. 2010. Does a lack of observed beaked whale strandings in military exercise areas mean no impacts have occurred? A comparison of stranding and detection probabilities in the Canary and main Hawaiian Islands. *Mar. Mamm. Sci.* 26(3); 602-613.
- Fernández, A., Arbelo, M. and Martín, V. 2013. No mass strandings since sonar ban. *Nature* 497:317.
- Filadelfo R., Mintz J., Michlovich E., D’Amico A., Tyack P.L. 2009. Correlating military sonar use with beaked whale mass strandings: what do the historical data show? *Aquat Mamm* 34: 435–444.
- Frantzis, A. 1998. Does acoustic testing strand whales? *Nature* 392(5):29.
- Galbreath, E. C. 1963. Three beaked whales stranded on the Midway Islands, central Pacific Ocean. *J. Mamm.* 44:422-423.
- Heyning, J. E. 1989. Cuvier's beaked whale *Ziphius cavirostris* G. Cuvier, 1823. *In:* S. H. Ridgway and R. Harrison (eds.), *Handbook of Marine Mammals, Vol. 4: The River Dolphins and Larger Toothed Whales*, pp. 289-308. Academic Press, 442 pp.
- 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.
- Jacob, J.M., K.L. West, G. Levine, S. Sanchez, B.A. Jensen. 2016. Initial characterization of novel beaked whale morbillivirus in Hawaiian cetaceans. *Disease of Aquatic Organisms* 117:215-227. doi:10.3354/dao02941.
- Jepson, P.D., M. Arbelo, R. Deaville, I. A.P. Patterson, P. Castro, J.R. Baker, E. Degollada, H.M. Ross, P. Herraiez, A.M. Pocknell, F. Rodriguez, F.E. Howie, A. Espinoza, R.J. Reid, J.R. Jaber, V. martin, A.A. Cunningham, and A. Fernandez. 2003. "Gas-bubble lesions in stranded cetaceans." *Nature* 425, no. 6958 (2003): 575-576.
- Maldini, D., L. Mazzuca, and S. Atkinson. 2005. Odontocete stranding patterns in the Main Hawaiian Islands (1937-2002): How do they compare with live animal surveys? *Pacific Science* 59(1):55-67.
- McCracken, M. 2017. Preliminary assessment of incidental interactions with marine mammals in the Hawaii longline deep and shallow set fisheries from 2011 to 2015. PIFSC Internal Report IR-17-003.
- McSweeney, D.J., R.W. Baird, and S.D. Mahaffy. 2007. Site fidelity, associations, and movements of Cuvier’s (*Ziphius cavirostris*) and Blainville’s (*Mesoplodon densirostris*) beaked whales off the island of Hawaii. *Mar. Mamm. Sci.* 23(3):666-687.
- Nitta, E. 1991. The marine mammal stranding network for Hawaii: an overview. *In:* J.E. Reynolds III, D.K. Odell (eds.), *Marine Mammal Strandings in the United States*, pp.56-62. NOAA Tech. Rep. NMFS 98, 157 pp.
- [NMFS. 2005. Revisions to Guidelines for Assessing Marine Mammal Stocks. 24 pp.](#)
- Richards, L. P. 1952. Cuvier's beaked whale from Hawaii. *J. Mamm.* 33:255.
- 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.

- Shallenberger, E. W. 1981. The status of Hawaiian cetaceans. Final report to U.S. Marine Mammal Commission. MMC-77/23, 79pp.
- Simmonds, M. P., and L.F. Lopez-Jurado. 1991. Whales and the military. *Nature*, 351(6326): 448.
- Tyack, P. L., W.M.X. Zimmer, D. Moretti, B.L. Southall, D.E. Claridge, J.W. Durban, C. W. Clark, A. D'Amico, N. DiMarzio, S. Jarvis, E. McCarthy, R. Morrissey, J. Ward, and I.L. Boyd. 2011. Beaked whales respond to simulated and actual navy sonar. *PLoS One* 6(3): e17009.
- 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.
- Wade, P. R. and T. Gerrodette. 1993. Estimates of cetacean abundance and distribution in the eastern tropical Pacific. *Rep. Int. Whal. Commn.* 43:477-493.
- Weilgart, L.S. 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. *Canadian Journal of Zoology* 85:1091-1116.