Fin Whale

(Balaenoptera physalus)

5-Year Review:
Summary and Evaluation

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National Marine Fisheries Service
Office Protected Resources
Silver Spring, MD
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5-YEAR REVIEW
Fin Whale *(Balaenoptera physalus)*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional or Headquarters Office:

Therese Conant, Office of Protected Resources, 916-930-3627
Christian Young, Intern, Office of Protected Resources, 301-427-8403

1.2 Methodology used to complete review

A 5-year review is a periodic analysis of a species' status conducted to ensure that the listing classification of a species as threatened or endangered on the List of Endangered and Threatened Wildlife and Plants (List) (50 CFR 17.11 – 17.12) is accurate. The 5-year review is required by section 4(c)(2) of the Endangered Species Act of 1973, as amended (ESA). The review was prepared pursuant to the joint National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife 5-year Review Guidance and template (NMFS and USFWS 2018). The NMFS Office of Protected Resources led the 5-year review with input from other NMFS regional offices and science centers. We updated information from the 5-year review completed in 2011 based on peer-reviewed publications, government and technical reports, conference papers, dissertations, and theses. We gathered information *through September 2018*. The information on the fin whale (*Balaenoptera physalus)* biology and habitat, threats, and conservation efforts was summarized and analyzed in light of the ESA section 4(a)(1) factors (see Section 2.3.2.1) and the recovery criteria identified in the recovery plan (NMFS 2010; see Section 2.3.3) to determine whether a reclassification or delisting may be warranted (see Section 3.0).

NMFS initiated a 5-year review of the fin whale and solicited information from the public on January 29, 2018 (83 FR 4032). We received five public comment letters and incorporated information as appropriate in this review.

1.3 Background

1.3.1 FRN Notice citation announcing initiation of this review

83 FR 4032, January 29, 2018

1.3.2 Listing History

<u>Original Listing</u>

FR notice 35 FR 8491

Date listed: 6/2/1970 ("grandfathered" in from precursor to ESA)
Entity listed: Finback Whale *(Balaenoptera physalus)*
Classification: Endangered

1.3.3 Associated rulemakings

NA

1.3.4 Review History

S.L. Perry, D.P. DeMaster, and G.K. Silber. 1999. The Great Whales: History and Status of Six Species Listed as Endangered Under the U.S. Endangered Species Act of 1973. Marine Fisheries Review 61:1, pp.44-51. Department of Commerce.

Conclusion: No change in endangered classification

NMFS. 2011. Fin whale (Balaenoptera physalus) 5-year review: summary and evaluation. NMFS Office of Protected Resources, Silver Spring, MD. 23 pages.

Conclusion: No change in endangered classification

1.3.5 Species' Recovery Priority Number at start of 5-year review

11[1], which indicates that threats are low, recovery potential is low to moderate, and there is the potential for conflict.

1.3.6 Recovery Plan or Outline

Name of plan or outline: Final Recovery Plan for the Fin Whale (*Balaenoptera physalus*)
Date issued: Final plan issued July 2010
Dates of previous revisions, if applicable: NA

[1] The recovery priority number 11 was based on NMFS' 1990 (55 FR 24296) priority system. In 2017, NMFS proposed changes to the recovery priority system (82 FR 24944, May 31, 2017). For the Biennial Report to Congress 2015-2016, the new proposed recovery priority was reported as a 12, which indicates a high demographic risk, low to moderate understanding of major threats, low to moderate U.S. jurisdiction exists for management or protective actions to address major threats, and high certainty that management or protective actions will be effective.

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

__X_**Yes**, *go to section 2.1.2*
_____**No**, *go to section 2.2*

2.1.2 Is the species under review listed as a DPS?[2]

_____**Yes**, *give date and go to section 2.1.3.1*
___X_**No**, *go to section 2.1.4*

2.1.3 Was the DPS listed prior to 1996?

_____**Yes**, *go to section 2.1.2*
_____**No**, *go to section 2.2*

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

_____**Yes**, *provide citation and go to section 2.1.4*
_____**No**, *go to section 2.1.3.2*

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

_____**Yes**, *discuss how it meets the DPS policy, and go to section 2.1.4*
_____**No**, *discuss how it is not consistent with the DPS policy and consider the 5-year review completed. Go to section 2.4., Synthesis.*

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[2] To be considered for listing under the ESA, a group of organisms must constitute a "species," which is defined in section 3 of the ESA to include "any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature." NMFS and USFWS jointly published a policy regarding the recognition of DPSs of vertebrate species under the Endangered Species Act (DPS Policy, 61 FR 4722; February 7, 1996). "DPS" is not a scientifically defined term; it is a term used in the context of ESA law and policy. Furthermore, when passing the provisions of the ESA that give us authority to list DPSs, Congress indicated that this provision should be used sparingly. We have discretion with regard to listing DPSs and, in order to be consistent with the directive of the Congressional report that followed the introduction of the DPS language in the ESA to identify DPSs sparingly, we will generally not, on our own accord, evaluate listings below the taxonomic species or subspecies level if the best available information indicates that the species or subspecies is in danger of extinction throughout all or a significant portion of its range. We should only identify DPSs if there is an overriding conservation benefit to the species.

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

___X__**Yes**, The Mediterranean population is genetically distinct from other populations in the North Atlantic (Panigada and Notarbartolo di Sciara 2012). The Gulf of California and Eastern China Sea populations may also represent differentiated populations. See section 2.3.1.5.
_____**No**, *go to section 2.2., Recovery Criteria*

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan[3] containing objective, measurable criteria?

X *Yes, continue to section 2.2.2.*

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

_____**Yes**, *go to section 2.2.2.2*
___X_**No**, *go to section 2.2.3, and note why these criteria do not reflect the best available information. Consider developing recommendations for revising recovery criteria in section 4.0.*

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

_____**Yes**, *go to section 2.2.3*
_____**No**, *go to section 2.2.3*

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

Downlisting Criteria from the Final Fin Whale Recovery Plan:

1. Given current and projected threats and environmental conditions, the fin whale population in each ocean basin in which it occurs (North Atlantic, North Pacific and

[3] Although the guidance generally directs the reviewer to consider criteria from final approved recovery plans, criteria in published draft recovery plans may be considered at the reviewer's discretion.

Southern Hemisphere) satisfies the risk analysis standard for threatened status (has no more than a 1% chance of extinction in 100 years) *and* has at least 500 mature, reproductive individuals (consisting of at least 250 mature females and at least 250 mature males) in each ocean basin. Mature is defined as the number of individuals known, estimated or inferred to be capable of reproduction. Any factors or circumstances that are thought to substantially contribute to a real risk of extinction that cannot be incorporated into a Population Viability Analysis will be carefully considered before downlisting takes place.

This criterion likely has been met. Although population numbers do not include life stages, it is logical to assume that at least a portion of the estimates per ocean basin include mature reproductive individuals. In addition, population abundance and distribution appear sufficient to ensure the species has no more than a 1% chance of extinction in 100 years (see Section 2.4). Trend data are available for some populations (see discussion by ocean basin below).

Reilly *et al.* (2013) estimated the global population declined by more than 70% from 1929-2007. The majority of the decline is likely occurring in the Southern Hemisphere while the North Atlantic subpopulation may have increased, and there appear to be increases in certain regions in the North Pacific. A rough total global estimate was about 53,000 fin whales in the year 2000 (Reilly *et al.* 2013). The most recent IUCN assessment of the global status changed the Red List category from Endangered to Vulnerable, which means the fin whale is considered to be at high risk of unnatural (human-caused) extinction without further human intervention (Cooke 2018).

While NMFS acknowledges that Marine Mammal Protection Act (MMPA) stock structure does not align with the ESA listed entity for fin whales, MMPA stock assessment reports contain the best available demographic information for fin whales in U.S. waters. The final 2016 and draft 2017 stock assessment reports provide the following minimum population estimates for fin whales in U.S. waters: western North Atlantic stock: 1,234 (NMFS 2017b); California/Oregon/Washington stock: 8,127 (NMFS 2016); Hawaii stock: 75 (NMFS 2017c); and Northeast Pacific stock: 2,554 (NMFS 2017a). More detailed abundance information by ocean basin follows.

North Atlantic

According to Reilly *et al.* (2013) best abundance estimates by region are: 25,800 (CV = 0.125) in 2001 for the central North Atlantic (East Greenland-Iceland, Jan Mayen Norway and the Faeroes in Denmark); 4,100 (CV 0.21) in 1996-2001 for the northeastern North Atlantic (North and West Norway); 17,355 (CV 0.27) in 1989 for the Spain-Portugal-British Isles area; and 1,722 (CV = 0.37) for West Greenland in 2005. Vikingsson *et al.* (2015) estimated abundance of fin whales in the central North Atlantic as 15,200 in 1987 and 20,600 in 2007 (no CVs reported). During 1987–2001, the annual increase in the total central North Atlantic was estimated as 4%, while the annual growth rate was estimated as 10% in the Irminger Sea (Vikingsson *et al.* 2009). Vázquez *et al*. (2013) estimated fin whale abundance in the Bay of Biscay between 2003 and 2011 to be 10,267 (CV = 0.048, 95% CI: 9,507-11,101) with a density of 0.0155 animals per square kilometer. Partial estimates for the western North Atlantic are 1,013 (95% CI: 459-2,654) for Newfoundland in 2002-3 (see Reilly *et al*. 2013). Ramp *et al.* (2014) reported estimates of 328 fin whales (of all sizes; 95% CI: 306 to 350) for the period 2004 to 2010 for the Gulf of St. Lawrence. This estimate is similar to estimates of 340 whales for the late 1960s and 380 whales for the early 1990s, indicating the population has not increased over the last 50 years (Ramp *et al.* 2014). NMFS (2017b) estimated the fin whale abundance in U.S. waters in the Western North Atlantic as 1,618 (CV = 0.33) with a minimum population estimate of 1,234 and an unknown population trend.

In the Mediterranean, population estimates exist for only certain regions. Line-transect surveys yielded estimates of 3,583 fin whales (S.E. 967, 95% C.I. 2,130–6,027) over a large portion of the western Mediterranean in 1991 and 901 (S.E. 196.1, 95% C.I. 591–1,374) in the Corsican-Ligurian-Provençal Basin in 1992 (see Panigada and Notarbartolo di Sciara 2012). In the Pelagos Sanctuary, a fin whale subpopulation was estimated as 539 mature whales (95% CI = 345-732) over the period 1990-1999 (Rossi *et al.* 2014). Overall, the Mediterranean population is thought to be declining and is listed by the IUCN as Vulnerable (Panigada and Notarbartolo di Sciara 2012).

North Pacific

Before whaling, the total North Pacific fin whale population was estimated at 42,000–45,000, based on catch data and a population model (Ohsumi and Wada 1974; Omura and Ohsumi 1974). The population in the eastern North Pacific in 1973 was estimated to be 8,000–11,000 fin whales (Ohsumi and Wada 1974). From a crude analysis of catch statistics and whaling effort, Rice (1974) concluded that the population of fin whales in the eastern North Pacific declined by more than half between 1958 and 1970, from about 20,000 to 9,000 "recruited animals" (i.e., individuals longer than the minimum length limit of 50 ft.). Chapman (1976) concluded that the "American stock" had declined to about 38% and the "Asian stock" to 36% below their Maximum Sustainable Yield (MSY) levels (16,000 and 11,000, respectively) by 1975. These abundance estimates derived from CPUE techniques are not certain, therefore, the absolute values of the cited abundance estimates should not be relied upon (International Whaling Commission (IWC) 1989).

An abundance estimate for 2014 off California, Oregon, and Washington based on line-transect data from 1991 through 2014 was 9,029 (CV=0.12) whales (Nadeem *et al*. 2016). Based on this data, NMFS (2016) estimated the minimum population for fin whales to be approximately 8,127 whales. There is now evidence of recovery in California coastal waters. Fin whale abundance off California approximately doubled between 1991 and 1993, from approximately 1,744 (CV = 0.25) to 3,369 (CV= 0.21), which may suggest dispersal of animals into this area. Mean annual abundance from 1991 to 2014 increased 7.5% off California, Oregon, and Washington, although abundance appeared stable between 2008 and 2014 (NMFS 2016). Fin whales were considered common off the outer coast of Washington in the 1800s and early 1900s, but whaling depleted the population, and Washington recently recommended the fin whale remain as a state endangered species (Wiles 2017). Population increases off the U.S. west coast are expected to continue, although annual fluctuations in the population growth rate are anticipated (Moore and Barlow 2011).

The best estimate of fin whale abundance for the Hawaiian stock is 154 (CV = 1.05) (Carretta *et al.* 2017). The minimum population estimate for the stock is 75 fin whales within the Hawaiian Islands Exclusive Economic Zone (EEZ). These data are from sightings during summer/fall shipboard surveys in the U.S. EEZ off Hawaii. Because fin whales are not resident to Hawaiian waters, this abundance estimate likely does not represent the abundance of fin whales in the central North Pacific.

In the eastern Bering Sea shelf, a provisional estimate for fin whale abundance was 1,061 (CV = 0.38) based on summer shipboard surveys conducted from 1997 through 2010 (NMFS 2017a). In the Gulf of Alaska, Rone *et al.* (2017) conducted line-transect surveys in 2013 and 2015. Fin whale abundance was estimated to be 3,168 fin whales (CV = 0.26) in 2013 and 916 (CV = 0.39) in 2015. Survey objectives and designs likely contributed to the marked differences in fin whale results between years. In 2015, the objective was to identify right whales, which biased effort towards counting humpback whales that have blows similar to right whales. Also in 2015, considerably less trackline was surveyed (Rone *et al.* 2017). Based on the survey results from 2013, NMFS (2017a) estimated a minimum population for the U.S. Northeast Pacific population to be 2,554 whales. This abundance estimate is a minimum estimate for the entire stock because it was estimated from surveys that covered only a small portion of the range of this stock.

Zerbini *et al*. (2006) found evidence of increasing abundance trend for fin whales in Alaskan waters (Kenai Peninsula to Shumagin Islands) at a rate of 4.8% (95% CI: 4.1–5.4%) per year between 2001 and 2003. Friday *et al.* (2013; as cited in NMFS 2017a) estimated a 14% (95% CI: 1.0-26.5%) annual rate of increase in abundance of fin whales from 2002 to 2010. However, this apparent rate of increase in abundance is higher than most plausible estimates for large whale populations (see NMFS 2017a). It is likely that changes in fin whale distribution contributed, in part, to the high rate of increase in abundance estimated by Friday *et al.* (2013).

<u>*Southern Hemisphere*</u>

Historically, over 725,000 fin whales were recorded caught in the Southern Hemisphere during 1905-76 (Allison 2017 cited in Cooke 2018). In 1979, the fin whale population in the Southern Hemisphere was estimated to be 85,200 (no CV given) based on the history of catches and trends in CPUE (IWC 1979). The 1979 abundance estimate is considered a poor estimate because CPUE-based abundance estimates are no longer accepted in IWC stock assessments, and the historical back calculation was based on historical catches known to be seriously flawed. Also, when abundance estimates become many years old, at some point they will no longer meet the requirement that they provide reasonable assurance that the stock size is presently greater than or equal to that estimate (NMFS 2005). Therefore, there is low confidence in this abundance estimate for the Southern Hemisphere.

Abundance estimates for 1978-1991 for the area south of 30°S using Japanese Scouting Vessel data from 1978-88 provided a circumpolar estimate of 15,000 fin whales (no CV given) (IWC 1996 cited in Cooke 2018). However, the Scouting Vessel data were not collected based on statistical design and should be interpreted with caution (Cooke 2018). More recent estimates include a circumpolar estimate in the Antarctic south of 60° S of 5,445 (95% CI 2000-14,500) between 1991 and 2004 (Leaper and Miller 2011). In 2016, fin whale abundance was estimated based on line-transect sampling to be 528 ± 362 and 796 ± 516 around Elephant Island and South Orkney Islands, respectively (Viquerat and Herr 2017). A dedicated aerial survey conducted in 2013 within the Bransfield Strait and Drake Passage produced a minimum abundance estimate of at 4,898 (95% CI: 2,221−7,575) (Herr *et al.* 2016). Fin whales aggregated at the shelf edge of the South Shetland Islands in the Drake Passage—an area of high krill density. The results of these studies suggest expansion of high-density areas for fin whales in the West Antarctic Peninsula region (Viquerat and Herr 2017).

and

2. Factors that may limit population growth, *i.e.*, those that are identified in the threats analysis in the recovery plan as high or medium or unknown under relative impact to recovery, have been identified and are being or have been addressed to the extent that they allow for continued growth of populations. Specifically, the factors in 4(a)(l) of the ESA are being or have been addressed as follows:

Factor A: The present or threatened destruction, modification, or curtailment of a species' habitat or range.

- *Competition with fisheries for resources is being addressed through fishery management plans and other measures.* (Threat discussed in Recovery Plan section G.10.)

The severity of this threat was ranked as unknown and the uncertainty as high in the recovery plan, thus the relative impact to recovery of fin whales due to this threat is ranked as unknown (further research is needed to determine whether it falls into high, medium, or low threat category).

NMFS (2010) identified different types of uncertainty relating to threats. For example, there may be uncertainty about the extent to which something affects fin whales (*e.g*., ship strikes); whether a factor affects fin whales negatively or positively (*e.g*., climate change); or how a factor affects fin whales (*e.g*., anthropogenic noise). Therefore, how severity and uncertainty interact (to produce Relative Impact to Recovery ranking) is unique by situation. For this criterion, NMFS (2010) identified the following uncertainties: (a) The prey species taken by fin whales are also taken by other baleen whales. Thus, competitive interactions are possible; however, there is no basis for assuming that competition for food among baleen whales, per se, is a factor in determining their population trend and abundance; (b) The effect on fin whales' foraging efficiency resulting from disruption of large prey aggregations due to commercial fishing is not well known. Commercial removal of prey species may have a limited effect on fin whales, particularly if a large biomass remains unharvested and accessible; (c) Furthermore, the disruption of large aggregations of prey into multiple smaller aggregations by fishing activity could enhance fin whale foraging success; (d) The species-specific duration and degree of prey disruption due to commercial harvest are also unknown and it is not known what impact switching to alternate prey may have on fin whales; and (e) Other threats that could be confounded with fisheries are environmental variability and inter-specific competition. NMFS (2010) concluded that research was needed to reduce these uncertainties.

Since the last 5-year review in 2011, new information on fisheries competition remains sparse. The commercial krill fishery has operated for over 30 years in the Southern Ocean and is thought to be harvesting at a level far below sustainable catch (Nicol *et al.* 2008). However, the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) was established because of concerns that increasing krill catches in the Southern Ocean could have serious effects on the population of krill (Hofman 2017). New developments in fishing gear enables the krill fishery to set nets for weeks and continuously pump krill to the ship (Santora *et al.* 2014). The effect of these new fishing technologies to fin whale populations is unknown, but has the potential to impact prey availability.

There is no competition between fin whales and fisheries in the Mediterranean because in this region fin whales are almost exclusively planktophagous (Panigada and Notarbartolo di Sciara 2012).

Based on those stated uncertainties and it being unknown whether competition with fisheries for resources is a threat, we conclude that the appropriateness of this recovery criterion should be re-evaluated. See Section 4 Recommendations.

- *Effects of reduced prey abundance due to climate change continue to be investigated and action is being taken to address the issue, as necessary.* (Threat discussed in Recovery Plan section G.11.)

The effects of reduced prey abundance due to climate change continue to be investigated, but whether actions are necessary to address the issue remains unknown.

The threat severity posed by environmental variability to fin whale recovery was ranked as medium in the recovery plan due to the oceanographic and atmospheric conditions that have changed over the last several decades. Uncertainty was ranked as high, due to the unknown potential impacts of climate and ecosystem change on fin whale recovery and regime shifts on fin whale prey. Thus, the relative impact to recovery was ranked as unknown but potentially high.

Since the last 5-year review, new information exists on the impacts of climate and oceanographic change on prey species. Such changes could affect fin whales that are dependent on those affected prey.

In the North Atlantic, copepod distribution has showed signs of shifting due to climatic changes (Hays *et al.* 2005; Grieve *et al.* 2017). Climate change was assessed to have a high potential to change the distribution of Atlantic herring (*Clupea harengus*) resulting in negative effects on productivity (Hare *et al.* 2016). In waters off the Azores, fin whales arrive in April/May when the phytoplankton bloom. Individual whales were observed in Azorean waters up to 17 days during the spring bloom, and allocated most of their time to foraging and travelling behavior (Visser *et al.* 2011). The authors cite global warming as likely to suppress the spring bloom development in Azorean waters. This may change migratory patterns of baleen whales in this part of the North Atlantic and reduce opportunities for the build-up of their energy reserves. In the Norwegian Sea, significant changes in the prey community, including northerly expansion and movement in the distribution of pelagic fish, have been reported over the last decade (Nøttestad *et al.* 2014). However, no apparent changes in fin whale distribution could be found compared to their observed summer distribution 10–15 years ago (Nøttestad *et al.* 2014). Fin whale abundance in the Irminger Sea off Iceland increased between 1987 and 2001 concurrent with increasing sea temperatures (Vikingsson *et al.* 2009).

In the Arctic Sea, sea ice coverage has decreased since satellite monitoring began in 1978, with sea ice cover being lowest in 2012 (Parkinson and Comiso 2013). Fin whale migration to the area depends on the extent of ice, elevated water temperature and salinity, and increased prey abundance (Tsujii *et al.* 2016). As ice cover decreases, it will likely affect fin whale distribution and migration (Simon *et al.* 2010; Thomas *et al.* 2016). The overall impact to the species is unknown. However, fin whales search for high-density patchy prey, which means they regularly move large distances to locate euphausiid swarms and then forage in localized areas as long as they last.

Within certain geographic areas in the Southern Ocean, summer krill density is linked to the duration and the extent of sea ice from the previous winter (Atkinson *et al.* 2004). Krill rely on the summer phytoplankton blooms, which occur when extensive sea ice provides winter food from ice algae and promote krill larval recruitment. An examination of net sampling data from 1926 to 2003, indicate that krill density has declined since the 1970s (Atkinson *et al.* 2004). The western Antarctic Peninsula is one of the world's fastest warming areas, and winter sea-ice duration is shortening, presumably from global warming (Hoegh-Guldberg and Bruno 2010). Antarctic krill are also sensitive to ocean acidification. Krill hatch rates and larval development are adversely affected by increased carbon dioxide partial pressure, and substantial declines in Antarctic krill are anticipated within the next 100 years (Kawaguchi *et al.* 2013).

The feeding range of fin whales is larger than that of other large whale species and consequently, it is likely that the fin whale may be more resilient to climate change, should it affect prey, than a species with a narrower range (NMFS 2010).

Based on those stated uncertainties and results of recent research, it remains unknown whether reduced prey abundance due to climate change is a threat. Further research is needed to determine impacts, if any, on prey due to climate change.

Effects of anthropogenic noise continue to be investigated and actions taken to minimize potential effects, as necessary. (Threat discussed in Recovery Plan section G.2.)

Effects of anthropogenic noise continue to be investigated, but whether actions are necessary to address potential effects remains unknown.

The relative impact of anthropogenic noise to the recovery of fin whales was ranked in the recovery plan as unknown due to an unknown severity and a high level of uncertainty. The effects of anthropogenic noise are difficult to ascertain and research on this topic is ongoing. Controlled exposure experiments are being conducted to evaluate the effect of mid-frequency sound on a variety of marine mammals, including large whale species (Southall *et al.* 2011). Preliminary results indicate variable responses, depending on species, type of sound, and behavioral state during the experiments. Some observations in certain conditions suggest avoidance responses, while in other cases subjects seemed unresponsive (Southall *et al.* 2011). These studies include documenting fine scale calling behavior as a baseline to understand the effects anthropogenic sources may have on fin whales (Stimpert *et al.* 2015). Redfern *et al.* (2017) examined the co-occurrence of blue, fin, and humpback whales with sound from commercial shipping off southern California and identified several regions of overlap where the acoustic habitat of these species was degraded by noise. Fin whales may modify their calls in the presence of high noise conditions resulting from ship traffic and airguns (Castellote *et al.* 2012a). Fin whale 20-Hz call duration, bandwidth, center and peak frequency decreased in high noise conditions. Fin whales also appeared to move away from an airgun array source during a 10-day seismic survey (Castellote *et al.* 2012a). The authors hypothesize that fin whale acoustic communication is modified to compensate for increased background noise and that a sensitization process may play a role in the observed temporary displacement when exposed to airguns. Data collected from sites along Mid-Atlantic Ridge to monitor seismic activity between 1999 and 2009, indicate fin whale calls are present during seismic activity. Nieukirk *et al.* (2012) found fin whale and airgun sounds were recorded at all sites, and fin whale vocalization levels increased during the late summer and fall months, a time when airgun noise levels were often high (>80% days/month with airgun sounds) at all sites.

Based on those stated uncertainties and results of recent research, it remains unknown whether anthropogenic noise is a threat. The possible impacts of the various sources of anthropogenic noise on fin whales requires further study.

Factor B: Overutilization for commercial, recreational, or educational purposes.

- *Management measures are in place that ensure that any direct harvest (commercial, subsistence, and scientific) is at a sustainable level.* (Threat discussed in Recovery Plan section G.9.)

This criterion has been met. The IWC's moratorium on the commercial hunting of fin whales in most of their range has been in force for more than three decades, and it has almost certainly had a positive effect on the species' recovery. The recovery plan (NMFS 2010) ranks the threat of direct harvest of fin whales as a medium severity, a medium level of uncertainty and a medium relative impact to recovery.

Whale hunting, although rare today, was the main cause of initial depletion of fin whales and other large whales. From 1900 through 1999, the whaling industry killed and processed nearly 2.9 million large whales globally. Fin whales were killed in larger numbers (874,068) than any other species (Rocha *et al.* 2015). Through the mid-1900s, fin whale catch increased because the preferred target, humpback whales, became rare (Mizroch *et al.* 1984), and factory whaling ships, introduced in 1925, were extremely efficient at killing whales. From 1911 to 1924, there were 2,000–5,000 fin whales taken per year. From 1931 to 1972, approximately 511,574 fin whales were caught (Kawamura 1994). In 1937 alone, over 28,000 fin whales were taken. From 1953 to 1961, the number of fin whales taken per year continued to average around 25,000. In 1962, sei whale catches began to increase as fin whales became scarce. By 1974, less than 1,000 fin whales were being caught per year.

In accordance with the IWC moratorium, fin whales are presently commercially hunted in the Northern Hemisphere only in Greenland under the IWC's procedure for aboriginal subsistence whaling (Caulfield 1993; Gambell 1993). Meat and other products from whales killed in this hunt are widely marketed within the Greenland economy, but export is illegal. The IWC Scientific Committee has repeatedly expressed concern about the small central estimate and lower confidence limit (1,096, 95% CI, 520–2,106) for this stock (IWC 1998b). In the absence of scientific management advice, the IWC has continued to set a quota of 19 fin whales per year for Greenland (IWC 1998a). Iceland and Norway do not adhere to IWC's moratorium on commercial whaling because both countries filed objections to that moratorium. Iceland resumed commercial whaling after whalers caught a fin whale and issued a quota of 9 fin whales in 2006–2007 (7 reportedly killed). According to IWC catches taken under objection or reservation (https://iwc.int/table_objection), Iceland caught 125 fin whales in 2009, 148 in 2010, 134 in 2013, 137 in 2014, 155 in 2015, and zero in 2016.

Fin whales were a target species for Japanese Antarctic Special Permit whaling for the 2005/2006 and 2006/2007 seasons at 10 fin whales per year. The proposal for the following 12 years includes 50 fin whales per year; despite this higher target, Japan took zero fin whales in the 2007/2008 season, one in the 2008/2009 season, possibly one in the 2009/2010 season, and 5 over the seasons 2011/2012 through 2016/2017 (IWC https://iwc.int/table_objection). Whale-meat trade has been revived between Japan and Iceland in 2008. Baker *et al.* (2015) inferred oceanic origins of 113 fin whale products sold in the Japanese markets from 1993 to 2009. The authors expected the mDNA classification of the market products to reflect three oceanic sources, depending on date of purchase: the North Atlantic for special permit hunting by Iceland, which ended in 1989, and commercial whaling by Iceland in 2006 and 2009, with importation after 2008; the Southern Hemisphere for special permit hunting by Japan in the Antarctic (JARPAII), initiated in 2005/06 season; and, the North Pacific for bycatch in Japanese coastal waters. In most cases, the market products matched to legitimate sources. However, haplotypes from at least 19 individual fin whales, exceeded the 15 reported as either JARPAII or as bycatch. In addition, products represented by 10 of the Southern Hemisphere haplotypes were purchased before fin whales were added to JARPAII, some dating back to as early as 1993. Baker *et al.* (2015) conclude their data points to an illegal, unreported or undocumented source of fin whales from the Antarctic.

Well-documented pirate whaling in the northeastern Atlantic was last documented in 1979 (Best 1992; Sanpera and Aguilar 1992), and attempted illegal trade in baleen whale meat was documented several times during the 1990s (Baker and Palumbi 1994). Since the mid-1970s, there has been some demand in world markets (most of it centered in Japan) for baleen whale meat (Aguilar and Sanpera 1982). The IWC was established under the International Convention for the Regulation of Whaling whose chapeau is to 'provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry' (Hofman 2017). Fin whales have been protected from commercial whaling since an IWC moratorium on commercial whaling took effect in 1986. It is highly likely that this moratorium will continue into the future, though Iceland has taken some fin whales under a reservation to the moratorium. Regardless, fin whales are currently legally protected through most of their range and deaths from hunting are very small in number compared to global abundance.

Factor C: Disease or predation.
The fin whale recovery plan did not include criteria for this factor. See Section 2.3.2: Five Factor Analysis for new information.

Factor D: The inadequacy of existing regulatory mechanisms.

- *Ship collisions continue to be investigated and actions taken to minimize potential effects as necessary*. (Threat discussed in Recovery Plan section G.3.)

The fin whale recovery plan (NMFS 2010) identified the threat of ship strikes at a medium severity, but with the high level of uncertainty, and the relative impact to recovery of fin whales as unknown but potentially high.

Laist et al. (2001), Jensen and Silber (2004), Vanderlaan and Taggart (2007), and Van Waerebeek and Leaper (2008) compiled information available worldwide regarding documented collisions between ships and large whales. Of the 292 ship strike records compiled by Jensen and Silber (2004), 75 of the records (26%) indicated that fin whales had been struck. In some areas studied, one-third of all fin whale strandings appeared to involve ship strikes.

NMFS records, from 2010 through 2014, indicate 10 fin whales were killed from collisions with vessels. These records constitute an annual rate of serious injury or mortality of 2.0 fin whales from vessel collisions (Henry *et al.* 2016 cited in NMFS 2017b). Ship strikes were implicated in the deaths of nine fin whales during 2010-2014 in the California/Oregon/Washington stock (see NMFS 2016). Based on detection probabilities of dead whales, Rockwood *et al.* (2017) estimated ship strike mortality for fin whales in U.S. west coast waters to be nearly twice the extrapolated value from strandings. The authors identified waters off California from Bodega Bay south in a band approximately 24 nm (44.5 km) offshore has a high mortality strike zone largely due to the designated shipping lanes leading to and from major ports. In the Southern California Bight, fin whales occur year-round and may be vulnerable to human activities such as shipping (Scales *et al.* 2017). In 2013, shipping routes into Los Angeles/Long Beach and San Francisco areas, the two major ports in California, were changed to protect large whales, including fin whales (http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/ship_strikes_recommendations.html).

In Alaska, two fin whales stranded dead in 2003, but were too far decomposed to determine adequately the cause of death. From 1978 through 2011, three fin whales were struck by vessels, of which two died (Neilson *et al.* 2012). Two of these whales were discovered on bulbous bows (a cruise ship and an oil tanker), while the third was a floater which was towed and necropsied to reveal ante-mortem fracturing of the skull indicative of vessel strike. Because many ship strikes go either undetected or unreported, these cases represent minimums for vessel interactions with fin whales (NMFS 2011).

Off the west coast of Vancouver Island, Canada, fin whales are vulnerable to ship strikes in the offshore approaches to shipping lanes in Juan de Fuca Strait and inside the western portion of the strait (Nichol *et al.* 2017). Ship speeds throughout the offshore area of the west coast of Vancouver Island were sufficiently high (>12 knots) that collisions with whales are more likely than not (>50%) to result in mortality (Nichol *et al.* 2017).

Within specified areas of U.S. waters in the Atlantic, NMFS has established ship speed restrictions, mandatory ship reporting systems, recommended routes, and an extensive sighting advisory system to protect North Atlantic right whales. In 2008, NMFS implemented a five-year regulation that required large ships to restrict their speed to 10 knots in North Atlantic right whale seasonal management areas. Reducing vessel speeds was found to reduce the mortality risk for North Atlantic right whales by 80-90% (Conn and Silber 2013). The rule was extended indefinitely in 2013. While these measures were designed to protect right whales specifically, they also are expected to reduce the risk of ship strikes to other marine mammals, including fin whales (NMFS 2008).

In Canada St. Lawrence Estuary, voluntary measures to reduce fin whale collisions with ships began in 2014. Measures include a slow-down area, a no-go area, a caution area, and a recommended route. The voluntary measures appear to be working, with a reduction of up to 40% of lethal collision risks with fin whales in the highest density area (Chion *et al.* 2018).

In the Bay of Biscay off France and Spain, fin whales (n = 227) in groups were on average closer to the fast going ferries than single individuals. However, these individuals swam in a non-random direction relative to the orientation of the vessel, indicating the whales may have been aware of the presence of the ship (Aniceto *et al.* 2011; in press). Fin whales are fast swimmers and may be able to detect and avoid a ship, given sufficient time. Gauffier *et al.* (2018) analyzed 15 years of ship and land-based surveys of fin whales in the Strait of Gibraltar. The authors found seasonal migration through the strait out to the Atlantic Ocean between May and October and towards the Mediterranean Sea between November and April. Given intense shipping in the Strait of Gibraltar, Gauffier *et al.* (2018) urged Spain and Morocco to cooperate through the International Maritime Organization (IMO) to extend the seasonal vessel speed reduction (13-knot) year-round. Ship strikes in the Mediterranean are a concern particularly in areas of heavy vessel traffic (see Panigada and Notarbartolo di Sciara 2012). In the Pelagos Sanctuary off Italy and France, maritime traffic is intense in the summer when fin whales are present. To reduce the risk of ship strikes in the Sanctuary, the REPCET (REal-time Plotting of CETaceans) system was created in 2009. The system transmits the positions of the whales from one ship to another so that ship crews can take evasive actions. In 2012, this system picked up 192 sightings, representing 525 animals, of which 36% were fin whales (Couvat *et al.* 2013).

The possible impacts of ship strikes on the recovery of fin whale populations is not well understood. Many ship strikes go unreported or undetected for various reasons and the offshore distribution of fin whales may make collisions with them less detectable than with other species, thus the estimates of serious injury or mortality should be considered minimum estimates. Where evaluated, estimates of detection rates of cetacean carcasses are consistently quite low across different regions and species (<1% to 33%) (see NMFS 2016). As a result, there is a high level of uncertainty associated with the evidence presented above.

Based on those stated uncertainties and results from recent studies, it remains unknown whether collisions with vessels are a threat at the species level. Collisions with vessels are not affecting the growth rate of certain populations (e.g., U.S. west coast). Further research is needed to determine impacts, if any, resulting from ship strikes.

Factor E: Other natural or manmade factors affecting its continued existence.
The fin whale recovery plan (NMFS 2010) did not include criteria for this factor. See Section 2.3.2: Five Factor Analysis for new information.

2.3 Updated Information and Current Species Status

In this section, we present new information since the fin whale recovery plan (NMFS 2010) and the last 5-year review completed in 2011. For new information related to the recovery criteria, see Section 2.2.3.

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Information on fin whale demography is not well known. Age to sexual maturity varies by region. Estimates for the Southern Hemisphere were 6-7 years based on catches in the 1960s and 1970s; thus, these values are likely negatively biased due to selection against smaller animals. For the North Atlantic, estimates ranged from 7.5-8.9 years and for the North Pacific, 8-12 years (see Reilly *et al*. 2013). Taylor (*et al*. 2007) used a 5-parameter Leslie matrix model to determine the generation time (defined as the average age of parents of the current cohort (i.e. newborn individuals in the population)) for fin whales to be 25.9 years. The maximum life-span is estimated to be 90 years (Lockyer *et al.* 1977).

In the North Atlantic, the gestation period is probably somewhat less than a year, and fin whale calves are nursed for 6–7 months (Haug 1981; Gambell 1985). The average calving interval has been estimated at about two years, based on whaling data (Christensen *et al.* 1992). In unexploited populations, the interval may be somewhat longer. The gross annual reproductive rate of fin whales in the Gulf of Maine (calves as a percentage of the total population) was about eight percent during the 1980s (Agler *et al.* 1993). Sigurjønsson (1995) gave the range of pregnancy rates for the species (proportion of adult females pregnant in a given year) as 0.36–

0.47. Female fin whale pregnancy rate in the North Atlantic declined at low blubber thickness, which is linked to prey availability (Williams *et al.* 2013). Blubber thickness in fin whales off western Iceland increased with per capita prey availability on feeding grounds, but reached an asymptote around the middle of the range of measured prey densities. This relationship is likely due to blubber thickness increased overall as the feeding season progressed and older animals, which generally have thicker blubber, were in the study area. Female whales of breeding age with thin blubber had a significantly lower probability of being pregnant than those with average blubber thickness, but extremely thick blubber had little effect on pregnancy rate. Williams *et al*. (2013) concluded that the relationship between pregnancy rate and body condition and between body condition and per capita prey abundance is consistent with a density-dependent response in North Atlantic fin whale pregnancy rate.

Arrigoni *et al.* (2011) developed a demographic model based on all available data on fin whale strandings recorded in the Mediterranean between 1986 and 2007. The authors found that calves defined as live birth from age 0 to 6 months were the most at risk of death at about 77% per year. In the immature stage (up to 7.5 years) death was nearly four times less likely (18%), and in the adult stage (up to 90 years) the risk of death was only about 6.3% per year.

The reproductive biology of fin whales in the North Pacific and Southern Hemisphere is assumed to be broadly similar to that of fin whales in the North Atlantic (see NMFS 2010).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Archer *et al.* 2013 provides new information on taxonomy (see Section 2.3.1.4 below).

2.3.1.4 Taxonomic classification or changes in nomenclature:

The fin whale recovery plan (NMFS 2010) described two named subspecies: *B. p. physalus* (Linnaeus 1758) in the North Atlantic and North Pacific and *B. p. quoyi* (Fischer 1829) in the Southern Hemisphere, but highlighted studies indicating the North Atlantic and North Pacific are distinct. In addition, Clarke (2004; as cited in NMFS 2010) presented evidence that fin whales from mid-latitudes in the Southern Hemisphere are smaller and darker in coloration, and he proposed they be recognized as a different subspecies, *B. p. patachonica* (Burmeister 1865). Today, the Society of Marine Mammalogy accepts these three subspecies: *B. p. physalus* in the Northern Hemisphere, *B. p. quoyi* in the Southern Hemisphere, and the pygmy fin whale, *B. p. patachonica* (2017). Results from recent genetic studies indicate that the North Pacific fin whales, which are included with in the nominate subspecies with North Atlantic fin whales but have never been compared, are not the same subspecies (Archer *et al.* 2013) and further genetic analyses are being reviewed to make the case for a new subspecies.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Distribution

Fin whales are highly migratory and exhibit complex movement patterns. Movements can be either inshore/offshore or north/south. Fin whales occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally. Thus, their aggregate movements are patterned and consistent, but movements of individuals in a given year may vary according to their energetic and reproductive condition, climatic factors, etc. (NMFS 2010). Edwards *et al.* (2015) examined records from published literature, publicly available reports, and studies conducted by various organizations between 1980 and 2012 to summarize post-whaling era fin whale distributions (Fig. 1).

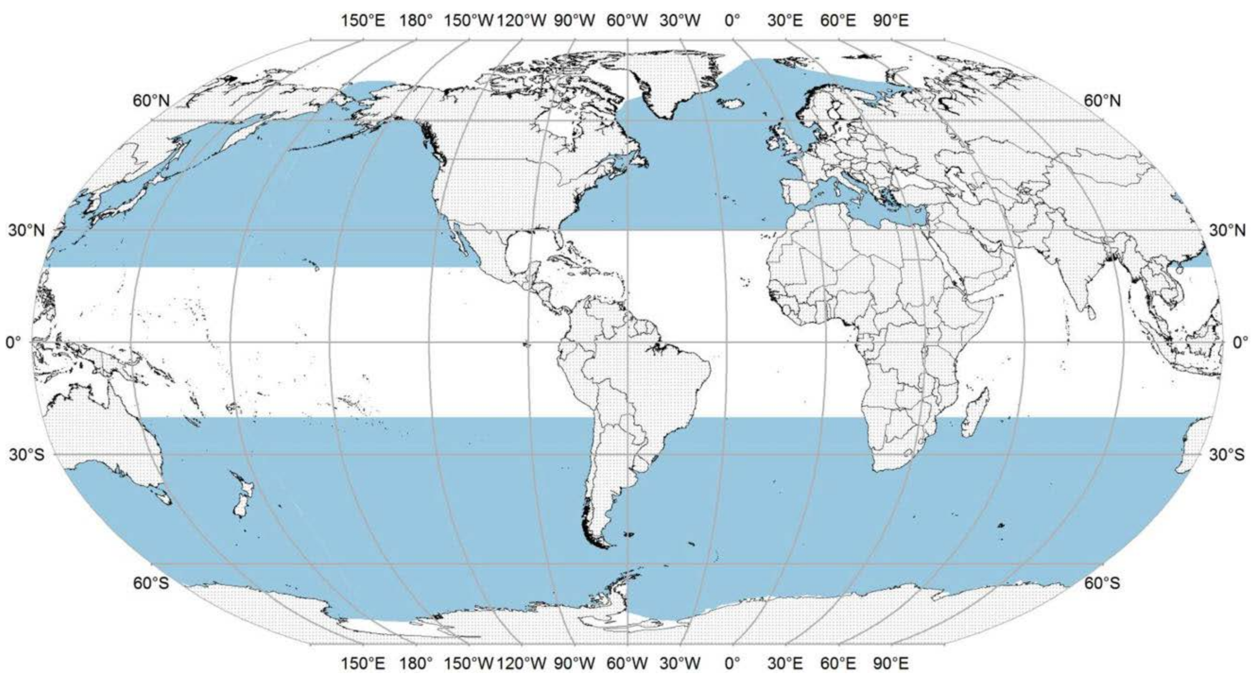

Figure 1. Global distribution of fin whales in the post-whaling era (1980–2012). Blue (dark grey in grey-scale) indicates fin whale occupancy (*source:* Edwards *et al.* 2015; Figure 6).

The authors' synthesis of data indicate that the global distribution of fin whales today includes temperate and polar latitudes higher than approximately 20°N in the North Pacific Ocean, 30°N in the North Atlantic Ocean, and 20°S in the Southern Hemisphere. In addition, there appears to be a gap in distribution at the equator (Fig 1.), which conflicts with some and agrees with other studies (see Edwards *et al*. 2015). Historical catch records from whaling indicate that few fin whales were caught in the equatorial regions despite heavy whaling effort in the area.

In the North Pacific, aerial surveys indicate that fin whales range as far north as the Bering Sea with occasional sightings north of the Bering Strait and rarely north of 67° N latitude (Clark *et al.* 2014 cited by Crance *et al*. 2015). However, with increased passive acoustic monitoring, fin whales were detected as far north as 71° N, 164° W (Delarue *et al*. 2013) and 71.5° N, 157.8° W Crance *et al*. 2015). These apparent expanded ranges may be due to the use of acoustic monitoring, which can detect large whales in remote areas and for periods of time not possible using visual methods. Another possibility is a true range expansion as new habitat and prey become available as sea ice retreats (Crance *et al*. 2015). Aerial surveys in the eastern Chukchi Sea showed an increase in fin whale presence from 2008-2016 compared to surveys conducted in 1982-1991 (Brower *et al.* 2018). The increase in presence could be due to an increase in survey effort, increase in population, changes in distribution due to climate change or some combination of all the above (Brower *et al.* 2018).

<u>Population Structure</u>

North Atlantic

In the North Atlantic, several genetic studies revealed significant divergence among some fin whales populations, which were also supported by tagging experiments and other non-genetic evidence such as analysis of whale vocalizations. Other studies have found no genetic structuring in the North Atlantic (see Pampoulie and Daníelsdóttir 2013). An analysis of genetic markers used in research over the last 20 years to describe the stock structure of North Atlantic fin whales within and between IWC stock boundaries was difficult to interpret, partly due to the different methods used in the various studies. Pampoulie and Daníelsdóttir (2013) concluded that stock structure based on genetic analyses, to date, cannot be confirmed and other approaches such as migration rates and relatedness studies should be explored.

Male fin whales from the northeastern North Atlantic migrate through the Strait of Gibraltar and into the southwestern Mediterranean Sea to overwinter, while males attributed to the Mediterranean population do not include the Northeast Atlantic and Strait of Gibraltar within their distribution range. These results, based on acoustic analysis of whale songs, suggest that the northeastern North Atlantic fin whale distribution extends into the southwest Mediterranean basin (Castellote *et al.* 2012b). The extent of spatial and temporal overlap of North Atlantic fin whales that enter Mediterranean with resident Mediterranean populations to east of the Alboran Sea remains uncertain. Genetic analyses between Mediterranean and North Atlantic subpopulations show a high level of isolation based on mitochondrial DNA, but not nuclear DNA, indicating male-mediated, low-recurrent gene flow between the subpopulations (see Castellote *et al.* 2012b). Gauffier *et al.* (2013) analyzed mtDNA and nuclear samples from 29 fin whales in the Strait of Gibraltar from 2007 to 2012. The data was compared to similar data from fin whale samples collected in the northwest Mediterranean Sea (Ligurian Sea), the northeastern North Atlantic (Spanish coast), the Azores, the Canary Islands as well as the Sea of Cortez. The authors' preliminary results suggest that the Strait of Gibraltar fin whale samples are more similar to fin whales from the Azores and the Canary Islands, than northeastern North Atlantic areas, such as Atlantic Spain and Ireland.

Isotope analysis confirmed a separation between Atlantic and Mediterranean fin whale subpopulations (Giménez *et al.* 2013, Ryan *et al.* 2013), but also confirmed that some Atlantic individuals wander into the Mediterranean Sea (Giménez *et al.* 2013). Isotope analysis also confirmed the currently accepted distinction between the Icelandic population and the population from northwestern Spain (Vighi *et al.* 2016). Significantly higher $d_{18}O$ values were found in fin whales feeding off northwestern Spain and indicate that they exploit separate feeding grounds and move between areas isotopically well differentiated from the Icelandic population.

North Pacific

Previous studies have found that fin whales in the Gulf of California are a relatively differentiated and isolated population (Bérubé et al. 1998; Bérubé et al. 2002; see review Urbán-Ramírez et al. 2005). Geographic variations in fin whale songs have been found worldwide, and song structure is increasingly acknowledged as a way to define population structure, particularly where other information is lacking (Delarue *et al*. 2013). Based on fin whale calling data, Širović *et al.* (2017) inferred that four fin whale populations occurred in Southern California and Gulf of California between 2000 and 2012. The authors recorded the doublet song as dominant in Southern California and the triplet as dominant in the Gulf of California. However, within each region there was an abrupt switch between predominant song types and a gradual, consistent, long-term and population-wide slowing down of song beat (or an increase in the IPI). Širović *et al*. (2017) were unable to definitively conclude whether these patterns in song changes indicate a change in population versus song switching by a single population, but they posited that the major shift from one song type to another at a single point over the 12 year datasets was more indicative of a shift in which population was present than a change in song function.

Studies attempting to infer population structure of fin whales in the North Pacific by analyzing song features of individual whales have been unsuccessful. These studies did not account for the seasonal lengthening in song inter-pulse intervals (IPI) (Oleson *et al.* 2014), long-term shifts in both frequency and IPI, and subtle shifts across regions (Weirathmueller (*et al.* 2017). Synchronous seasonal change in fin whale songs were recorded during four years in the Bering Sea, near Hawaii, and off southern California (Oleson *et al.* 2014). The song IPIs reset annually to a relatively short singlet or doublet in the late summer and fall and progressed to longer IPIs by the spring at all locations. Such changes are difficult to interpret given the lack of information on fin whale social structure and mating systems, but may suggest connectivity of fin whales across the eastern North Pacific (Oleson *et al.* 2014).

Fin whales in the East China Sea (ECS) are likely to be a highly differentiated population in the North Pacific. A linear discriminant function analysis of seven external measurements collected from 276 individuals produced correct classification rates of approximately 93% when ECS fin whales were compared to those off Kamchatka and the Aleutian Islands (Ichihara 1957). ECS fin whales were noted to have relatively shorter heads, and longer tails. Likewise, in a study of blood immunogenetic markers, Fujino (1960) found ECS fin whales had a significantly greater frequency of the Ju2 blood antigen phenotype and a lower frequency of Ju1 than those in Kamchatka or the Aleutians.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Fin whale migration patterns are complex. Acoustic recordings from passive-listening hydrophone arrays indicate a southward "flow pattern" occurs in the fall from the Labrador-Newfoundland region, south past Bermuda, and into the West Indies. Fin whales occur year-round in a wide range of latitudes and longitudes, but the density of individuals in any one area changes seasonally. Thus, their aggregate movements are patterned and consistent, but movements of individuals in a given year may vary according to their energetic and reproductive condition, climatic factors, etc. The local distribution of fin whales during much of the year is governed largely by prey availability (see NMFS 2010).

In the Antarctic, fin whale 'hot spots' in mid to late-summer were primarily in the Antarctic Circumpolar Current and associated with moderate levels of krill aggregations and warming sea surface temperatures, which shifted the hotspots poleward in late summer. Although eddy kinetic energy was positively related to the fin whale hot spots, the relationship was complex and changed from high to moderate levels as the season progressed. By late summer, fin whales tended to move away from the region north of Elephant Island (known for its complex eddy field) and into regions to the south and west, which are characterized by uniform eddy conditions (Santora *et al.* 2014).

In the North Atlantic, a large-scale phytoplankton spring bloom starts north of the North Atlantic Subtropical Gyre, and expands northward. Based on direct observations of whales and satellite data of ocean chlorophyll, fin whales were recorded in April/May in Azorean waters, and could be predicted with high precision (±1.2 weeks) from the timing of the onset of the spring bloom (Visser *et al.* 2011). During peak abundance, individual whales were observed foraging and traveling up to 17 days in association with the spring bloom. Whereas, during the summer and autumn when chlorophyll concentration was low, baleen whales were absent in the area during the southward migration. Silva *et al.* (2013) found that fin whales would suspend their northward migration to forage in the mid-latitudes in central North Atlantic for extended periods of time and much later into the summer than generally assumed. Depth, primary productivity, and distance to the closest major front were predictors of fin whale presence in the North Atlantic (Ramirez-Martinez and Hammond 2012).

In the Northeast Pacific, the Southern California Bight is a hotspot for fin whales, which spend extended periods (over 6 months) foraging associated with warm, shallow, nearshore waters (>18°C, <500 m), and with cool waters (14–15°C) occurring over complex seafloor topographies and with convergent (sub)mesoscale structures at the surface (Scales *et al.* 2017).

2.3.1.7 Other:

Not applicable.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

The fin whale recovery plan (NMFS 2010) did not identify recovery criteria for factor C: Disease or Predation and factor E: Other natural or manmade factors affecting its continued existence because there were no data to indicate these factors as threats. In this section, we provide updated information from several studies related to factors C and E. See Section 2.2.3 for updated information on the other factors.

Factor C: Disease or Predation.

Fin whales in the Mediterranean Sea (Mazzariol *et al.* 2012; 2016) and along the coast of Denmark (Jo *et al.* 2017) were exposed to dolphin morbillivirus and beached because of this virus. In September 2013, a 5.4 m long male newborn stranded alive in a port of Isola d'Elba (Tuscany) and later died. The animal turned out to be molecularly positive to dolphin morbillivirus, indicating the disease could be transmitted through the placenta (Mazzariol *et al.* 2016). Further research is needed to understand the relationship between dolphin morbillivirus and fin whales and whether the virus poses a threat.

Factor E: Other natural or manmade factors affecting its continued existence.

Blubber samples taken from fin whales in the North Western Mediterranean Sea showed concentration levels of persistent organic pollutants that surpass the threshold for toxic effects (Pinzone *et al.* 2015). Wise *et al.* (2015) measured chromium levels in skin biopsies of fin whales from the Gulf of Maine. The levels in the biopsies ranged from 1.71 to 19.6 μg/g with an average level of 10.07 μg/g, which is elevated relative to marine mammals in other regions. For example, the mean chromium level was 1.4 times higher than that of right whales. The authors suggest that fin whales exposed to chromium may experience cytotoxic and genotoxic effects.

An emerging threat to baleen whales, including fin whales, is the presence of microplastics (plastic fragments smaller than 5 mm) in the marine environment (Fossi *et al.* 2012, 2013, 2014, 2016, 2018; Panti *et al.* 2013; Germanov *et al.* 2018; Lusher *et al.* 2018). Fossi *et al.* (2013, 2016) compared levels of microplastics in water samples from the Mediterranean Sea and the Gulf of California, Mexico. The authors found abundant microplastics and plastic additives in the neustonic samples taken from Pelagos Sanctuary in the Mediterranean Sea, which is a known foraging area for fin whales. Phthalates used in production of plastics were found in the blubber of stranded dead fin whales in the region, indicating the whales had ingested mircoplastics (Fossi *et al.* 2012). Phthalates have been associated with molecular, cellular and organ effects in aquatic invertebrates and fish (Oehlmann et al., 2009 as cited in Fossi et al. 2012). Further research is needed to understand the effects, if any, of contaminants on fin whale populations.

2.4 Synthesis

The fin whale recovery plan identified direct harvest as the only known threat to recovery. Direct harvest has been addressed and no longer poses a threat so long as the IWC moratorium remains in place. Since the mid-1970s, there has been some demand in world markets for baleen whale meat, and evidence of illegal, unreported, or undocumented harvest exist. Therefore, it cannot be assumed that fin whales have been fully protected from commercial whaling since 1986 (see Section 2.2.3 criterion 2).

All other threats in the fin whale recovery plan were 'low', 'unknown', or 'unknown, but potentially high' in terms of relative impact to recovery. The two threats that were categorized as 'unknown, but potentially high' were ship strikes and loss of prey base due to climate and ecosystem change or shifts in habitat. However, both of these potential threats were identified as having a high degree of uncertainty about the extent of impact, if any, to fin whales. Based on the new information analyzed in this 5-year review, it remains unknown whether ship strikes and reduced prey abundance due to climate change are a threat. Further research is needed to determine impacts, if any, on fin whale populations.

Because we lack comprehensive data on demography, we must rely on distribution and abundance to understand the extinction risk for fin whales. Fin whales are distributed globally within temperate and polar latitudes higher than approximately 20°N in the North Pacific Ocean, 30°N in the North Atlantic Ocean, and 20°S in the Southern Hemisphere. Fin whale populations declined, due largely from direct harvest, by more than 70% from 1929-2007. The rough global estimate in 2000 was about 53,000 fin whales. Abundance data provided in this 5-year review can be tallied with the caveat that data were collected by different survey methods and estimates are from a subset of populations that may not represent the species rangewide: North Atlantic is at least 50,000; North Pacific is at least 12,000; and the Southern Hemisphere is at least 5,500. We lack population trends for the Southern Hemisphere and populations trends in the North Atlantic are varied, with some unknown trends, increasing trends (e.g., North Central Atlantic) and decreasing trends (e.g., Mediterranean). In the North Pacific, populations off the U.S. west coast and in Alaskan waters (Kenai Peninsula to Shumagin Islands) are increasing. Although, information is sparse on other demographic parameters, reasonable annual population growth rates have been reported to range from 4-7.5%, indicating threats acting on these populations are not limiting growth (see Section 2.2.3 criterion 1). We do not have a population trend for the Mediterranean, but of the threats under recovery criterion 2 (see Section 2.2.3) only ship strikes and anthropogenic noise were identified as possible threats. If the assumption is valid that the

Mediterranean population is declining, then these threats are likely limiting growth. However, the Mediterranean population is isolated from and relatively small compared to populations in the central North Atlantic, which are increasing. Thus overall, threats are not limiting population growth in the North Atlantic. However as noted above, we lack population trends for the entire Southern Hemisphere, so we cannot draw conclusions about possible threats and impacts to those populations.

Reproductive isolation occurs between ocean basins and hemispheres as evidenced by the named subspecies (see Section 2.3.1.5). In the North Atlantic, further research is needed to describe possible population substructure, but genetic, acoustic, and isotope analyses indicate there may be some population differentiation within the North Atlantic, and there is acknowledged differentiation between the North Atlantic and Mediterranean. In the North Pacific, fin whale populations in the Gulf of California and the East China Sea are thought to be highly differentiated from other regions (see Section 2.3.1.5).

Fin whale age to sexual maturity varies by region, and estimates range from 6 to 12 years. Reproductive females give birth about every two years. The gestation period is somewhat less than a year and calves are nursed for 6-7 months. The generation time may be as long as 25.9 years (see Section 2.3.1.5).

In summary, the species abundance is in the tens of thousands distributed across major ocean basins and hemispheres. This level of abundance and extent of distribution indicates that fin whales have a low probability of experiencing the deleterious effects of small population size such as depensatory processes and random biological and/or environmental variation (see McElhany *et al.* 2000). The increasing trend for the large central North Atlantic population and increasing populations in the North Pacific indicate that reproduction is exceeding mortality. Although the information is incomplete regarding population structure, in some areas populations are highly differentiated indicating a variation in life history traits or genetic characteristics to ensure adaptive potential. These facts support that the fin whale likely has met the criterion for downlisting the fin whale (see Section 2.2.3; downlisting criterion 1). The criterion specifies that the fin whale has no more than a 1% chance of extinction in 100 years *and* has at least 500 mature, reproductive individuals in each ocean basin. The healthy levels of abundance in the North Atlantic and the growing numbers in the North Pacific clearly exceed the recovery criteria. However, by far the largest numbers of this species were part of the subspecies in the Southern Hemisphere and there is insufficient data to determine trends in this subspecies. Further, given a generation time of up to 25 years and sexual maturity 6 to 12 years, threats occurring now may affect population growth, abundance, and distribution in the foreseeable future. For these reasons, we recommend the fin whale be downlisted from endangered to threatened (see Section 3.1).

3.0 RESULTS

3.1 Recommended Classification

___X_**Downlist to Threatened**

_____**Uplist to Endangered**

_____**Delist** *(Indicate reason for delisting per 50 CFR 424.11):*

_____*Extinction*

_____*Recovery*

_____*Original data for classification in error*

_____**No change is needed**

3.2 New Recovery Priority Number

11 or 10C[4]

Brief Rationale: The new recovery priority number (10C) is based on new guidelines, which are intended to be implemented in 2019 and cannot be compared to the number at the beginning of the review. The priority number indicates a low demographic risk due to its abundance and increasing trends in key populations, low to moderate understanding of major threats because other than whaling, all other threats have an associated high level of uncertainty, low to moderate U.S. jurisdiction exists for management or protective actions to address major threats due to its global distribution, high certainty that management or protective actions will be effective because species appears to be responding positively to the cessation of whaling, and is in conflict with development or other economic activities (e.g., shipping).

3.3 Listing and Reclassification Priority Number

Reclassification (from Threatened to Endangered) Priority Number: ____

Reclassification (from Endangered to Threatened) Priority Number: __4**__**

Delisting (Removal from list regardless of current classification) Priority Number: ____

Brief Rationale: The fin whale reclassification is assigned the lowest priority because the magnitude of threat is low to moderate and its immediacy is non-imminent.

[4] The recovery priority number 11 was based on NMFS' 1990 (55 FR 24296) priority system. In 2017, NMFS proposed changes to the recovery priority system (82 FR 24944, May 31, 2017). Based on comments and further internal review of the proposed changes, NMFS intends to publish a final recovery priority system. The new priority system goes from 1 -11 (for species that are not in conflict with construction or other development projects or other forms of economic activity or 1C-11C (for species that are in conflict.

4.0 RECOMMENDATONS FOR FUTURE ACTIONS

The recommendations herein are made within the context of agency resources and priorities.

Recovery Plan

We recommend the 2010 fin whale recovery plan be re-evaluated and revised, as necessary. Specifically, the recovery criterion that "competition with fisheries for resources is being addressed through fishery management plans and other measures" should be re-evaluated for appropriateness in determining whether the species can be delisted. There are no data to indicate that this is a threat to fin whales and, therefore, management measures are not needed.

In this 5-year review, we determined that further research is needed on the other recovery criteria: (a) effects of reduced prey abundance due to climate change continue to be investigated and action is being taken to address the issue, as necessary; (b) effects of anthropogenic noise continue to be investigated and actions taken to minimize potential effects, as necessary; and (c) ship collisions continue to be investigated and actions taken to minimize potential effects as necessary. These recovery criteria also should be assessed for progress made on investigations on whether any actions need to be taken. Although, these potential threats should continue to be researched, they may not represent a risk to the species such that their abatement would result in the species no longer being in danger or threatened with extinction.

Reclassification

This 5-year review indicates that, based on a review of the best available scientific and commercial information, that the fin whale should be downlisted from endangered to threatened. We recommend the agency commence rulemaking at some point in the future to reclassify the fin whale from endangered to threatened. In addition, NMFS may want to consider whether listing at the subspecies or distinct population segment level is appropriate in terms of potential conservation benefits and the use of limited agency resources.

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NATIONAL FISHERIES SERVICE
5-YEAR REVIEW of the Fin Whale

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

__X_ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: 4

Review Conducted By: Therese Conant, Office of Protected Resources; Christian Long, Intern, Office of Protected Resources

LEAD OFFICE APPROVAL:
Director, Office of Protected Resources, NOAA Fisheries

Approve: ______________________ Date: 2/7/19

HEADQUARTERS APPROVAL:
Assistant Administrator, NOAA Fisheries

__✓__ Concur _____ Do Not Concur

Signature ______________________ Date: 2/13/19