Revised 6/4/2014

BLUE WHALE (*Balaenoptera musculus musculus*): Central North Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) has formally considered only one management stock for blue whales in the North Pacific (Donovan 1991), but up to five populations have been proposed (Reeves et al. 1998). Rice (1974) hypothesized that blue whales from Baja California migrated far offshore to feed in the eastern Aleutians or Gulf of Alaska and returned to feed in California waters; though more recently concluded that the California population is separate from the Gulf of Alaska population (Rice 1992). Length frequency analyses (Gilpatrick et al. 1996) and photo-identification studies (Calambokidis et al. 1995) through the 1990s supported separate populations for blue whales feeding off California and those feeding in Alaskan waters. Whaling catch data indicated that whales feeding along the Aleutian Islands were probably part of a central Pacific stock (Reeves et al. 1998), which was thought to migrate to offshore waters north of Hawaii in winter (Berzin and Rovnin 1966). Blue whale feeding aggregations have not been found in Alaska despite several surveys (Leatherwood et al. 1982; Stewart et al. 1987; Forney and Brownell 1996). More recently, analyses of acoustic data obtained throughout the North Pacific (Stafford et al. 2001; Stafford 2003) have revealed two distinct blue whale call types, suggesting two North Pacific stocks: eastern and central (formerly western). The regional occurrence patterns suggest that blue whales from the eastern North Pacific stock winter off Mexico, Central America, and as far south as 8° S (Stafford et al. 1999), and feed during summer off the U. S. West Coast and to a lesser extent in the Gulf of Alaska. This stock has previously been observed to feed in waters off California (and occasionally as far north as British Columbia; Calambokidis et al. 1998) in summer/fall (from June to November) migrating south to productive areas off Mexico (Calambokidis et al. 1990) and as far south as the Costa Rica Dome (10° N) in winter/spring (Mate et al. 1999, Stafford et al. 1999). Blue whales belonging to the central Pacific stock appear to feed in summer southwest of Kamchatka, south of the Aleutians, and in the Gulf of Alaska (Stafford 2003; Watkins et al. 2000), and in winter migrate to lower latitudes in the western and central Pacific, including Hawaii (Stafford et al. 2001).

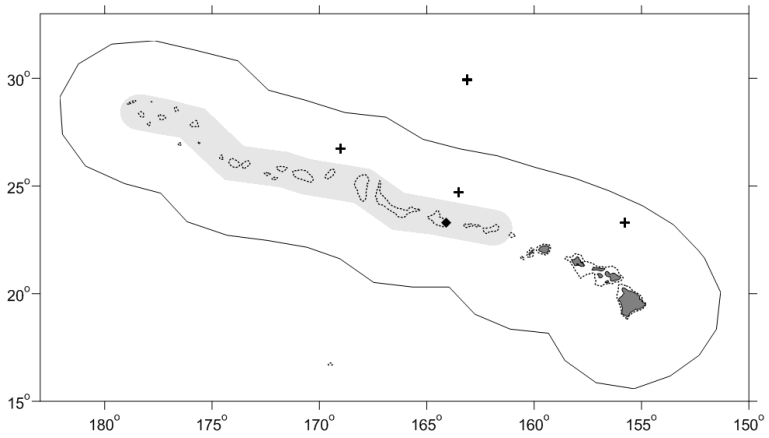

Figure 1. Locations of blue whale sightings made by observers aboard Hawaii-based longline fishing vessels between July 1994 and December 2009 (crosses, NMFS/PIR unpublished data), and location of a single blue whale sighting during a 2010 (black diamond) shipboard cetacean survey of U.S. EEZ waters surrounding the Hawaiian Islands (Bradford et al. 2013; see Appendix 2 for details on timing and location of survey effort). Outer line indicates approximate boundary of survey area and U.S. EEZ. Gray shading indicates area of Papahanaumokuakea Marine National Monument. Dotted line represents the 1000m isobath.

The first published sighting record of blue whales near Hawaii is that of Berzin and Rovnin (1966), though recently, two blue whales were seen with fin whales and an unidentified rorqual in November 2010 during a survey of Hawaiian U.S. EEZ waters (Bradford et al. 2013). Four sightings have been made by observers on Hawaii-based longline vessels (Figure 1; NMFS/PIR, unpublished data). Additional evidence that blue whales occur in this area comes from acoustic recordings made off Oahu and Midway Islands (Northrop et al. 1971; Thompson and Friedl 1982), which likely included at least some whales within the EEZ. The recordings made off Hawaii showed bimodal peaks throughout the year (Stafford et al. 2001), with central Pacific call types heard during winter and eastern Pacific calls heard during summer. For the Marine Mammal Protection Act (MMPA) stock assessment reports, there are two blue whale stocks within the Pacific U.S. EEZ: 1) the central North Pacific stock (this report), which includes whales found around the Hawaiian Islands during winter and 2) the eastern North Pacific stock, which feeds primarily off California.

POPULATION SIZE

From ship line-transect surveys, Wade and Gerrodette (1993) estimated 1,400 blue whales for the eastern tropical Pacific. No blue whale sightings were made during summer/fall 2002 shipboard surveys of the entire Hawaiian Islands EEZ (Barlow 2006). A 2010 shipboard line-transect survey of the entire Hawaiian Islands EEZ resulted in a summer/fall abundance estimate of 81 (CV = 1.14) blue whales (Bradford et al. 2013). This is currently the best available abundance estimate for this stock within the Hawaii EEZ, but the majority of blue whales would be expected to be at higher latitudes feeding grounds at this time of year.

Minimum Population Estimate

The 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 38 blue whales within the Hawaiian Islands EEZ.

Current Population Trend

The first sightings of blue whales during systematic surveys occurred in 2010, and there is currently insufficient data to assess population trends.

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 Central North Pacific stock of blue whales is calculated as the minimum population size within the U.S. EEZ of the Hawaiian Islands (38) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.1 (the default value for an endangered species with N_{min} <1500; Taylor et al. 2003), resulting in a PBR of 0.1 Central Pacific blue 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

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 2007 and 2011, no blue whales were observed hooked or entangled in the SSLL fishery (100% observer coverage) or the DSLL fishery (20-22% observer coverage) (McCracken 2013, Bradford & Forney 2013).

Historical Mortality

At least 9,500 blue whales were taken by commercial whalers throughout the North Pacific between 1910 and 1965 (Ohsumi and Wada 1972). Some proportion of this total may have been from a population or populations that migrate seasonally into the Hawaiian EEZ. The species has been protected in the North Pacific by the IWC since 1966.

STATUS OF STOCK

The status of blue whales in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Blue whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the central Pacific stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. Because there have been no reported fishery related mortality or serious injuries of blue whales within the Hawaiian Islands EEZ, the total fishery-related mortality and serious injury of this stock can be considered to be insignificant and approaching zero. Increasing levels of anthropogenic noise in the world's oceans has been suggested to be a habitat concern for blue whales (Reeves et al. 1998). Tagged blue whales exposed to

simulated mid-frequency sonar and pseudo-random noise demonstrated a variety of behavioral responses, including no change in behavior, termination of deep dives, directed travel away from sound sources, and cessation of feeding (Goldbogen et al. 2013). Behavioral responses were highly dependent upon the type of sound source and the behavioral state of the animal at the time of exposure. Deep-feeding and non-feeding whales reacted more strongly to experimental sound sources than surface-feeding whales that typically showed no change in behavior. The authors stated that behavioral responses to such sounds are influenced by a complex interaction of behavioral state, environmental context, and prior exposure of individuals to such sound sources. One concern expressed by the authors is if blue whales did not habituate to such sounds near feeding areas that "repeated exposures could negatively impact individual feeding performance, body condition and ultimately fitness and potentially population health." Currently, no evidence indicates that such reduced population health exists, but such evidence would be difficult to differentiate from natural sources of reduced fitness or mortality in the population.

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