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MESOPLODONT BEAKED WHALES (*Mesoplodon* spp.): California/Oregon/Washington Stocks

STOCK DEFINITION AND GEOGRAPHIC RANGE

Mesoplodont beaked whales are distributed throughout deep waters and along the continental slopes of the North Pacific Ocean. The six species known to occur in this region are: Blainville's beaked whale (*M. densirostris*), Perrin's beaked whale (*M. perrini*), Lesser beaked whale (*M. peruvianus*), Stejneger's beaked whale (*M. stejnegeri*), Gingko-toothed beaked whale (*M. gingkodens*), and Hubbs' beaked whale (*M. carlhubbsi*) (Mead 1989, Henshaw *et al.* 1997, Dalebout *et al.* 2002, MacLeod *et al.* 2006). Based on bycatch and stranding records in this region, it appears that Hubb's beaked whale is most commonly encountered (Carretta *et al.* 2008, Moore and Barlow 2013). Insufficient sighting records exist off the U.S. west coast (Figure 1) to determine any possible spatial or seasonal patterns in the distribution of mesoplodont beaked whales.

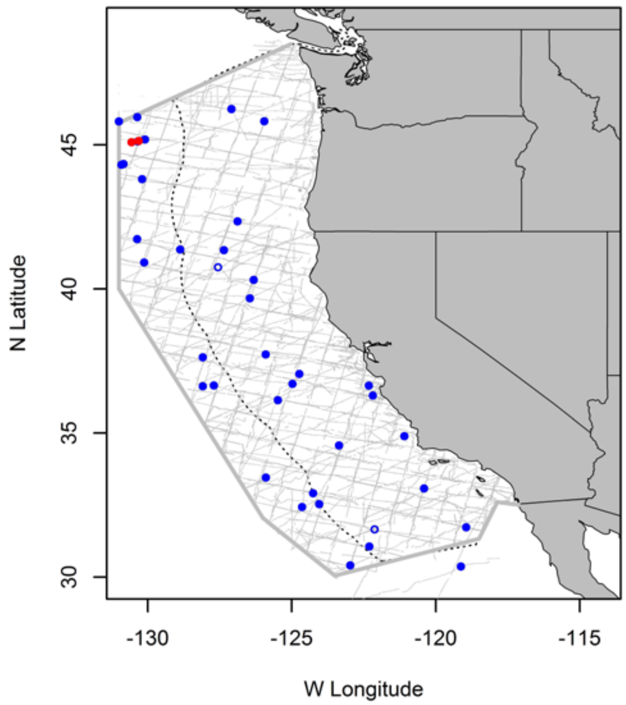

Figure 1. *Mesoplodon* beaked whale sightings based on shipboard surveys off California, Oregon and Washington, 1991-2014 . Key: ● = *Mesoplodon* spp.; ○ = identified *Mesoplodon densirostris*; ● = identified *Mesoplodon carlhubbsi*. Dashed line represents the U.S. EEZ, thin lines indicate completed transect effort of all surveys combined.

Until methods of distinguishing these six species at-sea are developed, the management unit must be defined to include all *Mesoplodon* stocks in this region. However, in the future, species-level management is desirable, and a high priority should be placed on finding means to obtain species-specific abundance information. For the Marine Mammal Protection Act (MMPA) stock assessment reports, three *Mesoplodon* stocks are defined: 1) all *Mesoplodon* species off California, Oregon and Washington (this report), 2) *M. stejnegeri* in Alaskan waters, and 3) *M. densirostris* in Hawaiian waters.

POPULATION SIZE

A trend-based analysis of line-transect data from surveys conducted between 1991 and 2014 provides new estimates of Mesoplodon species abundance (Moore and Barlow 2017). The new estimate accounts for the proportion of unidentified beaked whale sightings likely to be Mesoplodon beaked whales and uses a correction factor for missed animals adjusted to account for the fact that the proportion of animals on the trackline missed by observers increases in rough seas. The trend-model analysis incorporates information from the entire 1991- 2014 time series for each annual estimate of abundance, and suggests evidence of an increasing abundance trend over that time (Moore and Barlow 2017), which is a reversal of the population decline reported by Moore and Barlow 2013. The authors note caveats to this observation: sea surface temperatures in 2014 were extremely warm in the California Current, with many previously undetected (and rarely detected) subtropical and tropical species occurring in the study area (Cavole et al.

2016). They hypothesize that an influx of warm-water Mesoplodon species into the California Current may have contributed to the higher estimate for 2014. They also reiterate that very few temperate species of Mesoplodon have stranded in recent years, a piece of supporting evidence for the previously observed population decline (Moore and Barlow 2013). The best estimate of Mesoplodon abundance is represented by the model-averaged estimate for 2014 (Moore and Barlow 2017). Based on this analysis, the best (50th percentile) estimate of abundance for all species of Mesoplodon species combined in 2014 in waters off California, Oregon and Washington is 3,044 (CV=0.54).

Minimum Population Estimate

The minimum population estimate (defined as the log-normal 20th percentile of the abundance estimate) for mesoplodont beaked whales in California, Oregon, and Washington is 1,967 animals.

Current Population Trend

Moore and Barlow (2013) provided strong evidence, based on line-transect survey data and the historical stranding record off the U.S. west coast, that the abundance of *Mesoplodon* beaked whales declined in waters off California, Oregon and Washington between 1991 and 2008 (Moore and Barlow 2013,). This apparent trend is reversed with the additional analysis of data collected in 2014, which includes the highest estimate of *Mesoplodon* abundance in the 1991-2014 time series (Moore and Barlow 2017, Figure 2). Statistical analysis of line-transect survey data from 1991 - 2014 indicates a 0.87 probability of an increase during this period, with the mean long-term growth rate estimate from a Markov model of r = 0.03 (SD = 0.07), with 95% CRI ranging from −0.10 to +0.18, indicating high uncertainty in long-term dynamics. 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. In contrast, reported strandings for *M. carlhubbsi* and *M. stejnegeri* in the California Current region have declined monotonically since the 1980s.

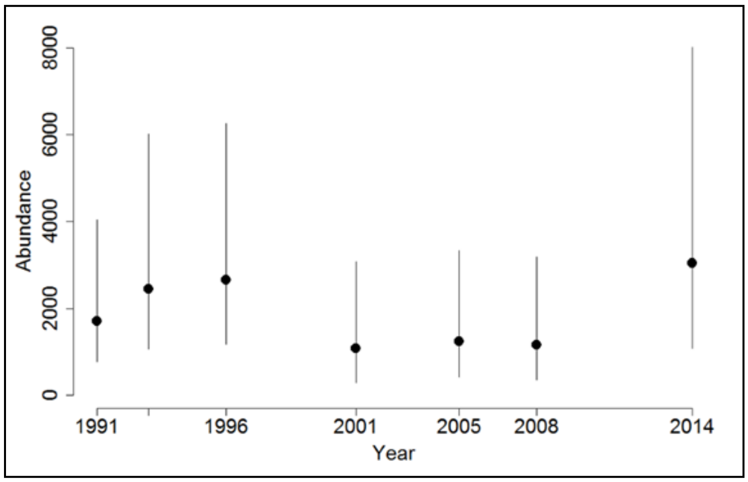

Figure 2. Abundance and trend estimates for mesoplodont beaked whales in the California Current, 1991-2014 (Moore and Barlow 2017). For each year, the Bayesian posterior median (●) is shown, along with 95% CRIs.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No information on current or maximum net productivity rates is available for mesoplodont beaked whales.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (1,967) <u>times</u> one half the default maximum net growth rate for cetaceans (½ of 4%) <u>times</u> a recovery factor of 0.50 (for a species of unknown status with no known recent fishery mortality; Wade and Angliss 1997), resulting in a PBR of 20 mesoplodont beaked whales per year.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The California large mesh drift gillnet fishery has been the only fishery historically known to interact with *Mesoplodon* beaked whales in this region. Between 1990 and 1995, a total of eight *Mesoplodon* beaked whales (5 Hubb's beaked whales (*Mesoplodon carlhubbsi*), one Stejneger's beaked whale (*Mesoplodon stejnegeri*), and two unidentified whales of the genus *Mesoplodon* were observed entangled in approximately 3,300 sets (Julian and Beeson 1998, Carretta *et al.* 2008, Carretta *et al.* 2017). Following the introduction of acoustic pingers into this fishery (Barlow and Cameron 2003), no beaked whales of any species have been observed entangled in over 5,400 observed sets (Carretta *et al.* 2008, Carretta *et al.* 2017). New model-based estimates of bycatch based on regression trees result in a very small estimate of bycatch with high uncertainty for a single species (*M. carlhubbsi*), for the most recent 5-year period, 2011-2015 (0.5 whales total, CV=2.3), despite zero entanglements observed during that time period (Carretta *et al.* 2017). This is due to the bycatch model incorporating all 26 years of observer data in the estimation process (Carretta *et al.* 2017). Estimates for *M. stejnegeri* and unidentified *Mesoplodon* species are zero for the same time period.
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.

Table 1. Summary of available information on the incidental mortality and injury of *Mesoplodon* beaked whales (California/Oregon/Washington Stocks) in commercial fisheries that might take these species. Mean annual takes are based on 2011-2015 data unless noted otherwise.

Fishery Name	**Data Type**	**Year**	**Percent Observer Coverage**	**Observed Mortality**	**Estimated Annual Mortality**	**Mean Annual Takes (CV in parentheses)**
CA/OR thresher shark/swordfish drift gillnet fishery	observer	2011 2012 2013 2014 2015	20% 19% 37% 24% 20%	0 0 0 0 0	0 0 0 0 0	0 (unidentified *Mesoplodon* and *M. Stejnegeri* only)
		2011-2015	24%	0	*M. carlshubbsi* only 0.5 (2.3)	*M. carlshubbsi* only 0.1 (2.3)
Minimum total annual takes of all *Mesoplodon* beaked whales						0.1 (2.3)

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 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).

STATUS OF STOCKS

The status of mesoplodont beaked whales in California, Oregon and Washington waters relative to OSP is not known, and the population decline previously reported by Moore and Barlow (2013) is no longer apparent with the addition of 2014 survey data, which includes the highest estimate of *Mesoplodon* abundance in the 1991-2014 time series (Moore and Barlow 2017). The probability of a population increase over the time period 1991-2014 was estimated as 0.87 by Moore and Barlow (2017), but this is confounded by the fact that most *Mesoplodon* sightings are not identified to species, and thus, which species are driving the observed increase are not known. The previously-reported decline in abundance by Moore and Barlow (2013) (trend-fitted 2008 abundance at approximately 30% of 1991 levels) and current uncertainty in the long-term growth rate of this genus in the region warrants further investigation. If the relatively high 2014 abundance estimate was due to a temporary influx of subtropical and tropical species into the region, the remaining temperate species may be below their carrying capacity and may be depleted, based on the previous findings of Moore and Barlow (2013). 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). The average annual known human-caused fishery mortality between 2011 and 2015 is zero for *M. stejnegeri* and unidentified *Mesoplodon.* A negligible estimate of drift gillnet bycatch (0.1 whales annually) is predicted for *M. carlshubbsi* over the same time period, despite zero observations of entanglements in the fishery since 1994 (Carretta *et al.* 2017). None of the six species is listed as "threatened" or "endangered" under the Endangered Species Act and given the relative lack of bycatch in gillnet fisheries in this region, these stocks are considered non-strategic. It is likely that the difficulty in identifying these animals in the field will remain a critical obstacle to obtaining species-specific abundance estimates and stock assessments in the future. 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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