

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. 2013).

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 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

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. A 2002 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in an abundance estimate of 15,242 (CV=1.43) Cuvier's beaked whales (Barlow 2006). The recent 2010 shipboard line-transect survey of the Hawaiian Islands EEZ resulted in an abundance estimate of 1,941 (CV = 0.70) Cuvier's beaked whales (Bradford et al 2013), including a correction factor for missed diving animals. This is currently the best available abundance estimate for the Hawaii stock.

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 1,142 Cuvier's beaked whales.

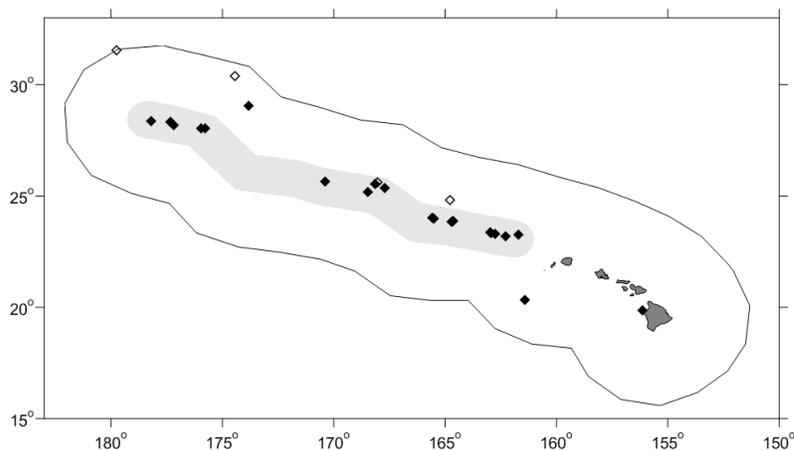


Figure 1. Cuvier's beaked whale sighting locations during the 2002 (open diamonds) and 2010 (black diamonds) shipboard surveys of U.S. EEZ waters surrounding the Hawaiian Islands (Barlow 2006; see Appendix 2 for details on timing and location of survey effort). Outer line represents approximate boundary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

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 0–5) 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. 2013). 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. This change precludes evaluation of population trends at this time.

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 (1,142) 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 11.4 Cuvier’s beaked whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998, Andersen et al. 2008, NOAA 2012). NMFS defines serious injury as an “*injury that is more likely than not to result in mortality*”. Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

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 (DSLL) fishery that targets primarily tunas, and a shallow-set longline (SLL) fishery that targets swordfish. Both fisheries operate within U.S. waters and on the high seas. Between 2007 and 2011, no Cuvier’s beaked whales were observed hooked or entangled in the SLL fishery (100% observer coverage) or the DSLL fishery (20-22% observer coverage) (Bradford and Forney 2013, McCracken 2013).

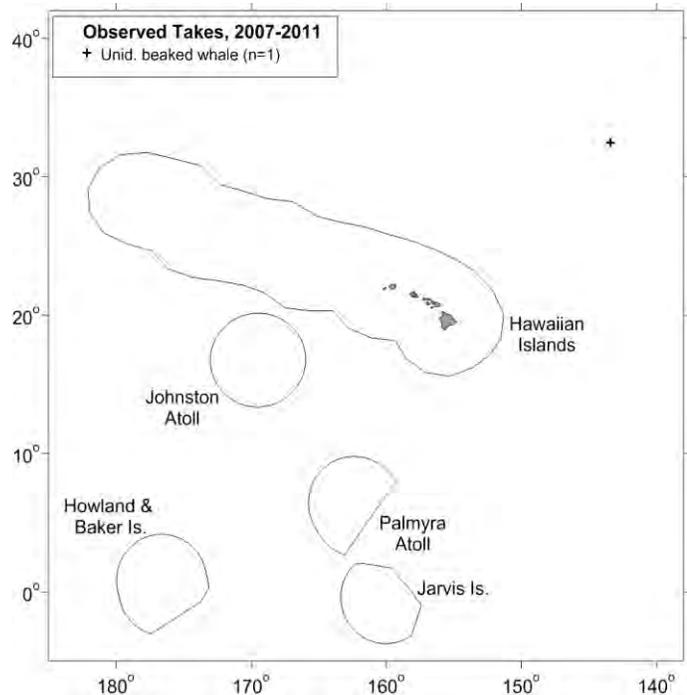


Figure 2. Location of the possible take of Cuvier’s beaked whale (cross) in Hawaii-based longline fisheries, 2007-2011. Solid lines represent the U.S. EEZ. Fishery descriptions are provided in Appendix 1.

One unidentified beaked whale was taken in the SSLL fishery and considered seriously injured based on an evaluation of the observer’s description of the interaction and following the most recently developed criteria for assessing serious injury in marine mammals (NMFS 2012). Average 5-yr estimates of annual mortality and serious injury for 2007-2011 are zero Cuvier’s beaked whales within or outside of the U.S. EEZs, and 0.2 unidentified beaked whales outside the U.S. EEZs (Table 1). Eight unidentified cetaceans were taken in the DSLL fishery, and two unidentified cetaceans were taken in the SSLL fishery, some of which could have been Cuvier’s beaked whales.

Table 1. Summary of available information on incidental mortality and serious injury of Cuvier’s beaked whales (Hawaii pelagic stock) and unidentified beaked whales (ZU) in commercial longline fisheries, within and outside of the Hawaiian Islands EEZ (McCracken 2013). Mean annual takes are based on 2007-2011 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) unidentified beaked whales			
				Outside U.S. EEZs		Hawaiian EEZ	
				Obs. T/MSI	Estimated ZU MSI (CV)	Obs. T/MSI	Estimated ZU MSI (CV)
Hawaii-based deep-set longline fishery	2007	Observer data	20%	0	0 (-)	0	0 (-)
	2008		22%	0	0 (-)	0	0 (-)
	2009		21%	0	0 (-)	0	0 (-)
	2010		21%	0	0 (-)	0	0 (-)
	2011		20%	0	0 (-)	0	0 (-)
Mean Estimated Annual Unidentified Beaked Whale Take (CV)				0 (-)		0 (-)	
Hawaii-based shallow-set longline fishery	2007	Observer data	100%	0	0	0	0
	2008		100%	0	0	0	0
	2009		100%	0	0	0	0
	2010		100%	0	0	0	0
	2011		100%	1/1	0.2	0	0
Mean Annual Unidentified Beaked Whale Takes (100% coverage)				0.2		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. 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 2012). Although *morbillivirus* is known to trigger lethal disease in cetaceans (Van Bresse et al. 2009), its impact on the health of the stranded animal is not known as it was found in only a few tested tissues (Jacob 2012). The presence of *morbillivirus* in 10 species of cetacean in Hawaiian waters, including all 3 known species of beaked whales (Jacob 2012), raises concerns about the history and prevalence of this disease in Hawaii and the potential population impacts on Hawaiian cetaceans.

REFERENCES

- Anderson, M.S., K.A. Forney, T.V.N. Cole, T. Eagle, R.P. Angliss, K. Long, L. Barre, L. VanAtta, D. Borggaard, T. Rowles, B. Norberg, J. Whaley, L. Engleby. Differentiating serious and non-serious injury of marine mammals: Report of the Serious Injury Technical Workshop 10-13 September 2007, Seattle, WA. NOAA Tech Memo NMFS-OPR-39, 94 p.
- Angliss, R.P. and D.P. DeMaster. 1997. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations: Report of the Serious Injury Workshop 1-2 April. 1997, Silver Spring, MD. NOAA Tech Memo NMFS-OPR-13, 48 p.
- 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-B09 presented to the Pacific Scientific Review Group, April 2-4, 2013. Del Mar, CA.
- Barlow, J. 2006. Cetacean abundance in Hawaiian waters estimated from a summer/fall survey in 2002. *Marine Mammal Science* 22: 446-464.
- 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. and K.A. Forney. 2013. Injury determinations for cetaceans observed interacting with Hawaii and American Samoa longline fisheries during 2007-2011. PIFSC Working Paper WP-13-002.
- Bradford, A.L., K.A. Forney, E.M. Oleson, and J. Barlow. 2013. Line-transect abundance estimates of cetaceans in the Hawaiian EEZ. PIFSC Working Paper WP-13-004.
- 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. 2012. Screening and characterization of morbillivirus in Hawaiian cetaceans. M.S. Marine Science Thesis. Hawaii Pacific University, Kaneohe, HI,
- Jepson, P.D., M. Arbelo, R. Deaville, I. A.P. Patterson, P. Castro, J.R. Baker, E. Degollada, H.M. Ross, P. Herraéz, 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. 2013. Preliminary assessment of incidental interactions with marine mammals in the Hawaii longline deep and shallow set fisheries from 2007 to 2011. PIFSC Working Paper WP-13.
- 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. Available at: <http://www.nmfs.noaa.gov/pr/pdfs/sars/gamms2005.pdf>
- NMFS. 2012. NOAA Fisheries Policy Directive 02-038-01 Process for Injury Determinations (01/27/12). Available at: http://www.nmfs.noaa.gov/pr/pdfs/serious_injury_policy.pdf
- 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.

- Van Bressem, M., J.A. Raga, G. Di Guardo, D.P. Jepson, P. J. Duignan, U. Siebert, T. Barrett, M. C. de Oliveira Santos, I.B. Moreno, S. Siciliano, A. Aguilar, K. Van Waerebeer. 2009. Emerging infectious diseases in cetaceans worldwide and the possible role of environmental stressors. *Diseases of Aquatic Organisms*. 85:143-157.
- 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.