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

STOCK DEFINITION AND GEOGRAPHIC RANGE

Northern Hemisphere fin whales (*B. physalus physalus*) likely comprise distinct Pacific and Atlantic subspecies (Archer *et al*. 2013). 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 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). 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 are scarce in the eastern tropical Pacific in summer (Wade and Gerrodette 1993) and winter (Lee 1993). 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 satellite-tagged in the Southern California Bight (SCB) appear to use the region year-round, although they seasonally range to central California and Baja California before returning to the SCB (Falcone and Schorr 2013). The longest satellite track reported by Falcone and Schorr (2013) was a fin whale tagged in the SCB in January 2014, with the whale moving south to central Baja California by February and north to the Monterey area by late June. Archer *et al*. (2013) present evidence for geographic separation of fin whale mtDNA clades near Point Conception, California: a significantly higher proportion of 'clade A' is composed of samples from the SCB and Baja California, while 'clade C' is largely represented by samples from central California, Oregon, Washington, and the Gulf of Alaska.

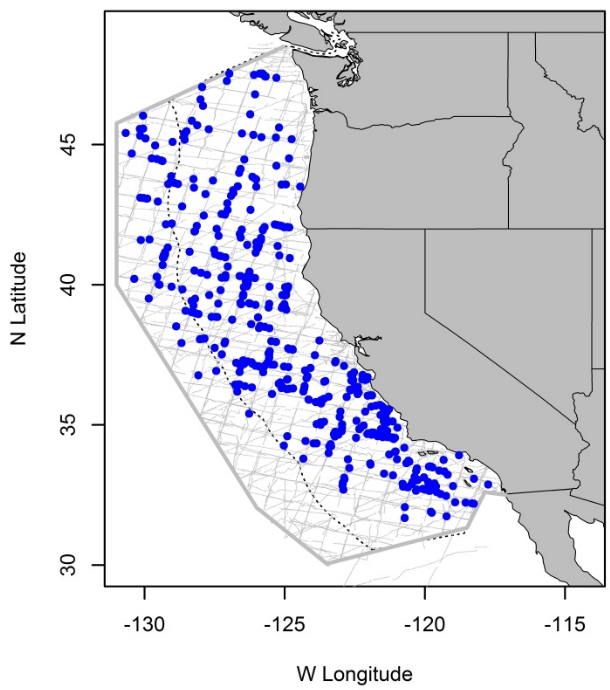

Figure 1. Fin whale sighting locations based on shipboard surveys off California, Oregon, and Washington, 1991-2014. Dashed line represents the U.S. EEZ; thin lines indicate completed transect effort of all surveys combined.

Insufficient information exists to determine population structure, but from a conservation perspective it may be risky to assume panmixia in the entire North Pacific. This report covers the stock of fin whales 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. Fin whales are present year-round in southern California waters, as evidenced by individually-identified whales photographed in all four seasons (Falcone and Schorr 2013). 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 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 2014 (Nadeem *et al*. 2016; Fig. 2), which generated an estimate for 2014 of 9,029 (CV=0.12) whales. The new estimates are based on similar methods to those first applied to this population by Moore and Barlow (2011). However, the new abundance estimates are substantially higher than earlier estimates because the new analysis incorporates lower estimates of *g(0)*, the trackline detection probability (Barlow 2015). The trend-model analysis incorporates information from the entire 1991-2014 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, Nadeem *et al.* 2016), the best estimate of abundance is represented by the estimate for the most recent year, or 2014. This is probably an underestimate because it excludes some fin whales that could not be identified in the field and 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 2014, or approximately 8,127 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 2014 (Nadeem *et al*. 2016, Figure 2). Abundance in waters out to 300 nmi off the coast of California approximately doubled between 1991 and 1993, from approximately 1,744 (CV = 0.25) to 3,369 (CV= 0.21), suggesting probable dispersal of animals into this area. Across the entire study area (waters off California, Oregon, and Washington), the mean annual abundance increase was 7.5%, although abundance appeared stable between 2008 and 2014. In all, there has been a roughly 5-fold increase between 1991 and 2014. Since 2005, the abundance increase has been driven by increases off northern California, Oregon and Washington, while numbers off Central and Southern California have been stable (Nadeem *et al*. 2016). 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.

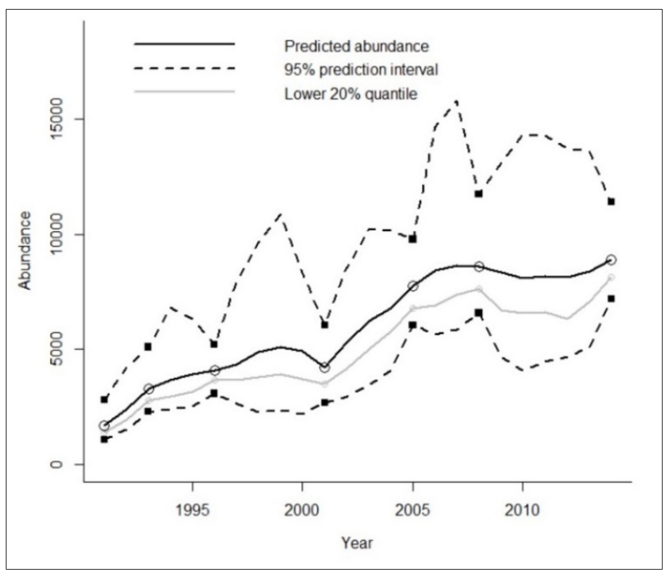

Figure 2. Trend-based estimates of fin whale abundance, 1991- 2014, with 95% Bayesian credible intervals (Nadeem *et al*. 2016).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Estimated annual rates of increase in the California Current (California, Oregon, and Washington waters) averaged 7.5% from 1991 to 2014 (Nadeem *et al*. 2016). However, it is unknown how much of this growth is due to immigration rather than birth and death processes. A 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 (8,127) times one half the default maximum net growth rate for cetaceans (½ of 4%) times a recovery factor of 0.5 (for an endangered species, with $N_{min} > 5{,}000$ and $CV_{Nmin} < 0.50$, Taylor *et al*. 2003), resulting in a PBR of 81 whales.

HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

One fin whale death (in 1999) was observed in the California swordfish drift gillnet fishery from over 8,600 observed sets between 1990 and 2014 (Carretta *et al*. 2016a.). Although no fin whales have been observed taken in the fishery since 1999, new model-based bycatch estimates include a very small estimate of 0.1 whales (CV=3) for the most recent 5-year period, 2010-2014 (Carretta *et al.* 2016a). The large CV of this bycatch estimate is a consequence of the mean estimate being very small. This estimate is based on inclusion of 25 years of observer data spanning 1990-2014 and reflects a very low long-term observed bycatch rate scaled up to levels of unobserved fishing effort. Mean annual takes (<0.1) for this fishery (Table 1) are based on 2010-2014 data. Some gillnet mortality of large whales may go unobserved because whales swim away with a portion of the net. One fin whale sighted at-sea was determined to be seriously injured (line cutting into the whale) as a result of interactions with unknown fishing gear during 2010-2014 (Carretta *et al.* 2016b). Including systematic fishery observations in the CA swordfish drift gillnet fishery and opportunistic sightings of fishery-related injuries, the mean annual serious injury and mortality of fin whales for 2010-2014 is ≥0.2 whales (Table 1). 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 Mortality (and serious injury)	Mean Annual Takes (CV in parentheses)
CA swordfish and thresher shark drift gillnet fishery	2010-2014	observer	22%	0[1]	0.1 (CV=3)	<0.1 (CV=3)
Unidentified fishery interactions	2010-2014	at-sea sightings	n/a	1	0 (1)	≥ 0.2
Minimum total annual takes						≥ 0.2 (CV=3)

Ship Strikes

Ship strikes were implicated in the deaths of nine fin whales during 2010-2014 (Carretta *et al*. 2015, Carretta *et al.* 2016b). During 2010-2014, there was one additional serious injury to an unidentified large whale attributed to a ship strike. 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 1.8 fin whales per year during 2010-2014. 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 33%), highlighting that observed numbers underestimate true impacts (Carretta *et al*. 2016c, Kraus *et al*. 2005, Williams *et al*. 2011, Prado *et al*. 2013, Wells *et al.* 2015).

STATUS OF STOCK

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

[1] There were no observations of fin whale entanglements in this fishery during 2010-2014, but the model-based estimate of bycatch for this period results in a positive estimate of bycatch (Carretta *et al*. 2016a).

to Washington stock is automatically considered as a "depleted" and "strategic" stock under the MMPA. The total documented incidental mortality and serious injury (2.0/yr) due to fisheries (0.2/yr) and ship strikes (1.8/yr) is less than the calculated PBR (81). 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, Nadeem *et al.* 2016). 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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