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FIN WHALE (*Balaenoptera physalus*): Northeast Pacific Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Within the U.S. waters in the Pacific Ocean, fin whales are found seasonally off the coast of North America and in the Bering Sea during the summer (Fig. 1). Information on seasonal fin whale distribution has been gleaned from the detection of fin whale calls using bottom-mounted, offshore hydrophone arrays along the U.S. Pacific coast, in the central North Pacific, and in the western Aleutian Islands (Moore et al. 1998, 2006; Watkins et al. 2000; Stafford et al. 2007; Širović et al. 2013; Soule and Wilcock 2013; Archer et al. 2019). Moore et al. (1998, 2006), Watkins et al. (2000), and Stafford et al. (2007) documented fin whale calling along the U.S. Pacific coast where rates were highest from August/September through February, suggesting that these may be important feeding areas during the winter. Širović et al. (2013) speculated that both resident and migratory fin whales may occur off southern California based on shifts in peaks in fin whale calling data. Širović et al. (2015) noted that fin whales were detected in the Southern California Bight year-round and found an overall increase in the fin whale call index from 2006 to 2012. Soule and Wilcock (2013) documented fin whale call rates in a presumed feeding area along the Juan de Fuca Ridge, offshore of northern Washington State, and found that some whales appear to transit northwest from August to October. They speculate that some fin whales migrate northward from the Juan de Fuca Ridge in fall and southward in winter. While peaks in call rates occurred during late summer, fall, and winter in the central North Pacific and the Aleutian Islands, fin whale calls were seldom detected during summer months even though fin whales are regularly seen in summer months in the Gulf of Alaska (Stafford et al. 2007). Fin whale calls have been detected in the southeast Bering Sea by a moored hydrophone. During April 2006 through April 2007, peaks in fin whale call detections were found from September through November 2006 and also in February and March 2007 (Stafford et al. 2010). In addition, fin whale calls were detected in the northeastern Chukchi Sea using instruments moored there from July through October between 2007 and 2010 (Delarue et al. 2013). Call data collected from the Bering Sea suggest that several putative fin whale stocks may feed in the Bering Sea; however, only one of these likely migrates into the Chukchi Sea to feed (Delarue et al. 2013). Some fin whale calls have also been recorded in the Hawaiian portion of the U.S. Exclusive Economic Zone in all months except June and July (Thompson and Friedl 1982, McDonald and Fox 1999). Sightings of fin whales in Hawaii are extremely rare: there was a sighting in 1976 (Shallenberger 1981), a sighting in 1979 (Mizroch et al. 2009), a sighting during an aerial survey in 1994 (Mobley et al. 1996), and five sightings during a survey in 2002 (Barlow 2006).

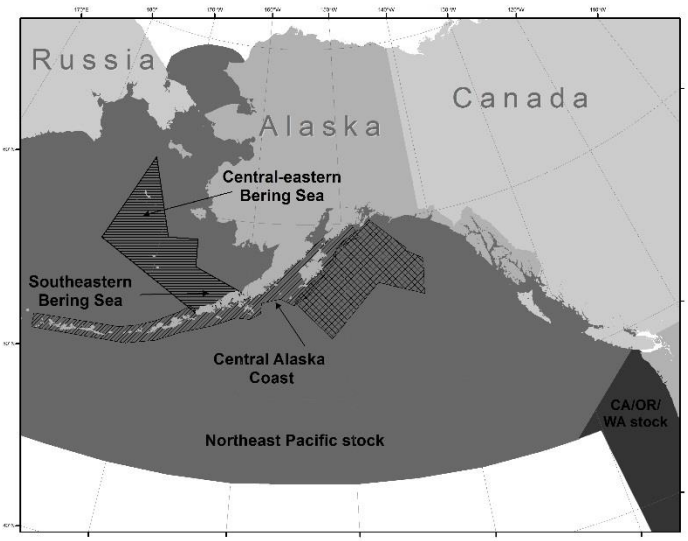

Figure 1. Approximate distribution of fin whales in the eastern North Pacific. Striped areas indicate where vessel surveys occurred in 1999-2010 (horizontal stripes - Bering Sea: Moore et al. 2002; Friday et al. 2012, 2013); 2001-2003 (diagonal stripes - Central Alaska coast and Aleutian Islands: Zerbini et al. 2006); and 2009, 2013, and 2015 (crosshatch - Gulf of Alaska: Rone et al. 2017).

Surveys on the Bering Sea shelf in 1997, 1999, 2000, 2002, 2004, 2008, and 2010 and in coastal waters of the Aleutian Islands and the Alaska Peninsula from 2001 to 2003 provided information about the distribution and abundance of fin whales in these areas (Moore et al. 2000, 2002; Zerbini et al. 2006; Friday et al. 2012, 2013). Fin whales were the most common large whale sighted during the Bering Sea shelf surveys in all years except for 1997 and 2004 (Friday et al. 2012, 2013). Fin whales were consistently distributed both in the "green belt," an area of high productivity along the edge of the eastern Bering Sea continental shelf (Springer et al. 1996), and, at a lower frequency, in the middle shelf. Abundance estimates for fin whales in the Bering Sea were consistently higher in cold years than in warm years (Friday et al. 2012, 2013) indicating a shift in distribution. This is consistent with a

fine-scale comparison of fin whale occurrence on the middle shelf between a cold year (1999) and a warm year (2002), which found that the group and individual encounter rates were 7 to 12 times higher in the cold year (Stabeno et al. 2012). Cold years are known to be more favorable for large copepods and euphausiids over the Bering Sea shelf (Stabeno et al. 2012) and fin whale distributions are likely driven by availability of preferred prey.

Based on whaling data, the historical range of fin whales extended into the southern Sea of Okhotsk and Chukchi Sea. It was assumed that they passed through the Bering Strait into the southwestern Chukchi Sea during August and September. Many fin whales were taken as far west as Mys (Cape) Shmidta (68°55'N, 179°24'E) and as far north as 69°04'N, 171°06'W (Mizroch et al. 2009). Fin whale sightings have been increasing during surveys conducted in the U.S. portion of the northern Chukchi Sea from July to October (Funk et al. 2010, Aerts et al. 2012, Clarke et al. 2013, Brower et al. 2018) and fin whale calls were recorded each year from 2007 to 2010 in August and September in the northeastern Chukchi Sea (Delarue et al. 2013) and August to October just north of the Bering Strait (Tsujii et al. 2016), suggesting they may be re-occupying habitat used prior to large-scale commercial whaling. A comparison of data from aerial surveys that covered the same general areas between 1982 and 1991 and between 2008 and 2016 found no fin whale sightings in the earlier time period as compared to regular sightings of fin whales in the latter (Brower et al 2018). In part, this could be due to increased effort from 2008 to 2016; however, the combination of acoustic and visual data seem to support increasing numbers and extended seasonal residency of fin whales in the Alaska Arctic.

The following information was considered in classifying stock structure based on the Dizon et al. (1992) phylogeographic approach: 1) Distributional data: geographic distribution continuous in winter, possibly isolated in summer; 2) Population response data: unknown; 3) Phenotypic data: unknown; and 4) Genotypic data: unknown. Based on this limited information, the International Whaling Commission (IWC) considers fin whales in the North Pacific to all belong to the same stock (Mizroch et al. 1984), although Mizroch et al. (1984) cited additional evidence that supported the establishment of subpopulations in the North Pacific. Further, Fujino (1960) described eastern and western groups, which are mostly isolated with the exception of potential intermingling around the Aleutian Islands. Recoveries of Discovery tags (Rice 1974, Mizroch et al. 2009) indicate that animals wintering off the coast of southern California range from central California to the Gulf of Alaska during the summer months.

Mizroch et al. (2009) provided a comprehensive summary of whaling catch data, recovery of Discovery tags, and opportunistic sightings data and found evidence to suggest there may be at least six populations of fin whales: two that are migratory (eastern and western North Pacific) and two to four more that are resident year-round in peripheral seas such as the Gulf of California, East China Sea, Sanriku-Hokkaido, and possibly the Sea of Japan. It appears likely that the two migratory stocks mingle in the Bering Sea in July and August, rather than in the Aleutian Islands as Fujino (1960) previously concluded (Mizroch et al. 2009). During winter months, fin whales have been seen over a wide geographic area from 23°N to 60°N, but winter distribution and location of primary wintering areas (if any) are poorly known and need further study. As a result, stock structure of fin whales remains uncertain.

For management purposes, three stocks of fin whales are currently recognized in U.S. Pacific waters: 1) Alaska (Northeast Pacific) (Fig. 1), 2) California/Washington/Oregon, and 3) Hawaii. Mizroch et al. (2009) suggest that this structure should be reviewed and updated, if appropriate, to reflect recent analyses, but the absence of any substantial new data on stock structure makes this difficult. The California/Oregon/Washington and Hawaii fin whale stocks are reported in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

There are no reliable estimates of current and historical abundances for the entire Northeast Pacific fin whale stock. Several studies provide information on the distribution and occurrence of fin whales in the Northeast Pacific, as well as estimates of abundance in certain areas within the range of the stock, however, many of these are over a decade or more old.

Visual shipboard surveys for cetaceans were conducted on the eastern Bering Sea shelf during summer in 1997, 1999, 2000, 2002, 2004, 2008, and 2010 (Moore et al. 2000, 2002; Friday et al. 2012, 2013). These surveys were conducted in conjunction with the Alaska Fisheries Science Center (AFSC) echo-integrated trawl surveys for walleye pollock. The surveys covered 789 to 3,752 km of tracklines and observation effort for marine mammals varied according to the availability of observers during each cruise. Results of the surveys in 2002, 2008, and 2010, years when the entire AFSC pollock survey sampling area was surveyed (see Fig. 1), provided estimates of 419 (coefficient of variation (CV) = 0.33), 1,368 (CV = 0.34), and 1,061 (CV = 0.38) fin whales (Friday et al. 2013).

Dedicated line-transect cruises were conducted in coastal waters (as far as 85 km offshore) of western Alaska and the eastern and central Aleutian Islands in July and August from 2001 to 2003 (Zerbini et al. 2006). Over 9,053 km of tracklines were surveyed between the Kenai Peninsula (150°W) and Amchitka Pass (178°W). Fin

whales (n = 276) were observed from east of Kodiak Island to Samalga Pass, with high aggregations recorded near the Semidi Islands. Zerbini et al. (2006) estimated that 1,652 fin whales (95% CI: 1,142-2,389) occurred in these areas between 2001 and 2003.

In 2013 and 2015, dedicated line-transect surveys of the offshore waters of the Gulf of Alaska recorded, respectively, 171 and 38 sightings of fin whales (Rone et al. 2017). These surveys provided fin whale abundance estimates of 3,168 fin whales (CV = 0.26) in 2013 and 916 (CV = 0.39) in 2015. The marked differences in these estimates can be partially explained by differences in sampling coverage across the two cruises (Rone et al. 2017).

Estimates of fin whale abundance in the eastern Bering Sea and in the Gulf of Alaska in any given year cannot be considered representative of the entire Northeast Pacific stock because the geographic coverage of surveys was limited relative to the range of the stock. In addition, these estimates have not been corrected for animals missed on the trackline, animals submerged when the ship passed, and responsive movement away from or towards the survey vessel. However, even though no data are available to compute correction factors, it is expected that these estimates are robust because previous studies have shown that these sources of bias are small for this species (Barlow 1995).

Minimum Population Estimate

Although the full range of the Northeast Pacific stock of fin whales in Alaska waters has not been surveyed, a rough estimate of the size of the population west of the Kenai Peninsula has been calculated in previous Stock Assessment Reports by summing the estimates from Moore et al. (2002) and Zerbini et al. (2006) (n = 5,700). However, based on analyses presented in Mizroch et al. (2009), whales surveyed in the Aleutians (Zerbini et al. 2006) could migrate northward and be counted during the Bering Sea surveys. There are also indications that fin whale distribution in the Bering Sea is related to oceanographic conditions and prey density (Stabeno et al. 2012, Friday et al. 2013, Zerbini et al. 2016), making it possible that whales could be double counted when estimates from different years are summed (Moore et al. 2002). Until recently, the best provisional estimate of the fin whale population west and north of the Kenai Peninsula in U.S. waters was 1,368 whales, the greater of the minimum estimates from the 2008 and 2010 surveys (Friday et al. 2013). However, the Gulf of Alaska surveys (Rone et al. 2017) are more recent. The higher of the two abundances computed for fin whales in this region, 3,168 whales (CV = 0.26), better represents a minimum abundance for the Northeast Pacific stock because it is more precise and because it represents a broader survey coverage. A minimum population estimate (N_{MIN}) for this stock can be calculated according to Equation 1 from the potential biological removal (PBR) guidelines (NMFS 2016): $N_{MIN} = N/\exp(0.842\times[\ln(1+[CV(N)]^2)]^{½})$. Using the best provisional estimate (N) of 3,168 from the 2013 survey and the associated CV(N) of 0.26 results in an N_{MIN} of 2,554 whales. However, this is an underestimate for the entire stock because it is based on surveys which covered only a small portion of the stock's range.

Current Population Trend

Zerbini et al. (2006) estimated rates of increase of fin whales in coastal waters south of the Alaska Peninsula (Kodiak and Shumagin Islands). An annual increase of 4.8% (95% CI: 4.1-5.4%) was estimated between 1987 and 2003. This estimate is the first available for North Pacific fin whales and is consistent with other estimates of population growth rates of large whales. It should be used with caution, however, due to uncertainties in the initial population estimate (in 1987) and due to uncertainties about the population structure of fin whales in the area. Also, the study represented only a small fraction of the range of the Northeast Pacific stock and it may not be appropriate to extrapolate this to a broader range.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Zerbini et al. (2006) estimated an annual increase of 4.8% (95% CI: 4.1-5.4%) between 1987 and 2003 for fin whales in coastal waters south of the Alaska Peninsula. However, there are uncertainties in the initial population estimate from 1987, as well as uncertainties regarding fin whale population structure in this area. Therefore, a reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the Northeast Pacific fin whale stock. Until additional data become available, the default cetacean maximum theoretical net productivity rate of 4% will be used for this stock (NMFS 2016).

POTENTIAL BIOLOGICAL REMOVAL

PBR is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: $PBR = N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.1, the recommended value for cetacean stocks that are listed as endangered (NMFS 2016). Using the best provisional estimate of 3,168 (CV = 0.26) from the 2013 survey and the associated N_{MIN} of 2,554, PBR is calculated to be 5.1

fin whales (2,554 × 0.02 × 0.1). However, because the estimate of minimum abundance is for only a small portion of the stock's range, the calculated PBR is likely biased low for the entire Northeast Pacific fin whale stock.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2014 and 2018 is listed, by marine mammal stock, in Young et al. (2020); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The minimum estimated mean annual level of human-caused mortality and serious injury for Northeast Pacific fin whales between 2014 and 2018 is 0.6 whales due to ship strikes. Ship strikes are a known threat for this stock and reductions in sea-ice coverage may lead to range extension and increased susceptibility to ship strikes from increased shipping in the Chukchi and Beaufort seas.

Fisheries Information

Information for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is available in Appendix 3 of the Alaska Stock Assessment Reports (observer coverage) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed December 2020).

No incidental mortality or serious injury of Northeast Pacific fin whales due to interactions with fisheries in Alaska waters was reported to the NMFS Alaska Region marine mammal stranding network between 2014 and 2018.

Table 1. Summary of mortality and serious injury of Northeast Pacific fin whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network between 2014 and 2018 (Young et al. 2020).

Cause of injury	2014	2015	2016	2017	2018	Mean annual mortality
Ship strike	1	0	1	0	1	0.6
Total due to ship strikes						0.6

Alaska Native Subsistence/Harvest Information

Subsistence hunters in Alaska and Russia have not been reported to take fin whales from this stock.

Other Mortality

Between 1900 and 1999, 75,538 fin whales were reportedly killed in commercial whaling operations throughout the North Pacific (Rocha et al. 2014).

In 2015, increased mortality of large whales was observed along the western Gulf of Alaska (including the areas around Kodiak Island, Afognak Island, Chirikof Island, the Semidi Islands, and the southern shoreline of the Alaska Peninsula) and along the central British Columbia coast (from the northern tip of Haida Gwaii to southern Vancouver Island). NMFS declared an Unusual Mortality Event (UME) for large whales that occurred from 22 May to 31 December 2015 in the western Gulf of Alaska and from 23 April 2015 to 16 April 2016 in British Columbia (https://www.fisheries.noaa.gov/national/marine-life-distress/active-and-closed-unusual-mortality-events, accessed December 2020). Forty-six large whale deaths attributed to the UME included 12 fin whales and 22 humpback whales in Alaska and 5 fin whales and 7 humpback whales in British Columbia. Based on the findings from the investigation, the UME was likely caused by ecological factors (i.e., the 2015 El Niño, Warm Water Blob, and Pacific Coast Domoic Acid Bloom).

Fin whale mortality due to ship strikes in Alaska waters was reported to the NMFS Alaska Region marine mammal stranding network in 2014, 2016, and 2018 (Young et al. 2020), resulting in a minimum mean annual mortality and serious injury rate of 0.6 fin whales due to ship strikes between 2014 and 2018 (Table 1).

STATUS OF STOCK

The fin whale is listed as endangered under the Endangered Species Act of 1973, and therefore designated as depleted under the MMPA. As a result, the Northeast Pacific stock is classified as a strategic stock. While estimates of the minimum population size and population trends are available for a portion of this stock, much of the

North Pacific range has not been surveyed. Therefore, the status of the stock relative to its Optimum Sustainable Population is not available. The minimum estimated mean annual level of human-caused mortality and serious injury for Northeast Pacific fin whales (0.6 whales) does not exceed the calculated PBR (5.1 whales). The minimum estimated mean annual rate of U.S. commercial fishery-related mortality and serious injury (0 whales) is less than 10% of the calculated PBR (10% of PBR = 0.5) and, therefore, can be considered insignificant and approaching a zero mortality and serious injury rate.

There are key uncertainties in the assessment of the Northeast Pacific stock of fin whales. While a single stock of fin whales is currently recognized in the Northeast Pacific, fin whale acoustic data suggest that multiple stocks overlap in the Bering Sea. Little is known about the pelagic distribution of fin whales due to the lack of dedicated marine mammal survey effort in the Bering Sea and Gulf of Alaska. The calculated PBR level is likely biased low because only a portion of the range has been surveyed. A reliable estimate of the trend in abundance is not available for this stock.

HABITAT CONCERNS

Changes in ocean conditions that affect the seasonal distribution and quality of prey may affect fin whale movements, distribution, and foraging energetics. Ship strikes are a known source of mortality, and reductions in sea-ice coverage may lead to range extension and concomitant exposure to increased shipping and oil and gas activities in the Bering and Chukchi seas. Ocean warming may increase the frequency of algal blooms that produce biotoxins known to be associated with large whale mortality. However, few data are available to assess the likelihood or extent of such impacts.

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