Revised 6/4/2014

FIN WHALE (*Balaenoptera physalus physalus*): California/Oregon/Washington Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The International Whaling Commission (IWC) recognized two stocks of fin whales in the North Pacific: the East China Sea and the rest of the North Pacific (Donovan 1991). Mizroch et al. (2009) described eastern and western north Pacific populations, based on a review of sightings data, catch statistics, recaptures of marked whales, blood chemistry data, and acoustics. The two populations are thought to have separate wintering and mating grounds off the coasts of Asia and North America and during summer, whales from each population may co-occur near the Aleutian Islands and Bering Sea (Mizroch et al. 2009). Additional, non-migratory populations exist in the Gulf of California (Tershy et al. 1993; Bérubé et al. 2002) and the East China Sea (Fujino 1960). Evidence of additional subpopulations near Sanriku-Hokkaido and the Sea of Japan exists, based on seasonal catch data and recaptures of marked animals (Mizroch et al. 2009). Fin whales occur throughout the North Pacific, from the southern Chukchi Sea to the Tropic of Cancer (Mizroch et al. 2009), but their wintering areas are poorly known. Fin whales occur year-round in the Gulf of Alaska (Stafford et al. 2007); the Gulf of California (Tershy et al. 1993; Bérubé et al. 2002); California (Dohl et al. 1983); and Oregon and Washington (Moore et al. 1998). Fin whales are scarce in the eastern tropical Pacific in summer (Wade and Gerrodette 1993) and winter (Lee 1993).

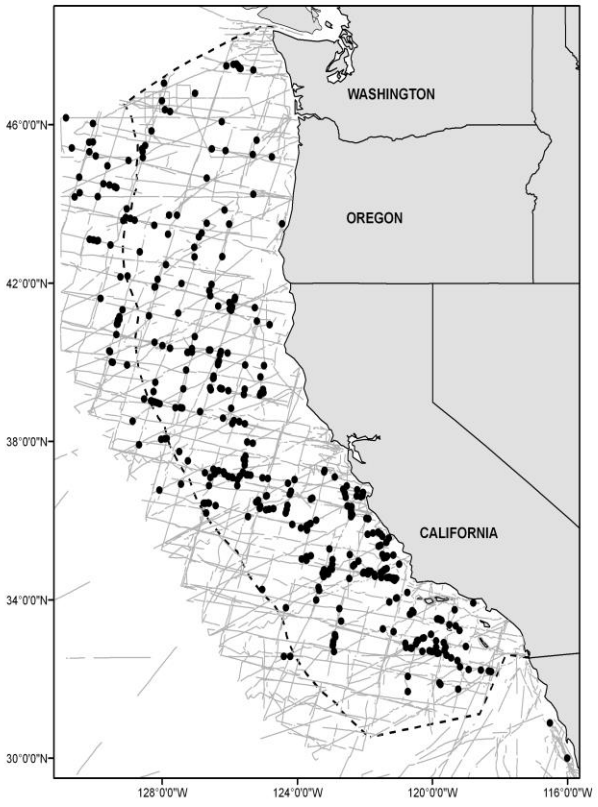

Figure 1. Fin whale sighting locations based on shipboard surveys off California, Oregon, and Washington, 1991-2008 (see Appendix 2 for data sources and information on timing and location of surveys). Dashed line represents the U.S. EEZ; thin lines indicate completed transect effort of all surveys combined.

There is still insufficient information to determine population structure, but from a conservation perspective it may be risky to assume panmixia in the entire North Pacific. This assessment will cover the stock of fin whales which is found along the coasts of California, Oregon, and Washington. Because fin whale abundance appears lower in winter/spring in California (Dohl et al. 1983; Forney et al. 1995) and in Oregon (Green et al. 1992), it is likely that the distribution of this stock extends seasonally outside these coastal waters. The Marine Mammal Protection Act (MMPA) stock assessment reports recognize three stocks of fin whales in the North Pacific: 1) the California/Oregon/Washington stock (this report), 2) the Hawaii stock, and 3) the Northeast Pacific stock.

POPULATION SIZE

The pre-whaling population of fin whales in the North Pacific was estimated to be 42,000-45,000 (Ohsumi and Wada 1974). In 1973, the North Pacific population was estimated to have been reduced to 13,620-18,680 (Ohsumi and Wada 1974), of which 8,520-10,970 were estimated to belong to the eastern

Pacific stock. The Gulf of California resident population was estimated at approximately 400 whales (Urbán 1996), but that estimate is now outdated. The best estimate of fin whale abundance in California, Oregon, and Washington waters out to 300 nmi is from a trend-model analysis of line-transect data from 1991 through 2008 (Moore and Barlow 2011), which generated an estimate for 2008 of 3,051 (CV=0.18). The trend-model analysis incorporates information from the entire 1991-2008 time series for each annual estimate of abundance and given the strong evidence of an increasing abundance trend over that time (Moore and Barlow 2011), the best estimate of abundance is represented by the model-averaged estimate for the most recent year, or 2008. This is probably an underestimate because it excludes some fin whales which could not be identified in the field and which were recorded as "unidentified rorqual" or "unidentified large whale".

Minimum Population Estimate

The minimum population estimate for fin whales is taken as the lower 20th percentile of the posterior distribution of abundance estimated for 2008 (Moore and Barlow (2011), or approximately 2,598 whales.

Current Population Trend

Indications of recovery in CA coastal waters date back to 1979/80 (Barlow 1994), but there is now strong evidence that fin whale abundance increased in the California Current between 1991 and 2008 based on analysis of abundance data from line transect surveys conducted in the California Current between 1991 and 2008 (Moore and Barlow 2011) (Figure 2). Abundance in waters out to 300 nmi off the coast of California approximately doubled between 1991 and 1996, from approximately 800 (CV = 0.29) to 1400 (CV=0.20), suggesting probable dispersal of animals into this area. Across the entire study area (waters off California, Oregon, and Washington), abundance from 1996 to 2008 increased by an estimated 51%. Mean population growth rate decreased from an estimated 7% per year in 1996/1997 to 3.5% per year by 2008. Zerbini et al. (2006) found similar evidence of increasing abundance trend for fin whales in Alaskan waters at a rate of 4.8% per year between 2001 and 2003.

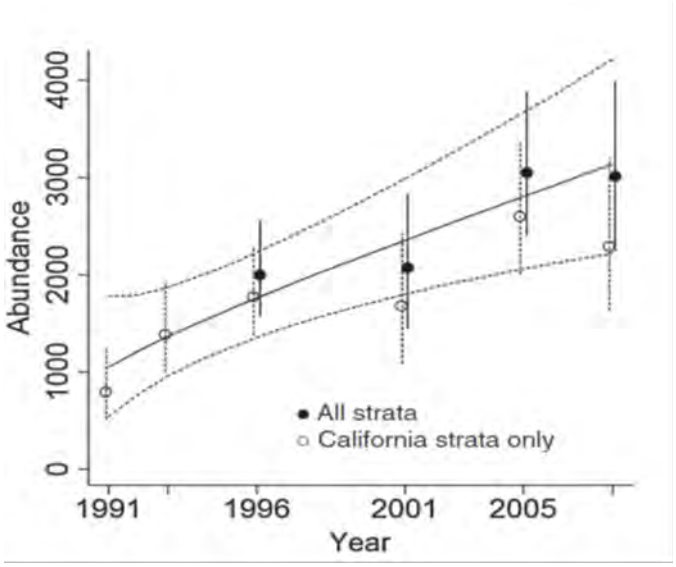

Figure 2. Trend-based estimates of fin whale abundance, 1991-2008, with 90% Bayesian credible intervals (Moore and Barlow 2011).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

There are no estimates of the growth rate of fin whale populations in the North Pacific (Best 1993). Estimated annual rates of increase in the California Current (California, Oregon, and Washington waters) averaged ≈ 7% during the mid-late 1990s, declining to ≈ 3.5% by 2008 (Moore and Barlow 2011). However, it is unknown how much of this growth is due to immigration rather than birth and death processes. A near doubling of the abundance estimate in California waters between 1991 and 1993 cannot be explained by birth and death processes alone, and movement of individuals between U.S. west coast waters and other areas (e.g., Alaska, Mexico) have been documented (e.g., Mizroch et al. 1984).

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for this stock is calculated as the minimum population size (2,598) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.3 (for an endangered species, with $N_{min} > 1,500$ and $CV_{Nmin} < 0.50$), resulting in a PBR of 16.

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.

Fisheries Information

One fin whale death (in 1999) has been observed in the California swordfish drift gillnet fishery in over 8,000 sets since 1990 when NMFS began observing the fishery. Mean annual takes for this fishery (Table 1) are based on 2007-2011 data (Carretta and Enriquez 2009a, 2009b, 2010, 2012a, 2012b). This results in an average estimate of zero fin whales taken annually. Some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net. Three fin whales sighted at-sea were determined to be seriously injured as the result of interactions with unknown fishing gear (buoys and/or line) during the period 2007-2011 (Carretta *et al.* 2013). 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 fin whales (CA/OR/WA stock) for commercial fisheries that might take this species.

Fishery Name	Data Type	Year(s)	Percent Observer Coverage	Observed (or self-reported)	Estimated Annual Mortality (and serious injury)	Mean Annual Takes (CV in parentheses)
CA swordfish and thresher shark drift gillnet fishery	observer	2007 2008 2009 2010 2011	16.4% 13.5% 13.3% 11.9% 19.5%	~~0~~ ~~0~~ ~~0~~ 0 0 0 0 0	0 0 0 0 0	0 (n/a)
Unidentified fishery interactions	2007-2011	at-sea sightings	n/a	3	0 (3)	≥ 0.6
Minimum total annual takes						≥ 0.6 (n/a)

Ship Strikes

Ship strikes were implicated in the deaths of seven fin whales and the serious injury of another during 2007-2011 Carretta et al. 2013). One ship strike was recorded in 2008, four in 2009, two in 2010, and one in 2011. During – 2007-2011, there were an additional four injuries of unidentified large whales attributed to ship strikes. Additional mortality from ship strikes probably goes unreported because the whales do not strand or, if they do, they do not always have obvious signs of trauma. The average observed annual mortality and serious injury due to ship strikes is 1.6 fin whales per year during 2007-2011. Documented ship strike deaths and serious injuries are derived from actual counts of whale carcasses and should be considered minimum values. Where evaluated, estimates of detection rates of cetacean carcasses are consistently quite low across different regions and species (<1% to 17%), highlighting that observed numbers are unrepresentative of true impacts (Kraus *et al*. 2005, Perrin *et al*. 2011, Williams *et al*. 2011, Prado *et al*. 2013).

STATUS OF STOCK

Approximately 46,000 fin whales were taken from the North Pacific by commercial whalers between 1947 and 1987 (C. Allison, IWC, pers. comm.). Approximately 5,000 fin whales were taken from the west coast of North America from 1919 to 1965 (Rice 1974; Tonnessen and Johnsen 1982; Clapham et

al. 1997). Fin whales in the North Pacific were given protected status by the IWC in 1976. Fin whales are formally listed as "endangered" under the Endangered Species Act (ESA), and consequently the California to Washington stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The total quantified incidental mortality due to fisheries (0.6/yr) and ship strikes (1.6/yr) is less than the calculated PBR (16). Total fishery mortality is less than 10% of PBR and, therefore, may be approaching zero mortality and serious injury rate. There is strong evidence that the population has increased since the early 1990s (Moore and Barlow 2011). Increasing levels of anthropogenic sound in the world's oceans has been suggested to be a habitat concern for whales, particularly for baleen whales that may communicate using low-frequency sound (Croll *et al.* 2002). Behavioral changes associated with exposure to simulated mid-frequency sonar, including no change in behavior, cessation of feeding, increased swimming speeds, and movement away from simulated sound sources has been documented in tagged blue whales (Goldbogen et al. 2013), but it is unknown if fin whales respond in the same manner to such sounds.

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