

BAIRD'S BEAKED WHALE (*Berardius bairdii*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Baird's beaked whales are distributed throughout deep waters and along the continental slopes of the North Pacific (Balcomb 1989, Macleod *et al.* 2006). They have been harvested and studied in Japanese waters, but little is known about this species elsewhere (Balcomb 1989). A second species of *Berardius*, '*minimus*', has been described in the North Pacific, based on genetic (Morin *et al.* 2016) and morphological data (Yamada *et al.* 2019). The new species is darker and smaller than *B. bairdii*, with an apparently limited range between 40°N and 60°N, and 140°E and 160°W (Yamada *et al.* 2019). Sightings along the U.S. West Coast represent *B. bairdii*. Along the U.S. west coast, Baird's beaked whales have been seen primarily along the continental slope (Figure 1) from late spring to early fall. They are seen less frequently and are presumed to be farther offshore during the colder water months of November - April. For the Marine Mammal Protection Act (MMPA) stock assessment reports, Baird's beaked whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington (this report), and 2) Alaskan waters.

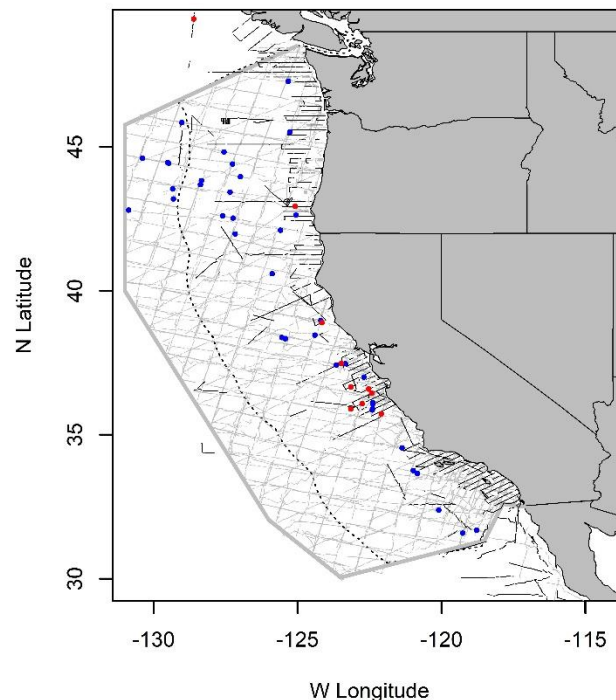


Figure 1. Baird's beaked whale sightings based on shipboard surveys off California, Oregon, and Washington, 1991-2018. Dashed line represents U.S. EEZ, thin lines indicate completed transect effort (gray = 1991-2014, black = 2018). Sightings from the 2018 survey are shown in red.

POPULATION SIZE

Abundance of Baird's beaked whales has recently been estimated from Bayesian trend analyses (Moore and Barlow 2017) and species distribution models based on 1991-2014 and 1991-2018 line-transect data respectively (Becker *et al.* 2020, Figure 2). The differences in absolute abundance estimates for the trend-based estimates (Moore and Barlow 2017) and SDM estimates (Becker *et al.* 2020) are due to different values of $g(0)$ that were used in the analyses. In both analyses, the overall $g(0)$ is calculated as the average of sea-state specific $g(0)$ values (Barlow 2015). Moore and Barlow (2017) assumed that in calm seas (Beaufort state = 0), $g(0) = 0.47$ (based on an estimate for *Mesoplodon*), with an average $g(0)$ across all sea states of 0.30 - 0.37 across years. Becker *et al.* (2020) assumed $g(0) = 1$ in calm seas, with an average $g(0)$ across effort segments > 0.5. The population size estimates from Becker *et al.* (2020) will be biased low, given the long synchronous dive times for *Berardius* groups, but an accurate correction for *Berardius* has not been estimated. The best estimate of abundance is taken as the most-recent estimate for 2018 from habitat-based species distribution models, or 1,363 (CV=0.533) whales.

Minimum Population Estimate

The minimum population size estimate is taken as the lower 20th percentile of the 2018 abundance estimate, or 894 whales (Becker *et al.* 2018).

Current Population Trend

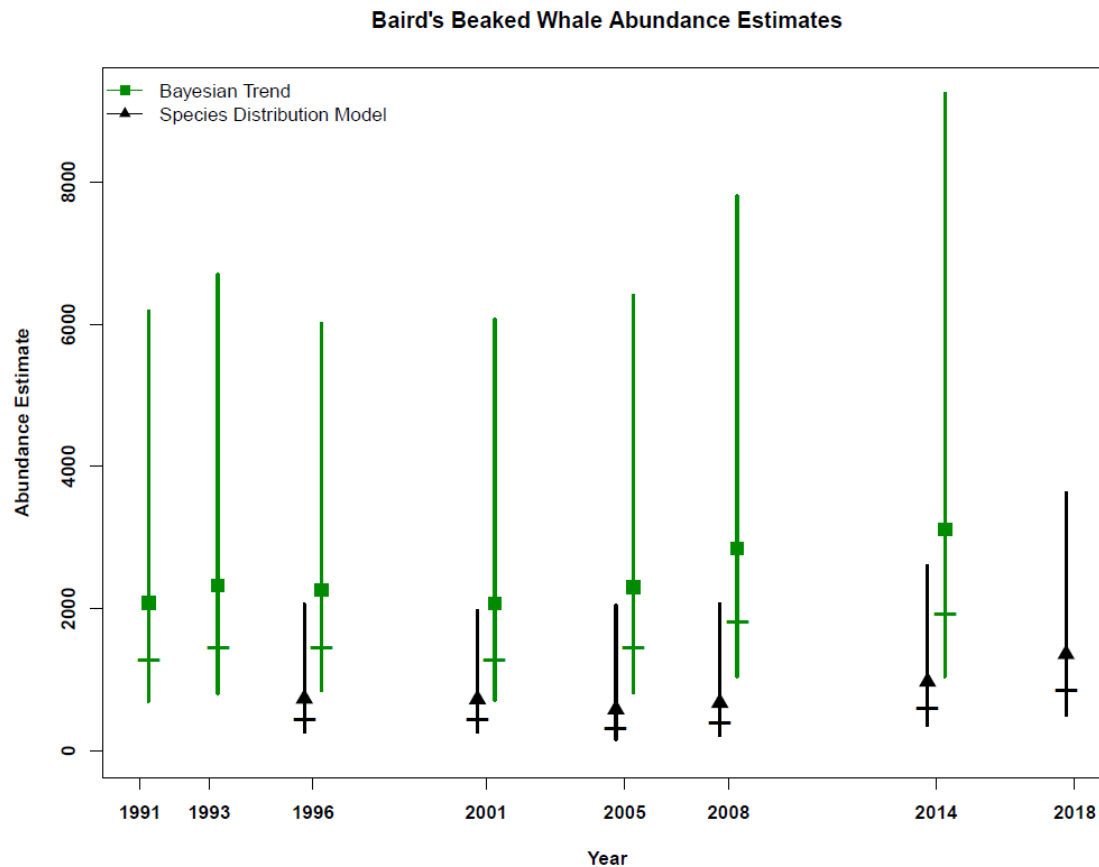


Figure 2. Baird's beaked whale abundance estimated from a Bayesian trend analysis (Moore and Barlow 2017) and habitat-based species distribution models based on 1991-2018 line-transect survey data (Becker *et al.* 2020). Vertical bars indicate approximate 95% log-normal confidence limits for Bayesian trend and species distribution model estimates. Horizontal hatch marks represent minimum population size estimates based on 20th percentiles of mean estimates.

The population of Baird's beaked whales has remained stable or increased slightly, based on a Bayesian trend analysis by Moore and Barlow (2017, Figure 2). An annual growth rate geometric mean (λ) of 1.02 (SD = 0.03) was estimated based on the latest analysis, with 95% CRI ranging from 0.96 to 1.08 and a 72% chance of being positive (Moore and Barlow 2017). Estimates from species distribution models, while lower than the Bayesian estimates due to different $g(0)$ values compared with Bayesian estimates, also show an apparent increase in abundance from 2008 to 2018 (Becker *et al.* 2020).

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 (894) 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; Wade and Angliss 1997), resulting in a PBR of 8.9 Baird's beaked whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The California large mesh drift gillnet fishery has been the only fishery known to interact with this stock. One Baird's beaked whale was incidentally killed in this fishery in 1994 (Julian and Beeson 1998), before acoustic pingers were first used in the fishery in 1996 (Barlow and Cameron 2003). Since 1996, no beaked whale of *any* species have been observed entangled or killed in this fishery (Carretta *et al.* 2008, Carretta 2021). Mean annual takes in Table 1 are based on 2015-2019 data. This results in an average estimated annual mortality of zero Baird's beaked whales (Carretta 2021).

Table 1. Summary of available information on the incidental mortality and injury of Baird's beaked whales (California/Oregon/Washington Stock) in commercial fisheries that might take this species. Coefficients of variation for mortality estimates are provided in parentheses. Mean annual takes are based on 2015-2019 data unless noted otherwise.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed Mortality	Estimated Annual Mortality	Mean Annual Takes (CV in parentheses)
CA/OR thresher shark/swordfish drift gillnet fishery	observer data	2015-2019	21%	0	0	0
Minimum total annual takes						0

Other mortality

California coastal whaling operations killed 15 Baird's beaked whales between 1956 and 1970, and 29 additional Baird's beaked whales were taken by whalers in British Columbian waters (Rice 1974). One Baird's beaked whale stranded in California in 2016 and the cause of death was attributed to a vessel strike (Carretta *et al.* 2021). No other human-caused mortality has been reported for this stock for the period 2015-2019 (Carretta *et al.* 2021).

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). 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 Baird's beaked whales in California, Oregon and Washington waters relative to OSP is not known, and no abundance trend is evident (Moore and Barlow 2017). They are not listed as "threatened"

or "endangered" under the Endangered Species Act nor designated as "depleted" under the MMPA. The average annual human-caused mortality during 2015-2019 is 0.2 animals/year (one vessel strike death). Because recent fishery and human-caused mortality is less than the PBR (8.9), Baird's beaked whales are not classified as a "strategic" stock under the MMPA. Moore and Barlow (2017) estimated that there was a 72% probability that this population had a positive growth rate over the period 1991-2014. Abundance estimates derived from species distribution models (Becker *et al.* 2020) also show an apparent increase between 2008 and 2018. The total fishery mortality and serious injury for this stock is zero and can be 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

- Anon. 2001. Joint interim report on the Bahamas marine mammal stranding event of 15-16 March 2000 (December 2001). NOAA unpublished report. 59p.
- Balcomb, K. C., III. 1989. Baird's beaked whale *Berardius bairdii* Stejneger, 1883: Arnoux's beaked whale *Berardius arnuxii* Duvernoy, 1851. In: Ridgway, S. H. and Harrison, R. (eds.), *Handbook of Marine Mammals*, Vol. 4. p. 261-288. Academic Press Limited.
- 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 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.
- Becker, E.A., Karin A. Forney, David L. Miller, Paul C. Fiedler, Jay Barlow, and Jeff E. Moore. 2020. Habitat-based density estimates for cetaceans in the California Current Ecosystem based on 1991-2018 survey data, U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-638.
- Carretta, J.V. 2021. Estimates of marine mammal, sea turtle, and seabird bycatch in the California large-mesh drift gillnet fishery: 1990-2019. NOAA Technical Memorandum NMFS-SWFSC-654.
- Carretta, J.V., J. Greenman, K. Wilkinson, J. Freed, L. Saez, D. Lawson, J. Viezbicke, and J. Jannot. 2021. Sources of human-related injury and mortality for U.S. Pacific West Coast Marine Mammal Stock Assessments, 2015-2019. NOAA Technical Memorandum NMFS-SWFSC-643. 157 pp.
- 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.
- 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. Hildebrand, D. Houser, T. Hullar, P. D. Jepson, D. Ketten, C. D. Macleod, P. Miller, S. Moore, D. C. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead and L. Benner. 2006. Understanding the impacts of anthropogenic Sound on beaked whales. *Journal of cetacean research and management* 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.
- 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.
- 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.
- Jepson, P.D., Arbelo, M., Deaville, R., Patterson, I.A.P., Castro, P., Baker, J.R., Degollada, E., Ross, H.M., Herraéz, P., Pocknell, A.M., Rodríguez, F., Howiell, F.E., Espinosa, A., Reid, R.J., Jaber, J.R., Martin, V., Cunningham, A.A. and Fernández, A. 2003. Gas-bubble lesions in stranded animals: Was sonar responsible for a spate of whale deaths after an Atlantic military exercise? *Nature* 425(6958):575-76.
- 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.

- 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., Barlow J.P. 2013. Declining Abundance of Beaked Whales (Family Ziphiidae) in the California Current Large Marine Ecosystem. PLoS ONE 8(1): e52770.
- Morin, P.A., Scott Baker, C., Brewer, R.S., Burdin, A.M., Dalebout, M.L., Dines, J.P., Fedutin, I., Filatova, O., Hoyt, E., Jung, J.L. and Lauf, M., 2017. Genetic structure of the beaked whale genus *Berardius* in the North Pacific, with genetic evidence for a new species. *Marine Mammal Science*, 33(1), pp.96-111.
- NMFS. 2005. Revisions to Guidelines for Assessing Marine Mammal Stocks. 24 pp.
- Rice, D. W. 1974. Whales and whale research in eastern North Pacific. p. 170-195 *In*: W. E. Schevill (ed.), *The Whale Problem - A Status Report*. Harvard University Press, Cambridge, MA.
- 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.
- Simmonds, M.P., and Lopez-Jurado, L.F. 1991. Whales and the military. *Nature (London)*, 351:448. doi:10.1038/351448a0.
- Tyack P.L., Zimmer W.M.X., Moretti D., Southall B.L., Claridge D.E., *et al.* 2011. Beaked Whales Respond to Simulated and Actual Navy Sonar. PLoS ONE 6(3):e17009. doi:10.1371/journal.pone.0017009
- 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.
- Yamada, T.K., Kitamura, S., Abe, S., Tajima, Y., Matsuda, A., Mead, J.G. and Matsuishi, T.F., 2019. Description of a new species of beaked whale (*Berardius*) found in the North Pacific. *Scientific reports*, 9(1), pp.1-14.