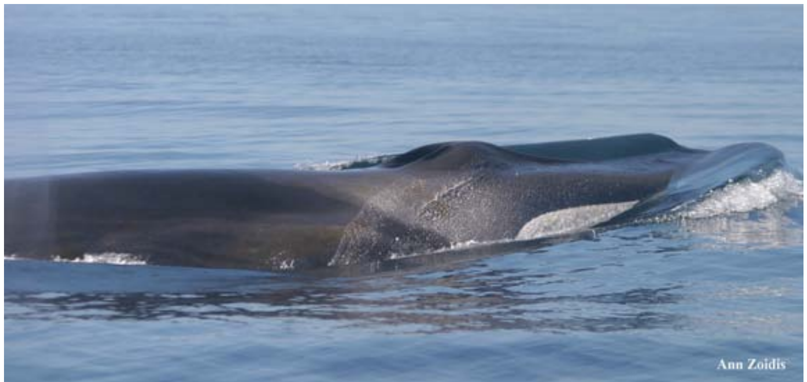
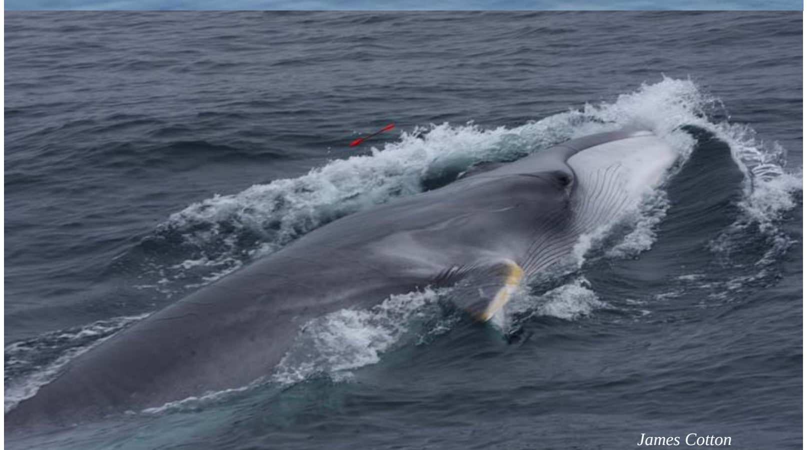
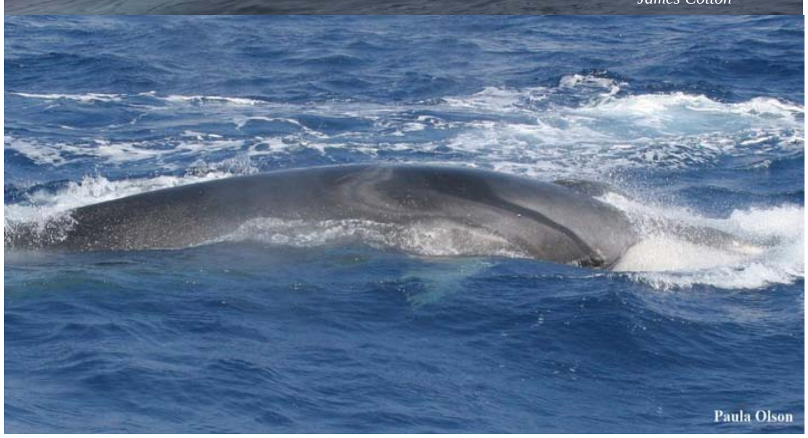
FINAL

RECOVERY PLAN FOR THE FIN WHALE

(*Balaenoptera physalus*)







Office of Protected Resources
National Marine Fisheries Service
National Oceanic and Atmospheric Administration

July 2010

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Prepared by:

Office of Protected Resources
National Marine Fisheries Service

Approved: ______________________
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National Oceanic and Atmospheric Administration

Date: JUL 3 0 2010

PREFACE

Congress passed the Endangered Species Act of 1973 (16 USC 1531 *et seq*) (ESA) to provide a means to conserve the ecosystems upon which endangered and threatened species depend, to provide a program for the conservation of such endangered and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions that conserve such species. The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service share responsibility for the administration of the Act. NMFS is responsible for most marine mammals including the fin whale. This Recovery Plan was prepared at the request of the Assistant Administrator for Fisheries to promote the conservation of fin whales.

The goals and objectives of the Plan can be achieved only if a long-term commitment is made to support the actions recommended here. Achievement of these goals and objectives will require the continued cooperation of the governments of the United States and other nations. Within the United States, the shared resources and cooperative involvement of federal, state, and local governments, industry, academia, non-governmental organizations, and individuals will be required throughout the recovery period.

DISCLAIMER

Recovery plans delineate such reasonable actions as may be necessary, based upon the best available scientific and commercial data available, for the conservation and survival of listed species. Plans are published by NMFS, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in the plan formulation, other than NMFS. They represent the official position of NMFS only after they have been signed by the Assistant Administrator. Recovery plans are guidance and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions.

LITERATURE CITATION SHOULD READ AS FOLLOWS:

National Marine Fisheries Service. 2010. Recovery plan for the fin whale (*Balaenoptera physalus*). National Marine Fisheries Service, Silver Spring, MD. 121 pp.

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http://www.nmfs.noaa.gov/pr/recovery/plans.htm

Cover photographs of fin whales by Paula Olson courtesy of the International Whaling Commission, Ann Zoidis courtesy of Cetos Research Organization/Allied Whale, and James Cotton courtesy of the Southwest Fisheries Science Center.

ACKNOWLEDGMENTS

The National Marine Fisheries Service gratefully acknowledges the contributions of Randall R. Reeves and Gregory K. Silber in developing the original draft of the Draft Recovery Plan for the Fin Whale. Subsequent revisions were made by Jay Barlow, Monica DeAngelis, Rick LeDuc, Susan Pultz, and Barbara L. Taylor.

Special thanks goes to Simona Perry, the lead author of "The Great Whales: History and Status of Six Species Listed as Endangered Under the U.S. Endangered Species Act of 1973" (Perry *et al.*, 1999), which proved very useful in drafting this document. Additional thanks go to the following for their technical assistance, editing, and review: Shannon Bettridge, Robert Brownell, Jr., Phil Clapham, Don Croll, Christina Fahy, Dan Goodman, Lance Garrison, David Gouveia, Bob Kenney, Naomi Lundberg, Mike Newcomer, Misty Neimeyer, Richard Pace, Per Palsbøll, Larissa Plants, Amy Scholik-Schlomer, Bernie Tershy, Mason Weinrich, and Chris Yates.

LIST OF TERMS AND ACRONYMS

The following is a list of acronyms, abbreviations and terms used throughout the recovery plan.

CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CPUE	Catch Per Unit Effort
dB	decibels
Delisting	removal from the list of Endangered and Threatened Wildlife and Plants
DPS	Distinct Population Segment
Downlisting	considered for reclassification from endangered to threatened under the ESA
DOS	U.S. Department of State
EEZ	Exclusive Economic Zone
ESA	Endangered Species Act
FR	Federal Register
HZ	hertz
IWC	International Whaling Commission
kHZ	kilohertz
LFA	Low Frequency Active (for sonar)
LNG	Liquefied Natural Gas
M	meters
MMPA	Marine Mammal Protection Act
MSY	Maximum Sustainable Yield
mtDNA	Mitochondrial Deoxyribonucleic acid
μPa	micro Pascal
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
SPLASH	Structure of Populations, Levels of Abundance and Status of Humpback whales
SURTASS	Surveillance Towed Array Sensor System

EXECUTIVE SUMMARY

Current Species Status: Fin whales, *Balaenoptera physalus*, are widely distributed in the world's oceans. The fin whale has been listed as "endangered" under the Endangered Species Act (ESA) since its passage in 1973. Although most populations were depleted by modern whaling in the mid-twentieth century, there are tens of thousands of fin whales worldwide. Commercial whaling for this species ended in the North Pacific in 1976, in the Southern Ocean in 1976–77, and in the North Atlantic in 1987. Fin whales are still hunted in Greenland, subject to catch limits under the International Whaling Commission's (IWC) "aboriginal subsistence whaling" scheme. Although reliable and recent estimates of fin whale abundance are available for large portions of the North Atlantic Ocean, this is not the case for most of the North Pacific Ocean nor for the Southern Hemisphere. Moreover, the status of populations in these ocean basins, stated in terms of present population size relative to "initial" (pre-whaling, or carrying capacity) level, is uncertain.

Fin whales have a global distribution and can be found in the Atlantic, Pacific, and Southern Hemisphere. Currently, the population structure of fin whales has not been adequately defined. Most models have assigned arbitrary boundaries, often based on patterns of historic whaling activity and catch reports, rather than on biological evidence. Populations are often divided on an ocean basin level. Since the Southern Ocean often refers only to waters surrounding Antarctica and fin whales occur not only in those waters but also in temperate waters, we refer to the geographic area for the fin whale subspecies *Balaena physalus quoyi* as the Southern Hemisphere. Therefore, this Recovery Plan is organized, for convenience, by ocean basin and discussed in three sections, those fin whales in the Atlantic Ocean, those in the Pacific Ocean and its adjoining seas and gulfs, and those in the Southern Hemisphere, referring particularly to areas near Antarctica. There is a need for improved understanding of the genetic differences among and between populations to determine stock structure — a prerequisite for assessing abundance and trends.

Habitat Requirements and Limiting Factors: Populations in the North Atlantic, North Pacific, and Southern Hemisphere have been legally protected from commercial whaling for the last twenty or more years, and this protection continues. Although the main direct threat to fin whales was addressed by the IWC whaling moratorium on commercial whaling, several potential threats remain. Among the current potential threats are collisions with vessels, reduced prey abundance due to overfishing and/or climate change, the possibility that illegal whaling or resumed legal whaling will cause removals at biologically unsustainable rates and, possibly, the effects of increasing anthropogenic ocean noise.

Recovery Strategy: This plan identifies measures that need to be taken to protect, promote, and monitor the recovery of fin whale populations in the North Atlantic, North Pacific, and Southern Hemisphere. Key elements of the recovery program for this species are 1) coordinate state, federal, and international actions to implement recovery efforts; 2) determine population discreteness and stock structure; 3) develop and apply methods to estimate population size and monitor trends in abundance; 4) conduct risk analyses; 5) identify and protect habitat essential to fin whale survival and recovery; 6) identify causes of and minimize human-caused injury and mortality; 7) determine and minimize any detrimental effects of anthropogenic noise in the oceans; 8) maximize efforts to acquire scientific information from dead, stranded, and entangled or entrapped fin whales; and 9) develop a post-delisting monitoring plan.

Recovery Goals and Criteria: The goal of this recovery plan is to promote the recovery of fin whales to the point at which they can be downlisted from endangered to threatened status, and ultimately to remove them from the list of Endangered and Threatened Wildlife and Plants, under the provisions of the ESA. The intermediate goal is to reclassify the species from endangered to threatened.

The recovery criteria presented in this Recovery Plan were based on the *Report of the Workshop on Developing Recovery Criteria for Large Whales Species* (Angliss *et al.* 2002). The fin whale is currently listed as a single species on a global scale.

Downlisting Criteria:

Fin whales will be considered for reclassifying from endangered to threatened when all of the following are met:

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 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.

and

2. None of the known threats to fin whales are known to limit the continued growth of populations. Specifically, the factors in 4(a)(l) of the ESA are being or have been addressed: A) the present or threatened destruction, modification or curtailment of a species’ habitat or range; B) overutilization for commercial, recreational or educational purposes; C) disease or predation; D) the inadequacy of existing regulatory mechanisms; and E) other natural or manmade factors.

Delisting Criteria:

Fin whales will be considered for removal from the list of Endangered and Threatened Wildlife and Plants under the provisions of the ESA, when all of the following are met:

1. Given current and projected threats and environmental conditions, the total fin whale abundance in each ocean basin in which it occurs (North Atlantic, North Pacific and Southern Hemisphere) satisfies the risk analysis standard for unlisted status (has less than a 10% probability of becoming endangered (has more than a 1% chance of extinction in 100 years) in 20 years). 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 delisting takes place.

and

2. None of the known threats to fin whales are known to limit the continued growth of populations. Specifically, the factors in 4(a)(l) of the ESA have been addressed: A) the present or threatened destruction, modification or curtailment of a species' habitat or range; B) overutilization for commercial, recreational or educational purposes; C) disease or predation; D) the inadequacy of existing regulatory mechanisms; and E) other natural or manmade factors.

Estimated Cost of Five-Year Recovery Efforts Including All Three Ocean Basins (estimates are in thousands of dollars). The costs below reflect task duration (*i.e.*, 5 years) and are included in the Fiscal Year when those tasks are anticipated to begin. If no start time was identified, we assumed the task started in FY1:

Action	FY1	FY2	FY3	FY4	FY5	Total
1	300	300	300	300	300	**1,500**
2	1,300	1,300	1,300	1,300	1,300	**6,500**
3	270	184,536	40	40	40	**184,926**[1]
4	n/a	n/a	n/a	200	200	**400**[2]
5	1,350	1,350	1,350	1,350	1,350	**6,750**
6	3,400	3,400	3,400	3,400	3,400	**17,000**
7	1,900	1,900	1,900	1,900	1,900	**9,500**
8	1,500	1,504	1,500	1,500	1,500	**7,504**[3]
9	*	*	*	*	*	*
Total	**10,020**	**194,290**	**9,790**	**9,990**	**9,990**	**234,080**

[1] This action is for one survey for each ocean basin. It was assumed that the surveys would begin in FY2 across ocean basins, thus cost is reflected in FY2 only (even though surveys in each of the ocean basins will be conducted for different lengths of time and it is likely the costs will be spread out over the length of the surveys rather than all at once).
[2] Should recovery occur in the minimum time of 6 years, then action 4 would likely occur for only the Atlantic Ocean/Mediterranean Sea and Pacific Ocean, cost reflected in Total. If efforts take longer to collect the data necessary for action item 4, then this action item would incur no cost during the first five years of recovery efforts for any ocean basin.
[3] Assumed that one time cost of $4K for action number 8.3 occurs in FY2.
[*] No cost associated, NMFS staff time.

ESTIMATED COST OF RECOVERY (FIRST 5 FISCAL YEARS) (in thousands): $234,080

Estimated Cost of Actions Necessary to Achieve Recovery, Including All Three Ocean Basins (estimates are in thousands of dollars):

Year	Action 1	Action 2	Action 3	Action 4	Action 5	Action 6	Action 7	Action 8	Action 9	Total[1]
N. Atl. (2020)	1,000	1,335	51,680	200	2,750	6,375	3,750	7,502	*	74,592
N. Pac. (2020)	1,000	1,830	15,072	200	2,750	6,375	3,750	7,502	*	38,479
S. Hem. (2030)	2,000	3,335	118,344	200	2,750	4,250	2,000			132,879
Total for Task Duration	**4,000**	**6,500**	**185,126**[2]	**600**	**8,250**	**17,000**	**9,500**	**15,004**	*	**245,980**

[1] Total reflects cost of recovery for ocean basin.
[2] Total reflects an additional cost of $30K that is not specific to one ocean basin.
[*] No cost associated, NMFS staff time.

ANTICIPATED DATE OF RECOVERY: The time to recovery is not predictable with the current information and global listing of fin whales. We can, however, estimate the minimum time it would take to meet the criteria above if fin whales were recovering at a conservative expected rate for a baleen whale. However, minimum data needed to satisfy criterion 1 for delisting are population structure work and ocean-basin wide surveys, which are estimated to take an additional 10 years within the North Atlantic and Pacific Ocean basins (date of recovery at 2020) and likely an additional 20 years in the Southern Hemisphere (date of recovery at 2030), given uncertainties about population structure in the Southern Hemisphere. The exact date of recovery cannot be determined as it will likely take decades. The effectiveness of many management activities is not known on a global level, and currently it is impossible to predict when such measures will bring the species to a point at which the protections of the ESA are no longer warranted. In the future, as more information is obtained on the threats, their impacts on fin whales, and how they can be effectively mitigated, it should be possible to make more informative projections about the time to recovery, and its expense.

TOTAL ESTIMATED COST OF RECOVERY FOR THREE OCEAN BASINS: $245.98 MILLION

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I. BACKGROUND

A. Brief Overview

Fin whales, *Balaenoptera physalus* (Linnaeus 1758), have been listed as "endangered" since 1970 under the precursor to the Endangered Species Act (ESA) and have remained on the list of threatened and endangered species since the ESA was passed in 1973 (35 FR 8491; June 2, 1970). Fin whales are widely distributed throughout the world's oceans; critical habitat has not been designated for fin whales. Although the original listing did not cite reasons, it is understood that the main reason for listing is that most populations were depleted by modern whaling. Commercial whaling for this species ended in the North Pacific in 1976, in the Southern oceans in 1976–77, and in the North Atlantic in 1987. Fin whales are still hunted in Greenland, subject to catch limits under the International Whaling Commission's (IWC) "aboriginal subsistence whaling" scheme. Iceland resumed commercial whaling of fin whales in 2006 under a formal objection to the IWC's ban on commercial whaling and Japan kills fin whales as part of its scientific whaling program. There are currently believed to be tens of thousands of fin whales worldwide. Although reliable and recent estimates of fin whale abundance are available for large portions of the North Atlantic Ocean, this is not the case for most of the North Pacific Ocean and Southern Hemisphere. Status of populations in both of these ocean basins, stated in terms of present population size relative to "initial" (pre-whaling, or carrying capacity) level, is uncertain.

Although the main direct threat to fin whales was addressed by the IWC whaling moratorium on commercial whaling, several potential threats remain. Among the current potential threats are collisions with vessels, reduced prey abundance due to overfishing and/or climate change, the possibility that illegal whaling or resumed legal whaling will cause removals at biologically unsustainable rates and, possibly, the effects of increasing anthropogenic ocean noise.

Collisions with vessels is considered a high threat (see Section G. Threats). Reduced prey abundance is considered a medium threat as trends in fish populations, whether driven by fishery operations, human-caused environmental deterioration, or natural processes, may strongly affect the size and distribution of fin whale populations. The effects of ever-increasing anthropogenic noise are unknown, but this plan stresses continuing to investigate these effects, which are potentially significant.

B. Species Description, Taxonomy, and Population Structure

Species Description

The fin whale is a well-defined, cosmopolitan species of baleen whale (Gambell 1985). Fin whales are the second-largest whale species by length. They are long-bodied and slender, with a prominent dorsal fin set about two-thirds of the way back on the body. The streamlined appearance can change during feeding when the pleated throat and chest area becomes distended by the influx of prey and seawater, giving the animal a tadpole-like appearance. The basic body color of the fin whale is dark gray dorsally and white ventrally, but the pigmentation pattern is complex. The lower jaw is gray or black on the left side and creamy white on the right side. This asymmetrical coloration extends to the baleen plates as well, and is reversed on the tongue. Individually distinctive features of pigmentation, along with dorsal fin shapes and body scars, have been used in photo-identification studies (Agler *et al*. 1990).

The general similarity in appearance of fin whales to sei whales (*B. borealis*) and Bryde's whales (*B. edeni*) has resulted in confusion about distributional limits and frequency of occurrence, particularly in low latitudes where "fin" whales described in the whaling literature have often proved to be Bryde's whales. The diagnostic features for distinguishing the three species were outlined by Mead (1977). Fin whales and blue whales (*B. musculus*) are known to interbreed occasionally in the North Atlantic (Bérubé and Aguilar 1998) and apparently also in the North Pacific (Doroshenko 1970).

Hearing

Marine mammal hearing has been reviewed by several authors, notably Popper (1980a,b), Schusterman (1981), Ridgway (1983), Watkins and Wartzok (1985), Moore and Schusterman (1987), Au (1993), Richardson *et al.* (1995), Wartzok and Ketten (1999), and Southall *et al.* (2007). Auditory thresholds at various frequencies can be determined either by tests with trained captive animals or by electrophysiological tests on captive or beached animals or indirectly predicted via inner ear morphology, taxonomy, behavior, or vocalizations. Hearing abilities have been studied in some toothed whales, hair seals, and eared seals. Most of the available data on underwater hearing deal with frequencies of 1 kilohertz (kHz) or greater, and many relate to frequencies above 20 kHz (up to 180 kHz). Recently, Southall *et al.* (2007) suggested that marine mammals be divided into five basic hearing groups: high-frequency cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhychids), mid-frequency cetaceans ("dolphins," toothed whales, beaked whales, and bottlenose whales), low-frequency cetaceans (mysticetes), pinnipeds in water, and pinnipeds in air.

There is no direct information about the hearing abilities of baleen whales but estimation of hearing ability based on inner ear morphology has been completed on two mysticete species: humpback whales (700 hertz [Hz] to 10 kHz; Houser *et al.* 2001) and North Atlantic right whales (10 Hz to 22 kHz; Parks *et al.* 2007a). The anatomy of the baleen whale inner ear seems to be well-adapted for detection of low-frequency sounds (Ketten 1991, 1992, 1994). Baleen whale calls, especially fin whale calls (especially known for their characteristic 20 Hz moans), are also predominantly at low frequencies, mainly below 1 kHz (Richardson *et al.* 1995), and their hearing is presumed good at corresponding frequencies. Southall *et al.* (2007) estimated the hearing range of low-frequency cetaceans to extend from approximately 7 Hz to 22 kHz. Thus, the auditory system of baleen whales is almost certainly more sensitive to low-frequency sounds than that of the small-to-moderate-sized tooth whales. However, auditory sensitivity in at least some species extends up to higher frequencies than the maximum frequency of the calls, and relative auditory sensitivity at different low-moderate frequencies is unknown.

Taxonomy

At present, there are 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. Most experts consider the North Pacific fin whales a separate unnamed subspecies. On a global scale, populations in the North Atlantic, North Pacific, and Southern Hemisphere (*e.g.*, particularly those found near Antarctica) probably mix rarely, if at all, and there are geographical populations within these ocean basins. The distinctness of North Pacific and North Atlantic fin whales has been supported by recent genetic analysis (Bérubé *et al.* 1998) and by differences in vocalizations (Clark 1995; Hatch 2004). Hatch (2004) also reported regional differences in fin whale vocalizations within the North Atlantic. Although whales from these ocean basins are genetically distinct, no formal consideration for different subspecies status has occurred. There are morphological distinctions between these three groups, as well. Adults in the Antarctic can be more than 23 m long and weigh more than 70,000 kg. In general, fin whales in the Northern Hemisphere attain a smaller maximum body length (by up to 3 m) than Antarctic fin whales, and those in the North Atlantic are leaner than their Antarctic counterparts (Lockyer and Waters 1986). The largest fin whales caught in the Northern Hemisphere were off California—a 24.7 m (81 ft) female and a 22.9 m (75 ft) male, between 1919 and 1926 (Clapham *et al.* 1997). As with other baleen whales, female fin whales grow to a larger size than males (Aguilar and Lockyer 1987).

Population Structure

From a U.S. perspective, fin whales are managed under three constructs, all with different objectives and, therefore, different terminology for population structure: the Marine Mammal Protection Act (MMPA), the IWC, and the ESA. Roughly, the MMPA protects marine mammal species with a goal of maintaining marine mammal population "stocks" as functioning elements of their ecosystem, the IWC manages whales with a goal of maintaining healthy stocks while authorizing harvest to meet aboriginal needs (and potentially commercial catches), scientific research and related purposes, and the ESA seeks to avoid extinction and recover threatened and endangered species to a point at which they no longer need ESA protections.

Both the MMPA and the IWC use the term "stocks" to refer to units to conserve.
In this document we use the term "stocks" in the context of MMPA or IWC stocks and use the more generic term "populations" when referring to subunits of the same species in other contexts. The stock concept has been the subject of much discussion among biologists and natural resource managers. A recent working definition of "stock" under the MMPA is a "demographically isolated biological population" (Wade and Angliss 1997) where internal dynamics (births and deaths) are far more important than external dynamics (immigration and emigration) to maintaining the population. The IWC continues to waver somewhere between two types of stock definitions: biological stocks based on genetic separation and management stocks referring to population units defined in functional terms of some kind (Donovan 1991). Although considerable effort has been expended to tighten the definition of stocks, current IWC practice continues to define on a case-by-case basis and only on stocks in need of current management. Thus, stock definition for areas with no aboriginal whaling or anticipated commercial whaling, as

would be the case for fin whales in the North Pacific, has not been considered for decades.

The IWC has considered only one stock of fin whales in the main body of the North Pacific even though studies suggest differently (Fujino 1960; Ohshumi *et al.* 1971; Rice 1974; Nasu 1974; Mizroch *et al.* 1984a; Donovan 1991; Hatch 2004). Based on a "conservative management approach," NMFS recognizes three MMPA stocks in U.S. Pacific waters: Alaska (Northeast Pacific), California/Oregon/Washington, and Hawaii (Barlow *et al.* 1997; Hill *et al.* 1997). A separate subspecies (*B. p. quoyi;* Fischer 1829) is recognized in the Southern Hemisphere and all southern ocean fin whales currently belong to the subspecies *B. p. quoyi*. To date there has been no effort to define subspecies or Distinct Population Segments (DPSs) for fin whales under the ESA. For a more detailed discussion on population structure, see the Life History sections in this Recovery Plan for the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere.

C. Zoogeography

Fin whale populations exhibit differing degrees of mobility, presumably depending on the stability of access to sufficient prey resources throughout the year. Most groups are thought to migrate seasonally, in some cases over distances of thousands of kilometers. They feed intensively at high latitudes in summer and fast, or at least greatly reduce their food intake, at lower latitudes in winter. Some groups apparently move over shorter distances and can be considered resident to areas with a year-round supply of adequate prey. The fin whale is a cosmopolitan species with a generally anti-tropical distribution centered in the temperate zones. Two subspecies, a larger Southern Hemisphere form and a smaller Northern Hemisphere form, have been supported by some scientists (Tomilin 1946, 1967; Sokolov and Arsen'ev 1994; Rice 1998).

In this Recovery Plan we separate description of the data into three sections: North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere. Since the Southern Ocean often refers only to waters surrounding Antarctica and fin whales occur not only in those waters but also in temperate waters, we refer to the geographic area for the fin whale subspecies *B. p. quoyi* as the Southern Hemisphere. This organization follows the way fin whales have been treated by both IWC and MMPA management regimes and the way that data are often gathered. Further work would be needed to identify population segments that are both discrete and significant as described in the NMFS and U.S. Fish and Wildlife Service joint policy regarding DPS' under the ESA (61 FR 4722). While no firm boundaries can be drawn, there is likely very limited movement between the North Atlantic Ocean, the North Pacific Ocean, and the Southern Hemisphere. Therefore, the Recovery Criteria in this Recovery Plan use these three large oceanic regions. The Recovery Criteria for the global listing, therefore, mean that all three of these oceanic regions must meet the criteria.

D. Life History – North Atlantic Ocean

D.1 Population Structure

Recent genetic analyses confirm that there is structuring within the North Atlantic population along the lines suggested by Ingebrigtsen (1929) and Kellogg (1929). They found significant heterogeneity in mitochondrial DNA (mtDNA) between the Mediterranean Sea, the eastern North Atlantic (Spain), and the western North Atlantic (Gulf of Maine and Gulf of St. Lawrence) (Bérubé *et al.* 1998; Palsbøll *et al*. 2004). Mixing between the eastern and western North Atlantic populations apparently occurs regularly in the waters around Iceland and Greenland. As noted earlier, it has also been suggested that the vocalizations of fin whales recorded off Bermuda and the West Indies differ from those recorded in the Norwegian Sea (Clark 1995).

Fin whales in the North Atlantic are defined by the IWC by seven management units: Nova Scotia, Newfoundland-Labrador, West Greenland, East Greenland-Iceland, North Norway, West Norway-Faroe Islands, and British Isles-Spain-Portugal. Results of mark-recapture experiments suggest that some movement occurs across the boundaries of these management units (Mitchell 1974; Gunnlaugsson and Sigurjønsson 1989; IWC 1992a), indicating that perhaps these management units are not completely discrete and some immigration and emigration does occur. Management of the exploitation of fin whales in the North Atlantic has presupposed the existence of these seven management units, although the scientific basis for defining some of these as biological populations was weak (Donovan 1991).

After evaluating all available evidence through 1991, the IWC Scientific Committee was unable to decide whether the population of fin whales in the North Atlantic consisted of several discrete breeding groups or instead, comprised a single stock existing in a "patchy continuum" (Sergeant 1977) across the entire ocean basin (IWC 1992a). It was, however, agreed that the balance of evidence from various types of analyses (*e.g.,* biochemical, genetic, tag-recapture, morphologic, and biometric; Lockyer 1982; Gunnlaugsson and Sigurjønsson 1989; Arnason *et al.* 1992; Jover 1992) indicated that the fin whales hunted off Spain belonged to a different stock than those hunted off Iceland (IWC 1992a). Based on a comparison of biological parameters and analyses of catch and effort at Canadian shore whaling stations, Breiwick (1993) supported Mitchell's (1974) hypothesis that there are at least two stocks in the western North Atlantic, one centered in Nova Scotia and New England waters and the other in Newfoundland waters.

NMFS posits that there is a single stock of fin whales in U.S. waters of the western North Atlantic (Waring *et al.* 1997), presumably equivalent to the Nova Scotia stock, as recognized by the IWC (Mitchell 1974; IWC 1992a). It is considered likely that fin whales in the U.S. Exclusive Economic Zone (EEZ) migrate into Canadian waters, open-ocean areas, and possibly more equatorial regions (Waring *et al.* 1997). Of particular importance in the current management context, is the IWC's continued recognition of a West Greenland stock of fin whales (IWC 1992a), even though the evidence for genetic isolation of this population remains inconclusive (IWC 1996a,b; IWC 1998a; Bérubé *et al.* 1998).

To date there has been no effort to define DPSs for fin whales under the ESA. In order to qualify as a DPS, a unit must first be discrete and second, significant (61 FR 4722). It is unlikely that the seven IWC stocks in the North Atlantic would all qualify as DPSs. It is likely, given the genetic and acoustic analyses of whaling data discussed above, that more than a single DPS could be identified within the North Atlantic.

D.2 Distribution and Habitat Use

The fin whale has an extensive distribution in the North Atlantic, occurring from the Gulf of Mexico (Jefferson and Schiro 1997) and Mediterranean Sea, northward to the edges of the arctic pack ice (Jonsgård 1966a, 1966b; Sergeant 1977; IWC 1992a). In general, fin whales are more common north of approximately 30°N latitude. Considerable confusion arises about their occurrence south of 30°N latitude, because of the difficulty in distinguishing fin whales from Bryde's whales (Mead 1977). Extensive ship surveys led Mitchell (1974) to conclude that the summer feeding range of fin whales in the western North Atlantic was mainly between 41°20'N and 51°00'N, from shore seaward to the 1,000-fathom contour.

Although fin whales are certainly migratory, moving seasonally into and out of high-latitude feeding areas, the overall migration pattern is confusing and likely complex (Christensen *et al.* 1992a). Regular mass movements along well-defined migratory corridors, with specific end-points, have not been documented by sightings. However, 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 (Clark 1995). 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. In some parts of their range, such as the Gulf of St. Lawrence and the Newfoundland shelf, ice formation in winter forces fin whales offshore, and its disintegration in spring allows them to move back inshore (Jonsgård 1966a; Sergeant 1977). One or more "populations" of fin whales were thought by Norwegian whalers to remain year-round in high latitudes, actually moving offshore, but not southward, in late autumn (Hjort and Ruud 1929; Jonsgård 1966a). These observations were recently reinforced by acoustic evidence that fin whales occur throughout the winter in the Norwegian and Barents Seas, apparently in considerable numbers (Clark 1995).

The local distribution of fin whales during much of the year is probably governed largely by prey availability (Ingebrigtsen 1929; Jonsgård 1966a, 1966b). For example, the positions off southwestern Iceland where fin whales were caught correlated well with the known distribution of spawning krill (*Meganyctiphanes norvegica*), their preferred prey in that area (Rørvik *et al.* 1976). In general, fin whales in the central and eastern North

Atlantic tend to occur most abundantly over the continental slope and on the shelf seaward of the 200 m isobath (Rørvik *et al.* 1976). In contrast, off the eastern United States they are centered along the 100-m isobath but with sightings well spread out over shallower and deeper water, including submarine canyons along the shelf break (Kenney and Winn 1987; Hain *et al.* 1992). Two feeding areas in the late 1970s and early 1980s were identified between the Great South Channel and Jeffrey's Ledge and in waters directly east of Montauk, Long Island, New York (Hain *et al.* 1992). Fin whales were also seen feeding as far south as the coast of Virginia (Hain *et al.* 1992).

Segregation seems to occur at least in summer, with the larger (mature) whales arriving at feeding areas earlier, and departing later, than the smaller individuals (Rørvik *et al.* 1976). Within the Gulf of Maine, lactating females and their calves primarily occupy, or at times are the only ones occupying, this southern portion of their summer feeding range (Agler *et al.* 1993).

Tagging and photo-identification studies suggest considerable site fidelity on feeding grounds (Mitchell 1974; Edds and Macfarlane 1987; Gunnlaugsson and Sigurjønsson 1989; Seipt *et al.* 1990; Agler *et al.* 1990; Clapham and Seipt 1991), but the documented long-distance movements of some individuals (Mitchell 1974; Watkins *et al.* 1984; Agler *et al.* 1990) show that fin whales are capable of using large resource areas.

Fin whales are locally common in the River and Gulf of St. Lawrence during the summer and fall, especially on the north shore shelf (Edds and Macfarlane 1987; Borobia *et al.* 1995; Kingsley and Reeves 1998). Sergeant (1977) suggested that they associate with steep contours of the Laurentian Channel, either because tidal and current mixing along such gradients drives high biological production or because changes in depth aid their navigation.

D.3 Feeding and Prey Selection

Fin whales in the North Atlantic eat pelagic crustaceans (mainly euphausiids or krill, including *Meganyctiphanes norvegica* and *Thysanoessa inerrnis*) and schooling fish such as capelin (*Mallotus villosus*), herring (*Clupea harengus*), and sand lance (*Ammodytes* spp.) (Hjort and Ruud 1929; Ingebrigtsen 1929; Jonsgård 1966a; Mitchell 1974; Sergeant 1977; Overholtz and Nicolas 1979; Christensen *et al.* 1992b; Borobia *et al.* 1995). The availability of sand lance, in particular, is thought to have had a strong influence on the distribution and movements of fin whales along the east coast of the United States (Kenney and Winn 1986; Payne *et al.* 1990; Hain *et al.* 1992).

Although there may be some degree of specialization, most individuals probably prey on both invertebrates and fish, depending on availability (Watkins *et al*. 1984; Edds and Macfarlane 1987; Borobia *et al.* 1995). Sergeant (1977) suggested that euphausiids were the "basic food" of fin whales and that they took advantage of fish when sufficiently concentrated, "particularly in the pre-spawning, spawning, and post-spawning adult stages on the Continental Shelf and in coastal waters." See section D.2 for a discussion on seasonal movements associated with feeding areas.

D.4 Interspecific Competition

There has been considerable discussion of interspecific competition among mysticete whales. The substantial dietary overlap among the balaenopterids (Nemoto 1970; Kawamura 1980) establishes the potential for interference competition but no conclusive evidence has been adduced to demonstrate that it occurs (Clapham and Brownell 1996). The fin whale feeds on a fairly broad spectrum of prey, but regional groups of fin whales seem to specialize on particular types of prey. From an analysis of annual sighting frequencies in the Gulf of Maine, Payne *et al.* (1990) concluded that fin whales were able to exploit more widely separated patches of prey and thus, were more independent of local fluctuations in prey availability than were humpbacks (*Megaptera novaeangliae*). The responses of fin whales to shifts in prey abundance were less pronounced than those of humpback, right (*Eubalaena glacialis*), and sei whales in this region. As pointed out by Clapham and Brownell (1996), this is not necessarily evidence of competition, per se, but rather could indicate simply that the four species have different adaptive traits (Kenney 1990).

D.5 Reproduction

Most reproductive activity, including mating and births, takes place in the winter season (November to March; peak December/January) (Haug 1981; Mitchell 1974), although "out-of-season" births do occur off the eastern United States (Hain *et al.* 1992). 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.* 1992b). In unexploited populations, the interval may be somewhat longer. Agler *et al.* (1993) used photo-identification data to estimate an average interval of 2.7 years for fin whales in the Gulf of Maine although they acknowledged that this value was probably biased upward by incomplete sighting histories. If certain females calved in "missed" years (*i.e.,* years in which they were not photo-identified in the study area), the mean interval could have been as low as 2.24 years (Agler *et al.* 1993). 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.

Breiwick (1993) found that the annual pregnancy rate (defined as the percentage of mature females that are pregnant in a given year) was significantly lower in the population hunted from Blandford, Nova Scotia, than in the population hunted from Williamsport and South Dildo, Newfoundland. Among the hypotheses that could explain this difference is that fin whales show a density-dependent response by shortening the birth interval (and/or the time to sexual maturity) and that the Nova Scotia population was less depleted than the Newfoundland population, at the time of sampling.

Fin whales, in populations near carrying capacity, may not attain sexual maturity until ten years of age or older, whereas those in exploited[1] populations can mature as early as six or seven years of age (Gambell 1985).

D.6 Natural Mortality

Little is known about the natural causes of mortality of fin whales in the North Atlantic. Ice entrapment is known to injure and kill some whales, particularly in the Gulf of St. Lawrence (Sergeant *et al.* 1970). Mitchell and Reeves (1988) reported evidence, most of it anecdotal, indicating that killer whales (*Orcinus orca*) attack fin whales in the western North Atlantic. Disease presumably plays a major role in natural mortality as well, and shark attacks on weak or young individuals are probably common, but have not been documented. Lambertsen (1986) contended that crassicaudiosis in the urinary tract was the primary cause of natural mortality in North Atlantic fin whales. Rates of natural mortality in fin whales generally are thought to range between 0.04 and 0.06 (Aguilar and Lockyer 1987).

D.7 Abundance and Trends

No good estimate of pre-exploitation population size is available, and it seems unlikely that a robust estimate will ever be possible, considering the long history of exploitation and the many uncertainties about current abundance and population boundaries (Breiwick 1993). An estimated abundance of about 56,000 fin whales throughout the North Atlantic in the early 1990s has been cited (Bérubé and Aguilar 1998), based on IWC (1992a) and Buckland *et al.* (1992a,b). Sigurjønsson (1995) estimated a total pre-exploitation population size in the North Atlantic in the range of 50,000 to 100,000, but provided no supporting data and no explanation of his reasoning. Sergeant's (1977) summary of population estimates, derived using various techniques and always assuming sustainable catch levels, suggested a "primeval" aggregate total of 30,000 to 50,000 fin whales throughout the North Atlantic. Of the 30,000, about 8,000 to 9,000 would have belonged to the Newfoundland and Nova Scotia "stocks" (Allen 1970; Mitchell 1974), with whales summering in U.S. waters south of Nova Scotia presumably not having been taken fully into account. With no explanation, Chapman (1976) gave the "original" population sizes as only 1,200 off Nova Scotia and 2,400 off Newfoundland. According to Chapman's calculations, the Nova Scotia stock of about 400 whales was 41% below its maximum sustainable yield (MSY) level (700 whales longer than 50 ft) in 1975, while the Newfoundland stock (1,600 whales) was still above its MSY level of 1,400. Breiwick (1993) concluded, based on population models, the Newfoundland stock likely declined during the most recent episode of whaling (1966 to 1972). A decline in abundance of the Nova Scotia stock (hunted from 1965 to 1972) was evident from both catch-per-unit-effort (CPUE) analyses and population modeling. Breiwick (1993) estimated the

[1] It should be noted, however, that the question of whether whaling data from the Southern Hemisphere (*i.e.*, an exploited population) do or do not demonstrate density-dependent responses in the reproductive cycle of fin whales is controversial (Mizroch and York 1984; Sampson 1989).

“exploitable” component of the Nova Scotia stock (*i.e.,* animals above the legal size limit of 50 ft) as about 1,500–1,600 animals in 1964, reduced to only about 325 in 1973.

Based on survey data, about 5,000 fin whales were estimated to inhabit northeastern United States continental shelf waters in the spring and summer of 1978–1982 (Hain *et al*. 1992). Combined shipboard and aerial surveys from Georges Bank to the mouth of the Gulf of St. Lawrence in the summer of 1999 (designed for harbor porpoise, *Phocoena phocoena*, abundance estimation), resulted in an estimate of 2,814 (CV=0.21) fin whales (Palka 2000). The best abundance estimate available for the Western North Atlantic stock is 2,269 (CV = 0.37) from August 2006 with a minimum population estimate of 1,678 (Waring *et al.* 2009).

The IWC has continued to use Mitchell’s (1974) mark-recapture data from 1965 to 1972 for estimating abundance of fin whales in eastern Canadian waters, with no attempt at updating the estimates to take account of possible changes in abundance since 1972, when whaling ended in this area (IWC 1992a). The central estimate was about 11,000, interpreted to refer only to animals longer than 50 ft. This presumably included at least some whales that moved seasonally into U.S. waters. Mitchell (1974) reported shipboard survey estimates of 340 fin whales (of all sizes) for the Gulf of St. Lawrence and 2,800 for “the remainder of the Nova Scotia area.” Two line-transect aerial survey programs have been conducted in Canadian waters since the early 1970s, giving negatively biased estimates of 79 to 926 fin whales on the eastern Newfoundland-Labrador shelf in August 1980 (Hay 1982) and a few hundred in the northern and central Gulf of St. Lawrence in August 1995 and 1996 (Kingsley and Reeves 1998).

Estimates of the number of fin whales in West Greenland waters in summer range between about 500 and 2,000 (Larsen 1995; IWC 1995). Jonsgård (1974) considered the fin whales off western Norway and the Faroe Islands to “have been considerably depleted in postwar years, probably by overexploitation.” The evidence of depletion around Iceland, however, was much less conclusive, and it was suggested that the population had undergone only a moderate decline since the early 1960s (Rørvik *et al.* 1976; Rørvik and Sigurjønsson 1981). Large-scale shipboard sighting surveys in the summers of 1987 and 1989 produced estimates in the order of 10,000 to 11,000 fin whales in the northeastern Atlantic between East Greenland and Norway (Buckland *et al.* 1992b). This compares with an estimate of 6,900 “fully recruited” whales in the East Greenland-Iceland stock in 1976 (including only animals longer than 50 ft) made using CPUE data from the Icelandic whaling industry (Rørvik *et al.* 1976). The CPUE data were interpreted as indicating a “slight” decrease in the population size since 1948 (Rørvik *et al.* 1976).

The most recent estimates for the British Isles-Spain-Portugal stock area in summer have ranged from about 7,500 (Goujon *et al.* 1995) to more than 17,000 (Buckland *et al.* 1992a). An estimation of the entire Mediterranean Sea population of fin whales is unknown, but the western basin portion of the population, where most of the population is found, is estimated to be 3,500 animals (Notarbartolo-di-Sciara *et al.* 2003).

E. Life History – North Pacific Ocean

E.1 Population Structure

The IWC has considered there to be only one stock of fin whales in the main body of the North Pacific even though early work by Fujino (1960), based on blood typing, mark-recapture, and morphological data, suggested there were separate stocks (Donovan 1991). A small separate stock in the East China Sea has been generally recognized, and Ohsumi *et al.* (1971) referred to "Asian" and "American" stocks as some type of management units. Tag recoveries have established a connection between southern California and the Gulf of Alaska (Rice 1974) and shown considerable movement by fin whales along the Aleutian Islands from areas near Kamchatka to the Alaska Peninsula (Nasu 1974).

Mizroch *et al.* (1984a) discussed five possible populations, which they called "feeding aggregations": the eastern and western groups that move along the Aleutians (Berzin and Rovnin 1966; Nasu 1974); the East China Sea group; a group that moves north and south along the west coast of North America between California and the Gulf of Alaska (Rice 1974); and a group centered in the Sea of Cortez (Gulf of California). Sighting data show no evidence of migration between the Sea of Cortez and adjacent areas in the Pacific, but seasonal changes in abundance in the Sea of Cortez suggests the possibility of such exchange (Tershy *et al.* 1993). Nevertheless, Bérubé *et al.* (2002) found the Sea of Cortez population to be genetically distinct from the oceanic population and to have lower genetic diversity. Hatch (2004) found heterogeneity in vocalizations among five regions of the eastern North Pacific: the Gulf of Alaska, the northeast North Pacific (Washington and British Columbia), the southeast North Pacific (California and northern Baja California), the Gulf of California (Sea of Cortez), and the eastern tropical Pacific. Tissue samples (from biopsies) to assess population structure questions for much of the eastern North Pacific are archived at the NMFS Southwest Fisheries Science Center, but not yet analyzed (B. Taylor, NMFS, pers. comm., 2006). Many tissue samples are also archived by Japan from commercial whaling, but these are also mostly unanalyzed and likely not available for analysis outside of Japan.

Based on a "conservative management approach," NMFS recognizes three MMPA stocks in U.S. Pacific waters: Alaska (Northeast Pacific), California/Oregon/Washington, and Hawaii (Barlow *et al.* 1997; Hill *et al*. 1997). To date there has been no effort to define DPSs for fin whales under the ESA. In order to qualify as a DPS, a unit must first be discrete and second, significant (61 FR 4722).

E.2 Distribution and Habitat Use

Rice (1974) reported that the summer distribution of fin whales included "immediate offshore waters" throughout the North Pacific from central Baja California to Japan, and as far north as the Chukchi Sea. They occurred in high densities in the northern Gulf of Alaska and southeastern Bering Sea from May to October, with some movement through the Aleutian passes into and out of the Bering Sea (Reeves *et al.* 1985). Fin whales were observed and taken by Japanese and Soviet whalers off eastern Kamchatka and Cape Navarin, both north and south of the eastern Aleutians, and in the northern Bering and southern Chukchi Seas (Berzin and Rovnin 1966; Nasu 1974). They were also taken by whalers off central California throughout the year (Clapham *et al.* 1997). In general, however, the numbers reached a peak in late May or early June, and then fell off until another influx occurred later in the summer (Rice 1974). Rice (1974) also reported that several fin whales tagged in the winter (November to January) off southern California were killed in the summer (May to July) off central California, Oregon, British Columbia, and in the Gulf of Alaska. A radio-tagged fin whale remained in Prince William Sound for almost the entire month of June and showed a strong preference for a small area within the Sound (Watkins *et al.* 1981).

Fin whales have been observed feeding in Hawaiian waters during mid-May (Balcomb 1987; Shallenberger 1981), and their sounds have been recorded there during the autumn and winter (Thompson and Friedl 1982; Northrop *et al.* 1968; Shallenberger 1981). Several winter sightings were made in recent years off the island of Kauai (Mobley *et al.* 1996; M. Newcomer, pers. comm., September 1998), and sightings were made in November northwest of the main Hawaiian Islands (Barlow *et al.* 2004). Thompson and Friedl (1982) and Northrup *et al.* (1968) suggested that fin whales migrate into Hawaiian waters mainly in fall and winter, based on acoustic recordings off Oahu and Midway Islands. McDonald and Fox (1999) reported calling fin whales about 16 km off the north shore of Oahu, based on passive acoustic recordings. Fin whales have also been observed year-round off central and southern California, with peak numbers in summer and fall (Dohl *et al.* 1983; Barlow 1995; Forney *et al.* 1995), in summer off Oregon (Green *et al.* 1992), and in summer and fall in the Gulf of Alaska (including Shelikof Strait), and the southeastern Bering Sea (Leatherwood *et al.* 1986; Brueggeman *et al.* 1990) Their regular summer occurrence has also been noted in recent years around the Pribilof Islands in the northern Bering Sea (Baretta and Hunt 1994).

Data suggest that, as in the North Atlantic, the migratory behavior of fin whales in the eastern North Pacific is complex: whales can occur in any one season at many different latitudes, perhaps depending on their age or reproductive state as well as their “stock” affinity. Movements can be either inshore/offshore or north/south. Some individuals remain at high latitudes through the winter (Berzin and Rovnin 1966). Japanese marking data suggest some differences in the movements of immature and mature whales, the latter tending to be more strongly migratory in the Aleutians area (Nasu 1974). Fin whale concentrations in the northern North Pacific and Bering Sea generally form along frontal boundaries, or mixing zones between coastal and oceanic waters, which themselves correspond roughly to the 200 m isobath (shelf edge) (Nasu 1974).

Although some fin whales apparently are present in the Gulf of California year-round, there is a marked increase in their numbers in the winter and spring (Tershy *et al.* 1990). Relatively large fin whale concentrations have been observed in the northern Gulf of California (Silber *et al*. 1994). Their migration into the mid- and lower Gulf is thought to be related to the high seasonal abundance of krill (Tershy 1992).

E.3 Feeding and Prey Selection

In the North Pacific overall, fin whales apparently prefer euphausiids (mainly *Euphausia pacifica*, *Thysanoessa longipes*, *T. spinifera*, and *T. inermis*) and large copepods (mainly *Calanus cristatus*), followed by schooling fish such as herring, walleye pollock (*Theragra chalcogramma*), and capelin (Nemoto 1970; Kawamura 1982).

Fin whales killed off central California in the early twentieth century were described as having either "plankton" (assumed to have been mainly or entirely euphausiids) or "sardines" (assumed to have been anchovies, *Engraulis mordax*) in their stomachs (Clapham *et al.* 1997). A larger sample of fin whales taken off California in the 1950s and 1960s were feeding mainly on krill, mostly *Euphausia pacifica* , with only about 10% of the individuals having anchovies in their stomachs (Rice 1963).

Fin whales in the Gulf of California prey mainly on zooplankton such as *Nyctiphanes* simplex (Tershy 1992).

E.4 Interspecific Competition

See summary in section D.4. In the Gulf of California where fin and Bryde's whales are sympatric, the two species apparently specialize on different prey types. Bryde's whales feed mainly on small pelagic fishes, and fin whales feed on krill (Tershy 1992).

E.5 Reproduction

The reproductive biology of fin whales in the North Pacific is assumed to be broadly similar to that of fin whales in the North Atlantic (see Section D.5). However, Ohsumi's (1986) analysis of age at sexual maturity for a large sample of fin whales killed in the eastern North Pacific from the mid-1950s to 1975 showed a marked decline with time. According to Ohsumi, the average age at attainment of sexual maturity declined from 12 to 6 years in females and from 11 to 4 years in males. This change was interpreted by Ohsumi as a density-dependent response to heavy exploitation of the population.

E.6 Natural Mortality

Injury or suffocation from ice entrapment is not known to be a factor in the natural mortality of fin whales in the North Pacific as it is in the western North Atlantic (see Section D.6). Although killer whales presumably attack fin whales at least occasionally, there is little evidence of such predation from the North Pacific (Tomilin 1967). Shark attacks presumably occur on young or sick fin whales, although such events have not been documented.

E.7 Abundance and Trends

The total North Pacific fin whale population before whaling began, has been estimated at 42,000–45,000, based on catch data and a population model (Ohsumi and Wada 1974; Omura and Ohsumi 1974). Of this, the "American population" (*i.e.*, the component centered in waters east of 180° W longitude) was estimated to be 25,000–27,000. Based on sighting and CPUE data and a population model, the same authors estimated that there were 8,000–11,000 fin whales in the eastern North Pacific in 1973 (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 MSY levels (16,000 and 11,000, respectively) by 1975. As pointed out by Barlow (1994), citing IWC (1989b), CPUE techniques for estimating abundance are not certain, therefore, the absolute values of the cited abundance estimates should not be relied upon.

Shipboard sighting surveys in the summer and autumn of 1991, 1993, 1996, and 2001 produced estimates of 1,600–3,200 fin whales off California and 280–380 fin whales off Oregon and Washington (Barlow 2003). The most recent estimate for California/Oregon/Washington is 2,636 (CV = 0.15), which is the geometric mean of the line transect estimate from summer/autumn ship surveys conducted in 2001 (Barlow and Forney 2007) and 2005 (Forney 2007). The minimum estimate for the California/Oregon/Washington stock, as defined in the U.S. Pacific Marine Mammal Stock Assessments: 2008, is about 2,316 (Carretta *et al.* 2009). An increasing trend between1979/80 and 1993 was suggested by the available survey data, but it was not statistically significant (Barlow *et al.* 1997).

An aerial survey of the former Akutan whaling grounds around the eastern Aleutians in 1984 produced no sightings of fin whales (Stewart *et al.* 1987). The absence of sightings in this area of former high abundance (at least 2,500 fin whales were taken there between 1912 and 1939 even though whaling was not conducted in five of these years; Reeves *et al.* 1985) was interpreted to mean that the local density of fin whales remained far below that of the early twentieth century (Stewart *et al.* 1987). A ship cruise south of the Aleutians in August 1994 also failed to find appreciable numbers of fin whales (Forney and Brownell 1996). However, large numbers of fin whales were seen in the Gulf of Alaska during the Structure of Populations, Levels of Abundance and Status of Humpback whales surveys (SPLASH) in 2004 (Jay Barlow, pers, comm., 2006). Seabird surveys near the Pribilof Islands in the Bering Sea indicated a substantial increase in the local abundance of fin whales between 1975–1978 and 1987–1989 (Baretta and Hunt 1994).

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 for the period 1987–2003. 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 for the first trend year (1987) and due to uncertainties about the population structure of the fin whales in the area. Also, the study represented only a small fraction of the range of the northeast Pacific stock.

F. Life History – Southern Hemisphere

F.1 Population Structure

A separate subspecies (*B. p. quoyi*; Fischer 1829) is recognized in the Southern Hemisphere and is commonly called the Antarctic fin whale. Antarctic fin whales are approximately 3 m longer than their Northern Hemisphere counterparts. The IWC has divided the Southern Hemisphere into six baleen whale stock areas (Donovan 1991). These areas may loosely correspond to fin whale stocks, but there are still insufficient distributional data on where these whales breed to validate this designation (IWC 1992b). All southern ocean fin whales currently belong to the subspecies *B. p. quoyi*. However, Clarke (2004) 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). In effect, these pygmy fin whales are comparable to the pygmy blue whale subspecies (*B. musculus brevicauda*), segregated during the austral summer from their sister subspecies further south.

F.2 Distribution and Habitat Use

Antarctic fin whales migrate seasonally from relatively high-latitude Antarctic feeding areas in the summer, to relatively low-latitude breeding and calving areas in winter. Arrival time on the summer feeding areas may differ according to sexual class, with pregnant females arriving earlier in the season than other whales (Mackintosh 1965). The location of winter breeding areas is still uncertain. These whales tend to migrate in the open ocean, and therefore migration routes and the location of wintering areas are difficult to determine.

F.3 Feeding and Prey Selection

Antarctic fin whales feed on krill, *Euphausia superba*, which occurs in dense near-surface schools (Nemoto 1959). However, off the coast of Chile, fin whales are known to feed on the euphasiid *E. mucronata* (Antezana 1970; Perez *et al*. 2006).

F.4 Interspecific Competition

There is some speculation, because of the sharing of the Antarctic krill resource between both whale and nonwhale predators (*e.g.*, birds), that interspecific competition may be a critical factor in the biology of Southern Hemisphere fin whales (IWC 1992a). However, there is no direct information on how such ecosystem level interactions may or may not affect the status of baleen whales (Kawamura 1994; Clapham and Brownell 1996). Murphy *et al.* (1988) and Fraser *et al.* (1992) suggest that competition among whales and other small krill predators in the Antarctic ecosystem is relatively low.

F.5 Reproduction

The reproductive biology of fin whales in the Southern Hemisphere is assumed to be broadly similar to that of fin whales in the North Atlantic (see Section D.5). It should be noted, however, that the question of whether whaling data from the Southern Hemisphere do or do not demonstrate density-dependent responses in the reproductive cycle of fin whales, is controversial (Mizroch and York 1984; Sampson 1989).

F.6 Natural Mortality

Little is known about the natural causes of mortality of fin whales in the Southern Hemisphere. Disease presumably plays a major role in natural mortality, and shark attacks on weak or young individuals are probably common, but have not been documented. Fin whales have been observed near the pack ice off of Antarctica and in other areas of complex bathymetry; however, injury or suffocation from ice entrapment is not known to be a factor in the natural mortality of fin whales in the Southern Hemisphere. Although killer whales presumably attack fin whales at least occasionally, there is no published literature documenting such predation in the Southern Hemisphere.

F.7 Abundance and Trends

From 1904 to 1975, there were 703,693 fin whales taken in Antarctic whaling operations (IWC 1990). Whaling in the Southern Hemisphere originally targeted humpback whales, but by 1913, this target species became rare, and the catch of fin and blue whales began to increase (Mizroch *et al.* 1984b). From 1911 to 1924, there were 2,000–5,000 fin whales taken per year. After the introduction of factory whaling ships in 1925, the number of whales taken per year increased substantially. 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. The IWC prohibited the taking of fin whales from the Southern Hemisphere in 1976.

Recently released Soviet whaling records indicate a discrepancy between reported and actual fin whale catch numbers by the Soviets in southern waters between 1947 and 1980 (Zemsky *et al.* 1995). The USSR previously reported 52,931 whales caught, whereas the new data indicates that only 41,984 were taken. Catches of fin whales were over-reported to hide the illegal catches of other species like pygmy blue, humpback, and right whales.

The most current (1979) population estimate is 85,200 (no CV) based on the history of catches and trends in CPUE (IWC 1979). In addition, 15,178 whales (no CV given and uncorrected for probability of sighting) were estimated to occur within surveyed areas south of 30°S latitude by combining data from Japan Scouting Vessels and IWC/International Decade of Cetacean Research 1978–88 ship-based estimated to contain 400,000 fin whales (IWC 1989). Both the current abundance estimate and historical estimates should be considered as poor estimates 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. There are no currently accepted estimates of trends in abundance.

Fin whales were a target species for Japanese Antarctic Special Permit whaling for the 2005/2006 and 2006/2007 seasons at 10 fin whales/year. The proposal for the following 12 years includes 50 fin whales/year; despite this higher target, Japan took zero fin whales in the 2007/2008 season and one in the 2008/2009 season.

G. Threats

A threat is defined as any factor that could represent an impediment to recovery. In this recovery plan all threats, those that are natural and those that are human-related, are considered. The rankings were developed relative to each other, and put into one of four categories: high, medium, low, and unknown (further research is needed to determine whether it falls into high, medium, or low). Relative Impact to Recovery, which is defined in the last column in the threats table (Table 1) and at the end of each subsection, is a combination of the severity (magnitude, scope, and relative frequency with which the threat is expected to occur) and uncertainty of information for each. There are 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. Threats to fin whales are summarized in Table 1.

G.1 Fishery Interactions – LOW

Fin whales may break through or carry away fishing gear. Whales carrying gear may die at a later time due to trailing fishing gear, become debilitated or seriously injured, or have normal functions impaired, but with no evidence of the incident recorded. More information is needed to evaluate the serious injury and mortality of fin whales from entanglement. Fin whales are occasionally killed or injured by inshore fishing gear (*e.g.,* gillnets and lobster lines) off of eastern Canada and the east coast of the United States (Read 1994; Lien 1994; Waring *et al.* 1997). Fin whales apparently are entangled in inshore fishing gear in the North Pacific, but only very rarely (Barlow *et al.* 1994, 1997).

G.1.1 Global

Globally, the ranking of the threat posed by the incidental capture of animals by gillnet, trawl, pot/trap, sink gillnet, and purse seine fishing practices to fin whale recovery was based on the assertion that while the uncertainty of information is medium, the severity of this threat is low, and the overall impact to the recovery of fin whale populations is considered low (Table 1). Rankings of these threats for some populations are also shown in the table and discussed below.

Western North Atlantic Ocean
In the Western North Atlantic[2], there were 4 confirmed entanglements of fin whales from 2002 to 2006; two resulted in mortalities and two resulted in serious injury (Waring *et al.* 2009). In addition to those mentioned above, there were four additional records of entanglement within the period that either lacked substantial evidence to make a serious injury determination or did not provide the detail necessary to determine if an entanglement had been a contributing factor in the mortality (Waring *et al.* 2009). The ranking of the threat posed by the incidental capture of animals in the western North Atlantic and Nova Scotia from lobster and mixed species pot/trap and sink gillnet fishing practices to fin whale recovery was based on the assertion that there is a low uncertainty with regard to impacts to individual animals and the impact to the recovery of fin whale populations due to these fishing practices is considered low (Table 1).

U.S. Pacific Ocean
In the North Pacific, Heyning and Lewis (1990) made a crude estimate of about 73 rorquals killed per year in the southern California offshore drift gillnet fishery during the 1980s. Some of these may have been fin whales and some of them sei whales. Some balaenopterids, particularly fin whales, may also be taken in the drift gillnet fisheries targeting sharks and swordfish along the Pacific coast of Baja California, Mexico (Barlow *et al.* 1997) and from the California/Oregon/Washington stock. While the California/Oregon drift gillnet fishery killed/seriously injured fin whales, since the leatherback sea turtle (*Dermochelys coriacea*) conservation area was implemented in 2001 off central California and Oregon (66 FR 44549), no fin whales have been observed taken in this fishery. Based on the most recent observer data, the average fin whale bycatch in the offshore drift gillnet fishery was approximately zero per year from 2002–2006 (Carretta *et al*. 2009) and between 1994 and 2002, no interactions with fin whales were observed in the Hawaii-based longline fishery (Forney 2004). Between 2002 and 2006, there was one observed incidental mortality of a fin whale in the Bering Sea/Aleutian Islands pollock trawl (Angliss and Allen 2009). The ranking of the threat posed by the incidental capture of animals off of California/Oregon/Washington from gillnet and from the Northeast Pacific from the pollock trawl fishing practices to fin whale recovery was based on the assertion that there is a low uncertainty with regard to impacts to individual animals and the impact to the recovery of fin whale populations due to these fishing practices is considered low (Table 1). In Hawaii, the ranking of the threat posed by the incidental capture of animals from the longline and pot/trap fisheries was also based on the assertion that there is a low uncertainty with regard to impacts to individual animals and the impact to the recovery of fin whale populations due to these fishing practices is considered low (Table 1). However, Heyning and Lewis (1990) suggested that most whales killed by offshore fishing gear do not drift close enough to shore to strand on beaches or be detected floating in the nearshore corridor, where most whale watching and other types of boat traffic occur. Thus, the small amount of

[2] The IWC has proposed stock boundaries for North Atlantic fin whales of the eastern United States, Nova Scotia, and the southeastern coast of Newfoundland and are believed to constitute a single stock, however, whether the current stock boundaries define biologically isolated units has long been uncertain (Waring *et al.* 2009).

documentation should not be interpreted to mean that entanglement in fishing gear is an insignificant cause of mortality.

Southern Hemisphere
It is not known if fin whales interact with fisheries in the Southern Hemisphere. However, the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) was established chiefly as a result of concerns that increasing krill catches in the Southern Ocean could have serious effects on the population of krill. Krill is a major and vital part of the Antarctic food web and so disturbances to populations could have major and far-reaching effects on the whole ecosystem. Typically, krill is fished using trawl gear. In addition to krill fishing, the Patagonia toothfish is also a target species for fisheries in Antarctica and those fisheries likely use hooks and lines or demersal longline gear for their catch. It is assumed, based on the types of fisheries and fishing gear that could be used in the Southern Hemisphere, interactions are possible and the small amount of documentation should not be interpreted to mean that entanglement in fishing gear is an insignificant cause of mortality. The impact to the recovery of fin whale populations due to these fishing practices is considered low (Table 1).

G.2 Anthropogenic Noise – UNKNOWN

Humans have introduced sound intentionally and unintentionally into the marine environment for underwater communication, navigation, and research. Noise exposure can result in a multitude of impacts, ranging from those causing little or no impact to those being potentially severe, depending on level and on various other factors. Response to noise varies by many factors, including the type and characteristics of the noise source, distance between the source and the receptor, characteristics of the animal (*e.g.*, hearing sensitivity, behavioral context, age, sex, and previous experience with sound source) and time of the day or season. Noise may be intermittent or continuous, steady or impulsive, and may be generated by stationary or transient sources. As one of the potential stressors to marine mammal populations, noise may seriously disrupt marine mammal communication, navigational ability, and social patterns. Many marine mammals use sound to communicate, navigate, locate prey, and sense their environment. Both anthropogenic and natural sounds may cause interference with these functions.

The effects of anthropogenic noise are difficult to ascertain and research on this topic is ongoing. The possible impacts of the various sources of anthropogenic noise, described below, have not all been well studied on fin whales. The threat occurs at an unknown severity and there is a high level of uncertainty associated with the evidence described below. Thus, the relative impact of anthropogenic noise to the recovery of fin whales due to anthropogenic noise is ranked as unknown (Table 1).

Types of Noise: Ambient and Discrete Sources
Ambient or background noise levels are an important consideration in assessing acoustic impacts. Natural (*e.g.*, wind, biologics) and anthropogenic sources contribute significantly to ambient noise levels as a whole (*i.e.*, composite of all sources together) (Wenz 1962). These sound sources can occur locally or contribute from afar, like distant

shipping (Curtis *et al.* 1999; Andrew *et al.* 2002; McDonald *et al.* 2006; McDonald *et al.* 2008). The ambient noise level of an environment can be quite complicated and vary from location to location (deep versus shallow water), from day to day, within a day, and/or from season to season. For example, the amount of noise from shipping can be correlated to amount of traffic (*e.g.*, major shipping lanes are louder than other areas outside shipping lanes; Hatch *et al*. 2008). Furthermore, soniferous fish species have a seasonal or diel pattern to their vocalizations (*e.g.*, Rountree *et al*. 2006; Širović *et al*. 2009). In addition to describing the ambient acoustic environment, sound can be described as discrete sources (*e.g.*, individual seismic vessel, individual tactical sonar, individual ships). More information on sound produced by discrete sources is provided later in this section.

Hearing Damage or Impairment
As mentioned previously, there are no direct measurements of the hearing abilities of baleen whales. Baleen whale calls, especially fin whale calls, are predominantly at low frequencies, mainly below 1 kHz (Richardson *et al.* 1995), and their hearing is presumably good at corresponding frequencies. Direct changes in hearing ability from noise exposure have only been measured in a laboratory on a limited number of species (odontocete or pinniped species only) and individuals within those species (see Southall *et al*. 2007 for a review).

The potential effects of continuous or impulse noise sources on fin whales are of particular concern. Intense sound transmissions in the marine environment (*i.e.*, explosives) may impact whales by causing damage to body tissue or gross damage to ears, causing a permanent threshold shift (PTS) or a temporary threshold shift (TTS) if the animal is in close range of a sound source or exposed for a long duration.

Masking
An animal's detection threshold may be masked by noise that is at frequencies similar to those of biologically important signals, such as mating calls. Masking, obscuring of sounds of interest by interfering sounds (generally at similar frequencies), occurs when noise interferes with a marine animal's ability to hear a sound of interest. Marine mammals use acoustic signals for a variety of purposes, which differ among species, but include communication between individuals, navigation, foraging, reproduction, and learning about their environment (Erbe and Farmer 2000; Tyack 2000). "Auditory Interference," or masking, generally occurs when the interfering noise is louder than, and of a similar frequency to, the auditory signal received by the animal. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations.

The size of this "zone of masking" of a marine mammal is highly variable, and depends on many factors that affect the received levels of the background noise and the sound signal (Richardson *et al.* 1995; Foote *et al*. 2004). Masking is influenced by the amount of time that the noise is present, as well as the spectral characteristics of the noise source (*i.e.*, overlap in time, space, and frequency characteristics between noise and receiver). There are still many uncertainties regarding how masking affects marine mammals. For example, it is not known how loud acoustic signals must be for animals to recognize or respond to another animal's vocalizations (National Research Council 2003). It is also unknown if animals listen/respond to all the sounds they can hear or can be selective about what they will listen to. Richardson *et al*. (1995) argued that the maximum radius of influence of an industrial noise (including broadband low frequency sound transmission) on a marine mammal is the distance from the source to the point at which the noise can barely be heard. This range is determined by the hearing sensitivity of the animal and/or the background noise level present. Masking of industrial noise is likely to affect some species' ability to detect communication calls and natural sounds (*i.e.*, surf noise, prey noise, etc.; Richardson *et al*. 1995).

Animals may try to minimize masking by changing their behavior. These behavior changes may include producing more calls, longer calls, or shifting the frequency of the calls. For example, it has been demonstrated that mysticetes, like the North Atlantic right whale (Parks *et al*. 2007b; Parks *et al*. 2009) and blue whale (Di Iorio and Clark 2009) alter their vocalizations (call parameters or timing of calls) in response to background noise levels. There are still many uncertainties regarding how masking affects marine mammals, including fin whales. The potential impacts that masking may have on individual survival, the behaviors marine mammals may exhibit to avoid masking, and the energetic costs of changing behavior to reduce masking, are poorly understood.

Behavioral Response

Behavioral reactions to noise can vary not only across species and individuals but also for a given individual, depending on previous experience with a sound source, hearing sensitivity, sex, age, reproductive status, geographic location, season, health, social behavior, or context. Severity of responses can also vary depending on characteristics associated with the sound source (*e.g.*, whether it is moving or stationary, number of sound sources) or the potential of source and individuals co-occurring temporally and spatially (*e.g.*, how close to shore, region where animals may be unable to avoid exposure, propagation characteristics of the area either enhancing or reducing exposure) (Richardson *et al*. 1995; National Research Council 2003, 2005). As one of the potential stressors to marine mammal populations, noise and acoustic influences could disrupt marine mammal communication, navigational ability, and social patterns.

Most observations of behavioral responses of marine mammals to the sounds produced have been limited to short-term behavioral responses, which included the cessation of feeding, resting, or social interactions. Relationships between specific sound sources, or anthropogenic sound in general, and the responses of marine mammals to those sources are still subject to scientific investigation, but no clear patterns have emerged (see Southall *et al*. 2007 for a review). Animals may adapt to alter vocalizations, but acute changes or slight modifications of normal vocalizing behavior or other behaviors for a period of time, could have efficiency and energetic consequences. Sensitization (increased behavioral or physiological responsiveness over time) to noise could also exacerbate other effects, and habituation (decreased behavioral responsiveness over time) to chronic noise could cause animals to remain close to noise sources. Sound transmissions could also displace animals from areas for a short or long time period.

Noise may also reduce the availability of prey, or increase vulnerability to other hazards, such as fishing gear, predation, etc. (Richardson *et al.* 1995).

It is important to recognize the difficulty of measuring behavioral responses in free-ranging whales. The cumulative effects of habitat degradation are difficult to define and almost impossible to evaluate. Additionally, there is a lack of information on how short-term behavioral responses to noise translate into long-term or population-level effects (Wartzok *et al*. 2004; NRC 2003, 2005). Responses of fin whales to anthropogenic sounds probably depend on the age and sex of animals being exposed, as well as other factors. There is evidence that many individuals respond to certain sound sources, provided the received level is high enough to evoke a response, while other individuals do not. Like other marine mammals, behavioral responses of fin whales to anthropogenic sounds may be highly variable and may not result in the death or injury of individual whales or result in reductions in the fitness of individuals involved. For more specific information on potential impacts of noise associated with military activities, oil and gas exploration, and research, see sections below.

G.2.1 Ship Noise – UNKNOWN

Sound emitted from large vessels, particularly in the course of transit, is the principal source of noise in the ocean today, primarily due to the properties of sound emitted by cargo vessels. Ship propulsion and electricity generation engines, engine gearing, compressors, bilge and ballast pumps, as well as hydrodynamic flow surrounding a ship's hull and any hull protrusions and vessel speed contribute to a large vessels' noise emission into the marine environment. Prop-driven vessels also generate noise through cavitations, which accounts for approximately 85% or more of the noise emitted by a large vessel. Larger vessels tend to generate lower frequency sounds and are louder (Polefka 2004).

Surface shipping is the most widespread source of anthropogenic, low frequency (0 to 1,000 Hz) noise in the oceans (Simmonds and Hutchinson 1996). Ross (1976) estimated that between 1950 and 1975, shipping had caused a rise in ambient noise levels of 10 dB. He predicted that this would increase by another 5 dB by the beginning of the 21^{st} century. The National Research Council (2003) estimated that the background ocean noise level at 100 Hz has been increasing by about 1.5 dB per decade since the advent of propeller-driven ships and others have estimated that the increase in background ocean noise is as much as 3 dB per decade in the Pacific (Andrew *et al*. 2002; McDonald *et al.* 2006, 2008). Clark *et al*. (2009) recently attempted to quantify the effects of masking on mysticetes, including fin whales, exposed to noise from ships (change in communication space). At this point, the severity of the threat of ship noise to fin whales is unknown, and uncertainty of the threat is high. Therefore, the relative impact to recovery of fin whales due to this threat is ranked as unknown (Table 1).

G.2.2 Oil and Gas Exploration – UNKNOWN

Drilling for oil and gas generally produces low-frequency sounds with strong tonal components. There are few data on the noise from conventional drilling platforms.

Recorded noise from an early study of one drilling platform and three combined drilling production platforms found that noise was so weak it was almost not detectable alongside the platform at Beaufort scale sea states of three or above. The strongest tones were at very low frequencies near 5 Hz (Richardson *et al.* 1995).

Oil and gas exploration, including seismic surveys, typically operate with marine mammal observers as part of required mitigation measures detailed in permits issued for the activity. There have been no reported seismic-related or industry ship-related mortalities or injuries to fin whales in areas where marine mammal observers are present. However, the severity of this threat is unknown and the uncertainty of this threat is high. Therefore, the relative impact to recovery of fin whales due to this threat is ranked as unknown (Table 1).

A variety of devices and technologies exist which introduce energy into the water for purposes of geophysical research, bottom profiling, and depth determination. They are often characterized as high-resolution or low-resolution systems. Low-resolution systems such as 2-D and 3-D seismic surveys put appreciable sound energy into the water and operate at low frequencies, which overlap those used by baleen whales. Thus low-resolution systems have more potential to affect fin whales when used in open water. All these systems require a vessel platform (or several vessels) which themselves may impact whales. Baleen whales are known to detect the low-frequency sound pulses emitted by airguns and have been observed reacting to seismic vessels (*e.g.*, McCauley *et al*. 2000; Stone 2003). However, in a study off Oregon, fin whales continued to produce their normal sounds despite the presence of seismic air gun pulses (McDonald *et al.* 1995).

Seismic surveys have also occurred in areas of krill abundance, where fin whales have occasionally been seen feeding in Australia (Department of the Environment and Heritage 2005). The results of collaborative research conducted by several scientists from a variety of nations and the Cornell Lab of Ornithology from 1999–2000 in the Sea of Cortez, suggest that the long, low-frequency songs of male fin whales function to attract females to dense patches of food, where mating then occurs. The findings of that study helped to focus growing concern over the potential effects of human-produced underwater noise on large whales because if whales rely on long-distance acoustic signals to find each other for mating, the recovery rate of fin whale populations from past exploitation could be impeded by low-frequency sounds generated by human activities such as seismic surveys (http://www.birds.cornell.edu/brp/research/fin-whales-in-the-sea-of-cortez).

During exploration, noise is also produced by supply vessels and low-flying aircraft, construction work, and dredging. The transmission of aircraft sound to cetaceans or other marine mammals while they are in the water is influenced by the animal's depth, the altitude, aspect, and strength of the noise coming from the aircraft. Generally, the greater the altitude of the aircraft, the lower the sound level received underwater.

G.2.3 Coastal Development – Low

Anthropogenic noise associated with construction (*e.g.*, pile driving, blasting, or explosives) has the potential to affect fin whales. In-water construction activities, such as pile driving and dredging, can produce sound levels sufficient to disturb marine mammals under certain conditions. The majority of the sound energy associated with both pile driving and dredging is in the low frequency range (<1,000 Hz) (Illingworth and Rodkin, Inc. 2001, 2007; Reyff *et al.* 2002, Reyff 2003). Several techniques have been adopted to reduce the sound pressure levels to minimize impacts to marine mammals. Because fin whales would only be affected when close to shore, it is assumed that effects would be low in the life cycle of the whale. However, if coastal development occurred in seasonal areas or migration routes where animals concentrate, individuals in the area could be compromised. Scheduling in-water construction activities to avoid those times when whales may be present would likely minimize the disturbance.

In recent years, many Liquefied Natural Gas (LNG) facilities have been proposed worldwide. The noise generated from construction and operation activities could affect marine mammals located within the vicinity of the project site. In addition, any increase in vessel traffic resulting from construction or operation of an LNG facility could negatively impact fin whales in or moving through the area. For more information on vessel impacts, see section G.3

Based on this information, the threat occurs at a low severity and there is a medium level of uncertainty. Thus, the relative impact to recovery of fin whales due to noise associated with coastal development is ranked as low (Table 1).

G.2.4 Military Sonar and Explosives – Unknown

Military training activities by the U.S. Navy and the navies of other countries regularly occur in the Atlantic (including the Gulf of Mexico, Mediterranean Sea), Indian, and Pacific Oceans. These activities include anti-submarine warfare, surface warfare, anti-surface, mine warfare exercises, missile exercises, sinking exercises, and aerial combat exercises. In addition to these training activities, the U.S. Navy conducts ship shock trials, which involve detonations of high explosive charges, and operates several permanent and temporary (portable) undersea warfare training ranges that employ acoustic sensors.

As part of its suite of training activities, the U.S. Navy employs low-frequency, mid-frequency, and high-frequency active sonar systems. The primary low-frequency sonar active sonar system is the Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar system, which produces loud signals in the 100–500 Hz range, and has operated in the western and central Pacific Ocean. The U.S. Navy employs several mid-frequency sonar systems that range from large systems mounted on the hulls of ships (*e.g.*, AN/SQS-53 and -56), to smaller systems that are deployed from helicopters and fixed-wing aircraft, sonobuoys, and torpedoes. These sonar systems can produce loud sounds at frequencies of between 1 and 10 k Hz and higher (Evans and England 2001; U.S. Department of the Navy 2008).

The effect of active sonar on fin whales has not been studied extensively and remains uncertain; however, active sonar associated with naval training activities might adversely affect fin whales in several different ways. First, low-frequency sonar transmissions that overlap with fin whale vocalizations might mask communication between whales which would affect the social ecology and social interactions of fin whale groups. Second, overlap between fin whale hearing and low- and mid-frequency active sonar, sonar transmissions might result in noise-induced losses of hearing sensitivity or behavioral disturbance as fin whales avoid or evade sonar transmissions. Nevertheless, studies of the effects of SURTASS LFA sonar on foraging blue and fin whales in California did not detect biologically significant responses to the LFA sonar in fin whales (U.S. Department of the Navy 2007).

Underwater detonations associated with military training activities range from large high explosives such as those associated sinking exercises or ship shock trials, to missile exercises, gunnery exercises, mine warfare, disposal of unexploded ordnance, and grenades. Detonations produce shock waves and sound fields of varying size. Animals that occur close to a large detonation might be killed or seriously injured; animals that are further away might suffer lesser injury (*i.e.*, tympanic membrane rupture, or slight to extensive lung injury); while animals that are even further away might experience physiological stress responses or behavioral disturbance whose severity depends on their distance from the detonation.

Various measures are being developed to prevent fin whales from being exposed to active sonar transmissions or underwater detonations. For example, the SURTASS LFA sonar system employs a high-frequency active sonar that allows the U.S. Navy to detect large and most small cetaceans and shut down sonar transmissions until whales have moved away from the sonar source; tests of this sonar system suggest that it detects more than 96 percent of the whales that occur within 1 kilometer of the sonar system. As another example, the suite of monitoring protocols the U.S. Navy developed during the ship shock trial on the U.S.S. Winston Churchill were effective at preventing fin whales, other cetaceans, and sea turtles from being exposed to the shock wave associated with those detonations. Other measures are being developed and tested to reduce the probability of exposing fin whales and other cetaceans to active sonar transmissions and shock waves of underwater detonations.

The relatively large spatial scale, frequency, duration, and diverse nature of these training activities in areas in which fin whales also occur suggests that these activities have the potential to adversely affect fin whales. However, the severity of the effect of military sonar and detonations on fin whales and the effectiveness of measures that avoid any adverse effects remains largely unknown and the uncertainty of our knowledge is high. Therefore, the relative impact to recovery of fin whales due to this threat is ranked as unknown (Table 1).

G.3 Vessel Interactions

G.3.1 Ship Strikes – 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.

From 1993–2002, a minimum of 15 fin whales were struck and killed by ships off the east coast of the U.S. (Jensen and Silber 2004). During the same time frame, a minimum of five were killed off the west coast of the U.S., one was killed off the Gulf Coast, one was hit but appeared uninjured in Alaska and 12 were hit in foreign waters (Canada, UK, France and Italy) (Jensen and Silber 2004). From January 2002–December 2006, six fin whales from the North Atlantic fin whale stock were struck and killed by ships off the east coast (Waring *et al.* 2009). During 2002–2006, ship strikes were implicated in the deaths of seven fin whales from the California/Oregon/Washington stock and the injury of another (Caretta *et al.* 2009) and in 2008, at least one confirmed mortality by ship strike of one fin whale occurred (California Marine Mammal Stranding Database, U.S. Department of Commerce 2009). Two additional fin whales from the California/Oregon/Washington stock stranded dead in California in 2007, but cause of death was not determined. From 2006–2008, an additional five unidentified cetaceans (likely baleen whales) were killed due to ship strikes and were reported in California (California Marine Mammal Stranding Database, U.S. Department of Commerce 2009). Four fin whales were struck off the Northwest coast of the United States; three were identified in Washington and one was identified in Oregon (S. Norman, pers. comm. 2006). Because many ship strikes go either undetected or unreported, these are minimum estimates.

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. While these measures were designed to protect right whales specifically, they are expected to also reduce the risk of ship strikes to other marine mammals, including fin whales (NMFS 2008a).

The possible impacts of ship strikes on recovery of fin whale populations is not well understood. Because 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, the estimates of serious injury or mortality should be considered minimum estimates, thus there is a high level of uncertainty associated with the evidence presented above. The threat occurs at a medium severity, but with the high level of uncertainty, the relative impact to recovery of fin whales due to ship strikes is ranked as unknown but potentially high (Table 1).

G.3.2 Disturbance from Whale Watching and Other Vessels – LOW

Fin whales are among the main attractions of whale watching enterprises in eastern Canada and the northeastern United States (Hoyt 1984; Beach and Weinrich 1989). As a result, they are regularly subjected to close and persistent following by vessels.

Several investigators reported behavioral responses to close approaches by vessels suggesting that individual whales might experience a stress response (Watkins *et al.* 1981; Baker *et al.* 1983; Malme *et al.* 1983; Bauer 1986; Bauer and Herman 1986; Baker and Herman 1987; Richardson *et al.* 1995; Jahoda *et al.* 2003). Others suggest that there is mounting evidence that wild animals respond to human disturbance in the same way that they respond to predators (Harrington and Veitch 1992; Lima 1998; Gill and Sutherland 2000; Gill *et al.* 2001; Frid and Dill 2002; Beale and Monaghan 2004; Romero 2004). These responses have been associated with the abandonment of sites (Bartholomew Jr., 1949; Allen 1991; Sutherland and Crockford 1993), reduced reproductive success (Giese 1996; Müllner *et al.* 2004), and the death of individual animals (from expending energy and thus compromising their survival) (Feare 1976; Daan *et al.* 1996).

According to Schevill *et al.* (1964), the fin whale "seems somewhat to avoid ships." In Cape Cod waters, fin whales were notably wary of vessels before the mid-1970s, but subsequently were observed to have become much less responsive to vessels (Watkins 1986). Edds and Macfarlane (1987) documented that a fin whale observed from an elevated site on the north shore of the St. Lawrence River, significantly reduced its mean dive time while it was being pursued by a ferry carrying whale watchers. Also in the St. Lawrence, Michaud and Giard (1998) documented short-term changes in dive behavior of fin whales approached by vessels. Fin whales observed from a lighthouse in Maine responded to the presence of vessels by decreasing dive times, surface times, and number of blows per surfacing (Stone *et al.* 1992). Fin whales observed in the Mediterranean had similar responses, including not returning to normal behaviors (*e.g.*, feeding) observed prior to the disturbance (Jahoda *et al.* 2003).

Fin whales are subject to whale watching much less often in the eastern North Pacific than in the western North Atlantic. Thus, disturbance in the Pacific is more likely to come from industrial, military, and fishing vessel traffic off the Mexican, U.S., and Canadian coasts, than from the deliberate approaches of whale watching vessels. The low-frequency sounds used by fin whales for communication and (possibly) in courtship displays (Watkins 1981) could be masked or interrupted by ship noise.

The potential for injury or disturbance to cetaceans from military ships is also a concern. NMFS conducted an assessment in its Biological Opinion on Rim of the Pacific (RIMPAC) exercises, focusing on ship traffic and mid-frequency sonar, and concluded that fin whales in the action area were likely to respond to ship traffic associated with the maneuvers (NMFS 2008b).

Based on this information, the threat occurs at a low severity and there is a medium level of uncertainty. Thus, the relative impact to recovery of fin whales due to disturbance from vessels and tourism is ranked as low (Table 1).

G.4 Contaminants and Pollutants – LOW

Based on studies of contaminants in baleen whales, including fin whales, and other marine mammals, habitat pollutants do not appear to be a major threat to fin whales in most areas where fin whales are found. O'Shea and Brownell (1995) state that concentrations of organochlorine and metal contaminants in tissues of baleen whales are low, and lower than other marine mammal species. They further state that there is no firm evidence that levels of organochlorines, organotins, or heavy metals in baleen whales generally are high enough to cause toxic or other damaging effects. In a study of organochlorine exposure and bioaccumulation in another baleen whale, the North Atlantic right whale (*Eubalaena glacialis)*, Weisbrod *et al.* (2000) note that biopsy concentrations are an order of magnitude lower than the blubber burdens of seals and odontocetes. They conclude that they do not have evidence that right whales bioaccumulate hazardous concentrations of organochlorines, and further note that these were consistent with other surveys of baleen whales (Weisbrod *et al.* 2000). Among baleen whales, Aguilar (1983) observed that mean levels of dichloro-diphenyl-trichloroethane (DDT) and polychlorinated biphenyls (PCB) in a study of North Atlantic fin whales were significantly lower (0.74 and 12.65 respectively) than in a study of North Atlantic sperm whales (4.68 and 26.88 respectively). In a review of organochlorine and metal pollutants in marine mammals from Central and South America, Borrell and Aguilar (1999) note that organochlorine levels in marine mammals (based on studies of franciscana dolphins, *Pontoporia blainvillei*, from Argentina and spotted dolphins, *Stenella attenuata*, from the eastern tropical Pacific) suggest low levels of exposure compared to other regions of the world. Indeed, although data are extremely scarce, concentrations of organochlorines in the tropical and equatorial fringe of the northern hemisphere and throughout the southern hemisphere are low or extremely low in marine mammals, and organochlorine concentrations in marine mammals off South America, South Africa and Australia are invariably low (Aguilar *et al.* 2002). The lowest organochlorine concentrations are found in the polar regions of both hemispheres. However, due to the systematic long-term transfer of airborne pollutants from warmer to colder regions, it is expected that the Arctic and, to a lesser extent, the Antarctic will become major sinks for organochlorines in the future, warranting long-term monitoring of polar regions (Aguilar *et al.* 2002).

The highest concentrations of organochlorines found in marine mammals, including fin whales, are in the Mediterranean Sea. High concentrations of organochlorines in marine mammals also occur, although to a lesser extent, along the Pacific coast of the U.S. and generally in other mid-latitudes in the northern hemisphere (Aguilar *et al.* 2002). Fossi *et al.* (2003) state that concentrations in the Mediterranean could have an effect on reproductive rates of this species, warranting further study (Fossi *et al.* 2003).

Little is known about the possible long-term and trans-generational effects of exposure to pollutants. Aguilar and Borrell (1988) note that while pollutant burdens in young fin whale specimens from the two sexes were indistinguishable, from the onset of sexual maturity, concentrations of all organochlorines increased with age and body size in males and decreased in females until both reached a plateau. The decrease observed in female blubber concentrations was attributed to reproductive transfer, mainly though lactation.

Oil Spills
Oil spills that occur while fin whales are present could result in skin contact with the oil, baleen fouling, ingestion of oil, respiratory distress from hydrocarbon vapors, contaminated food sources, and displacement from feeding areas (Geraci 1990). Actual impacts would depend on the extent and duration of contact, and the characteristics (age) of the oil. Most likely, the effects of oil would be irritation to the respiratory membranes and absorption of hydrocarbons into the bloodstream (Geraci 1990). If a marine mammal was present in the immediate area of fresh oil, it is possible that it could inhale enough vapors to affect its health. Inhalation of petroleum vapors can cause pneumonia in humans and animals, due to large amounts of foreign material (vapors) entering the lungs (Lipscomb *et al*. 1994). Long term ingestion of pollutants, including oil residues, could affect reproductive success, but data are lacking to determine how oil may fit into this scheme for fin whales.

In general, the threat from contaminants and pollutants occurs at a low severity and there is a medium level of uncertainty. Thus, the relative impact to recovery of fin whales due to contaminants and pollution is ranked as low (Table 1). However, this ranking may need to be elevated if future data indicate reproductive rates are indeed impacted by exposed to contaminants or pollution. For instance, we may obtain new information based on the 2010 Gulf of Mexico oil spill that leads us to reevaluate threats from contaminants in general. Given the limited geographic scope of this spill relative to fin whale distribution, we maintain the low ranking of this threat even in light of this specific event.

G.5 Disease – LOW

Disease presumably plays a role in natural mortality of fin whales but it is assumed that it is not a high threat to fin whale populations. Lambertsen (1986) indicated that crassicaudiosis in the urinary tract was a primary cause of natural mortality in individual North Atlantic fin whales. The potential for parasitism to have a population level effect on fin whales is largely unknown, although it is unlikely that parasites have much effect on otherwise healthy animals, but effects could become significant if combined with other stressors. Currently, there is no evidence of an increased level of disease in fin whales, so the severity of this threat is considered to be low. However, given the potential but unknown effect of disease on immune suppression, the uncertainty in this determination is considered to be medium. Thus, the relative impact to recovery of fin whales due to disease is ranked as low (Table 1).

G.6 Injury from Marine Debris – LOW

Harmful marine debris consists of plastic garbage washed or blown from land into the sea, fishing gear lost or abandoned by recreational and commercial fishers, and solid non-biodegradable floating materials (such as plastics) disposed of by ships at sea. Examples of plastic materials are: bags, bottles, strapping bands, sheeting, synthetic ropes, synthetic fishing nets, floats, fiberglass, piping, insulation, paints, and adhesives. Marine species confuse plastic bags, rubber, balloons, and confectionery wrappers with prey and ingest them. The debris usually causes a physical blockage in the digestive system, leading to painful internal injuries.

Observational studies cannot fully evaluate the potential for entanglement because many entangled animals may die at sea and thus not be seen or reported. Instances of stomach obstruction caused by marine debris have not been documented in fin whales, although there are documented cases of problematic ingestion of marine debris in sperm, pygmy sperm (*Kogia breviceps*), and minke whales (*Balaenoptera acutorostrata*) (Viale *et al.* 1992; Tarpley and Marwitz 1993), however, it is not believed to be a major threat to the species and the severity of this threat is ranked low. Given the unknown effect of entanglement and ingestion of marine debris on fin whales, the uncertainty in this determination is considered to be medium. Thus, the relative impact to recovery of fin whales due to injury from marine debris is ranked as low (Table 1).

G.7 Research – LOW

Fin whales have been the subject of field studies for decades. The primary objective of many of these studies has generally been monitoring populations to gather data for behavioral and ecological studies. Existing permits authorize investigators to make close approaches of endangered whales for photographic identification, behavioral observations, passive acoustic recording, aerial photogrammetry, and underwater observations. Reported responses of gray whales to research activities ranged from no visible responses to short-term behavioral responses; however the consequences of these levels of close approaches on the population ecology of listed species remains unknown (Moore and Clarke 2002). Research on fin whales is likely to continue and increase in the future, especially for oceanographic surveys, the collection of genetic information, photographic studies, and acoustic studies.

The effects of research not directly associated with fin whales are addressed in other subsections of the threats section of this Recovery Plan, such as vessel interactions, anthropogenic noise, contaminants and pollutants, oil and gas exploration, and military sonar and explosives.

Research activities could result in disturbance to fin whales, but are closely monitored and evaluated in an attempt to minimize any impacts of research necessary for the recovery of fin whales. Specifically, the National Environmental Policy Act requires the development of environmental impact statements to assess the potential impact of a project on protected species, and ESA and MMPA permits are required for any incidental take of fin whales. The threat occurs at a low severity and a medium level of uncertainty, as the potential does exist for unobserved mortality to occur following the completion of research activities. Thus, the relative impact to recovery of fin whales due to this threat is ranked as low (Table 1).

G.8 Predation and Natural Mortality – LOW

Shark attacks presumably occur on young or sick fin whales, although such evidence has not been documented. Injury and suffocation from ice entrapment is not known to be a factor for fin whales in the North Pacific, as it is for fin whales in the western North Atlantic. The potential impact of predation by killer whales on the dynamics of the North Pacific marine ecosystem over the last several decades, has received substantial attention within the scientific community in recent years. Information on killer whale abundance, diet, and movements, has increased, and new hypotheses have been developed within the scientific community on how predation by killer whales has influenced marine mammal populations. Although killer whales presumably attack fin whales everywhere, evidence has only been reported from the North Atlantic (Mitchell and Reeves 1988), with little evidence of such predation from the North Pacific (Tomilin 1967) or Southern Hemisphere. Evidence indicates that predation by killer whales has been, and still is, a source of natural mortality for fin whales; however, the extent of natural mortality and predation is not known as few observations have occurred. Thus, the relative impact to recovery from predation and natural mortality is ranked as low, based on low severity and medium uncertainty (Table 1).

G.9 Direct Harvest – MEDIUM

Direct harvest, although rare today, was the main cause of initial depletion of fin whales and other large whales. Fin whales were hunted occasionally by the sailing-vessel whalers of the 19th century (Scammon 1874; Mitchell and Reeves 1983). The introduction of steam power in the second half of that century made it possible for boats to overtake the large, fast-swimming rorquals, including fin whales, and the use of harpoon-gun technology resulted in a high loss rate (Schmitt *et al.* 1980; Reeves and Barto 1985). The eventual introduction of deck-mounted harpoon cannons made it possible to kill and secure blue, fin, and sei whales, on an industrial scale (Tønnessen and Johnsen 1982). Fin whales were hunted, often intensively, in all the world's oceans for the first three-quarters of the twentieth century. The total reported catch of fin whales in the Southern Hemisphere from 1904 through 1979 was close to three-quarters of a million, making them numerically dominant among the commercially exploited baleen whales (IWC 1995).

The IWC's moratorium on the commercial hunting of fin whales in most of their range has been in force for more than two decades, and it has almost certainly had a positive effect on the species' recovery. There is currently no legal commercial whaling for fin whales in the Northern Hemisphere by IWC member nations party to the moratorium. There is an annual take of up to about 20 fin whales in Greenland for subsistence purposes, which is sanctioned and managed under an IWC quota scheme. Iceland has consistently expressed a strong interest in resuming its whaling industry targeting fin, sei, and minke whales (Sigurjønsson 1989) and returned to commercial whaling of fin whales beginning in 2006. Iceland and Norway[3] do not adhere to the IWC's moratorium on commercial whaling because both countries filed objections to that moratorium. Japan started killing fin whales in its scientific whaling program in 2005–2006 and increased its target from 10 to 50 fin whales for the next twelve seasons beginning with the 2007/2008 season. Japan took zero fin whales in the 2007/2008 season and one in the 2008/2009 season.

Well-documented pirate whaling in the northeastern Atlantic occurred as recently as 1979 (Sanpera and Aguilar 1992; Best 1992), and attempted illegal trade in baleen whale meat has been 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). Therefore, it cannot be assumed that fin whales have been fully protected from commercial whaling since 1986 or that their current legal protection from commercial whaling will continue into the future. Based on this information, the threat occurs at a medium severity and there is a medium level of uncertainty. Thus, the relative impact to recovery of fin whales due to direct harvest is ranked as medium (Table 1).

G.9.1 North Atlantic

Some whaling for fin whales occurred in New England waters during the 1880s (Reeves and Barto 1985). Large numbers of fin whales were killed in the western North Atlantic beginning in the late 1890s when whaling stations were established on the coast of Newfoundland (Mitchell 1974). More than 12,500 fin whales were reported in the Newfoundland-Labrador catch statistics from 1903 to 1972, and this does not include the nearly 1,800 whales listed as taken but not identified as to species (Mitchell 1974: in Table 5-5; supplemented by data from Committee for Whaling Statistics 1973). Nearly 400 whales (blue and fin, combined) were taken at whaling stations in the Gulf of St. Lawrence between 1911 and 1915 (Mitchell 1974: in Table 5-7; supplemented by data from Committee for Whaling Statistics 1973), and an additional 1,564 fin whales were taken off Nova Scotia between 1964 and 1972 (Mitchell 1974; supplemented by data from the Committee for Whaling Statistics 1973). Thus, the total number of fin whales taken by modern whaling in eastern Canada is probably close to 15,000 animals.

Fin whales were hunted in Davis Strait by Norwegian and Danish pelagic whalers beginning in 1919 or earlier (Hjort and Ruud 1929) and 1924, respectively (Jonsgård 1977; Kapel 1979). Although this whaling had ended by the late 1950s, fin whales have continued to be taken from Greenlandic fishing vessels equipped with mounted harpoon cannons operating in coastal waters off Greenland (Kapel 1979).

[3] In 1982, the IWC adopted a temporary moratorium on the commercial whaling of all whale species, effective from 1986. Norway objected to the moratorium, but nevertheless introduced a temporary ban on minke whaling pending more reliable information on the state of stocks. The Norwegian government unilaterally decided to resume whaling in 1993. Norway's legal right to hunt minke whales is not disputed, as Norway objected to the moratorium when it was adopted by the IWC.

Shore-based commercial whaling for fin whales began in Iceland in 1883, was suspended for 20 years beginning in 1916, and was again interrupted during the Second World War (Hjort and Ruud 1929; Rørvik *et al.* 1976; Sigurjønsson 1988). From 1948, it continued without interruption through the 1986 season. Effort was especially intensive during the period 1889 to 1915, when an estimated 8,100 fin whales were taken at stations on the east and west coasts. From 1916 to 1948 fin whale catches around Iceland were more modest. From 1948 through 1985 the average annual take was 234, IWC quotas having been introduced in 1977. The total catch of fin whales near Iceland from 1948 through 1986 was 8,963 (Sigurjønsson 1988; IWC 1988). In 1987–89 Iceland took an additional 216 fin whales under a national scientific research permit (IWC 1989, 1990, 1991). Sigurjønsson (1988) noted that fin whales have long been the preferred target species in Icelandic whaling because of their large yield of high-quality meat.

Fin whales were hunted intensively off northern and western Norway from the earliest days of modern whaling. Between 1868 and 1904, about 10,500 were taken off Finnmark (Christensen *et al.* 1992a), and they continued to be hunted in this area through 1971 (Jonsgård 1977). Norwegian whalers took more than 8,700 fin whales off the west coast of Norway between 1913 and 1969 and close to 6,000 off the Faroe Islands between 1910 and 1969 (Jonsgård 1977). Large numbers of fin whales were taken off Spain and Portugal during the 1920s and 1930s, and some whaling continued in this region until the mid-1980s (Sanpera and Aguilar 1992).

An estimated 414 fin whales were taken in the eastern North Atlantic between 1977 and 1979 by “pirate” whalers, *i.e*., whalers whose operations were not subject to IWC regulation (Best 1992).

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 (Gambell 1993; Caulfield 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 1998a). In the absence of scientific management advice, the IWC has continued to set a quota of 19 fin whales per year for Greenland (IWC 1998b). As stated above, 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), and at least two fin whales were killed in 2009.

G.9.2 North Pacific

Fin whales were hunted at shore-based stations in western North America from the early twentieth century. Minimum recorded catches were 3,000 at Akutan, Alaska, 1912–39, and 464 at Port Hobron, Alaska, 1926–37 (Reeves *et al.* 1985); well over 6,000 in British Columbia, early 1900s to 1967 (Pike and MacAskie 1969); 602 in Washington, 1911–25

(Scheffer and Slipp 1948); 177 and 1,060 in California, 1919–26 (Clapham *et al.* 1997) and 1956–70 (Rice 1974), respectively.

Japanese pelagic whaling for fin whales in the Bering Sea and around the Aleutian Islands began in 1954 and continued through 1975 (Ohsumi 1986). A reported total of approximately 46,000 fin whales were killed by commercial whalers in the North Pacific between 1947 and 1987, including the shore-based catches mentioned above as well as Japanese and Russian pelagic catches (Barlow *et al*. 1997). Yablokov's (1994) acknowledgment that the Soviet Union engaged in the illegal killing of protected whale species in the North Pacific, both from land stations and in pelagic operations, implies that reported catch data are incomplete. Soviet catch data from the North Pacific have yet to be revised and validated, but judging from the Southern Hemisphere example (see below), it seems certain that the officially reported data for the North Pacific will prove to be equally unreliable.

G.9.3 Southern Hemisphere

From 1904 to 1975, there were 703,693 fin whales taken in Antarctic whaling operations (IWC 1990). Whaling in the Southern Hemisphere originally targeted humpback whales, but by 1913, this target species became rare, and the catch of fin and blue whales began to increase (Mizroch *et al.* 1984b). From 1911 to 1924, there were 2,000–5,000 fin whales taken per year. After the introduction of factory whaling ships in 1925, the number of whales taken per year increased substantially. 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. The IWC prohibited the taking of fin whales from the Southern Hemisphere in 1976.

There is evidence of large-scale misreporting of whaling data from Soviet factory ships in the Southern Hemisphere (Yablokov 1994; Zemsky *et al.* 1995). Soviet authorities originally over-reported fin whale catches to camouflage illegal takes of protected species (right, pygmy blue, and humpback whales).

Fin whales are a target species for Japanese Antarctic Special Permit whaling for the 2005/2006 and 2006/2007 seasons at 10 fin whales/year. The proposal for the following 12 years includes 50 fin whales/year; despite this higher target, Japan took zero fin whales in the 2007/2008 season and one in the 2008/2009 season.

G.10 Competition for Resources – UNKNOWN

In a review of the evidence for interspecific competition in baleen whales, Clapham and Brownell (1996) found it to be extremely difficult to prove that inter-specific competition comprises an important factor in the population dynamics of large whales. 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.

The fin whale feeds on a fairly broad spectrum of prey, but fishery-caused reductions in prey resources (*e.g.,* herring and mackerel in the North Atlantic) could have an influence on fin whale abundance (Waring *et al.* 1997). 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. Furthermore, the disruption of large aggregations of prey into multiple smaller aggregations by fishing activity could enhance fin whale foraging success. 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. Other threats that could be confounded with fisheries are environmental variability and inter-specific competition. Research is needed to reduce these uncertainties. The severity of this threat was ranked as unknown and the uncertainty is high, thus the relative impact to recovery of fin whales due to this threat is ranked as unknown (Table 1).

G.11 Loss of Prey Base Due to Climate and Ecosystem Change – UNKNOWN BUT POTENTIALLY HIGH

Climate change has received considerable attention in recent years, with growing concerns about global warming and the recognition of natural climatic oscillations on varying time scales, such as long term shifts like the Pacific Decadal Oscillation or short term shifts, like El Niño or La Niña. Evidence suggests that the productivity in the North Pacific (Quinn and Neibauer 1995; Mackas *et al.* 1989) and other oceans could be affected by changes in the environment. Increases in global temperatures are expected to have profound impacts on arctic and sub-arctic ecosystems, and these impacts are projected to accelerate during this century (ACIA 2004; IPCC Climate Change 2007). The potential impacts of climate and oceanographic change on fin whales will likely affect habitat availability and food availability. Site selection for whale migration, feeding, and breeding for fin whales, may be influenced by factors such as ocean currents and water temperature. Any changes in these factors could render currently used habitat areas unsuitable. Changes to climate and oceanographic processes may also lead to decreased productivity in different patterns of prey distribution and availability. Such changes could affect fin whales that are dependent on those affected prey. Recent work has found that copepod distribution has showed signs of shifting in the North Atlantic due to climate changes (Hays *et al.* 2005).

The feeding range of fin whales is larger than that of other 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. The threat severity posed by environmental variability to fin whale recovery was ranked as medium due to the oceanographic and atmospheric conditions that have changed over the last several decades and the 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 (Table 1).

The following table provides a visual synopsis of the text regarding threats to fin whales, the sources of these threats, and populations that are affected (where information is available). For each threat, the table describes the severity, including the magnitude, scope and relative frequency with which the threat is expected to occur; the uncertainty of information or effects; and the relative impact to recovery, which is a combination of the severity and uncertainty of each threat. The rankings were developed relative to each other, and put into one of four categories: high, medium, low and unknown (further research is needed to determine whether it falls into high, medium, or low). Ranking assignments were determined by an expert panel with contributions from reviewers.

Table 1. Fin whale threats analysis table.

Reference	**Population**	**Threat**	**Source**	**Severity**	**Uncertainty**	**Relative Impact to Recovery**
				(Unknown, Unknown but Potentially High, Low, Med, High)		
G.1		Fishery Interactions				
G.1.1	Global	Injury or mortality from gillnet gear entanglement	Gillnet, Trawl, Pot/trap, Sink gillnet, and Purse Seine fisheries	Low	Medium	Low
G.1.2	U.S. North Atlantic	Injury or mortality from trap/pot gear entanglement	Northeast/Mid-Atlantic American lobster trap/pot fishery	Low	Low	Low
G.1.2	U.S. North Atlantic	Injury or mortality from sink gillnet entanglement	Northeast sink gillnet fishery	Low	Low	Low
G.1.2	U.S. North Atlantic	Injury or mortality from trap/pot gear entanglement	Atlantic mixed species trap/pot fishery	Low	Low	Low

Reference	Population	Threat	Source	Severity	Uncertainty	Relative Impact to Recovery
G.1.2	Nova Scotia	Injury or mortality from trap/pot gear entanglement	American lobster trap/pot fishery	Low	Low	Low
G.1.2	Nova Scotia	Injury or mortality from sink gillnet entanglement	Sink gillnet fishery	Low	Low	Low
G.1.2	Nova Scotia	Injury or mortality from trap/pot gear entanglement	Atlantic mixed species trap/pot fishery	Low	Low	Low
G.1.3	CA/OR/WA	Injury or mortality from drift gillnet entanglement	CA/OR drift gillnet (≥14 in. mesh)	Low	Low	Low
G.1.3	Northeast Pacific	Injury or mortality from trawl entanglement	AK Gulf of Alaska Pollock trawl	Low	Low	Low
G.1.3	Hawaiian	Injury or mortality from longline	Hawaii-based longline fishery	Low	Low	Low
G.1.3	Hawaiian	Injury or mortality from trap/pot gear entanglement	Hawaii-based trap/pot fishery	Low	Low	Low
G.1.4	Southern Hemisphere	Injury or mortality from trawl, or longline gear entanglement	Krill or Patagonia toothfish fishery	Low	Low	Low
G.2		Anthropogenic Noise	Several sources			
G.2.1	Global	Ship Noise	Ships	Unknown	High	Unknown

Reference	Population	Threat	Source	Severity	Uncertainty	Relative Impact to Recovery
G.2.2	Global	Oil and Gas Activities	Seismic surveys, noise from construction and operation of oil exploration work	Unknown	High	Unknown
G.2.3	Global	Coastal Development	Coastal development, LNG facilities	Low	Medium	Low
G.2.4	Global	Military Sonar and Explosives	Vessel interactions, ship shock trials, low and mid-frequency sonar	Unknown	High	Unknown
G.3		Vessel interactions				
G.3.1	Global	Ship strikes	Areas of high vessel traffic and/or high speed vessel traffic	Medium	High	Unknown but potentially high
G.3.2	Global	Disturbance from Whale Watching and Other Vessels	Whale watching and military vessels	Low	Medium	Low
G.4	Global	Contaminants and Pollutants	Organochlorines, organotins, heavy metals	Low	Medium	Low
G.5	Global	Disease	Parasites, other vectors	Low	Medium	Low

Reference	Population	Threat	Source	Severity	Uncertainty	Relative Impact to Recovery
G.6	Global	Injury from Marine Debris	Plastic garbage from land, lost/abandoned fishing gear, non-biodegradable garbage from ships	Low	Medium	Low
G.7	Global	Disturbance due to Research	Oceanographic surveys, and genetic, photographic and acoustic studies	Low	Medium	Low
G.8	Global	Predation and Natural Mortality	Killer whales, sharks	Low	Medium	Low
G.9	Global	Direct Harvest	Greenland (sanctioned) whaling, Japanese whaling in Antarctic, Icelandic whaling, possible pirate whaling	Medium	Medium	Medium
G.10	Global	Competition for Resources	Competition with human fisheries	Unknown	High	Unknown
G.11	Global	Loss of Prey Base due to Climate and Ecosystem Change or Shifts in habitat	Climate and Ecosystem Change	Medium	High	Unknown but potentially high

H. Conservation Measures

Under the 1946 International Convention for the Regulation of Whaling, a minimum size limit of 55 ft (16.8 m) was in effect for fin whales taken by commercial whaling in the North Pacific, and two fin whales were calculated as equivalent to one "blue whale unit" under the initial production quota scheme (Allen 1980). The IWC did not begin managing commercial whaling for fin whales on a species basis until 1969 in the North Pacific (Allen 1980) and 1976 in the North Atlantic (Sigurjønsson 1988).

The fin whale was given protection from commercial whaling by the IWC in the Antarctic beginning in the 1976/77 whaling season, the North Pacific in the 1976 season, and the North Atlantic in the 1987 season. Since 1987, the only area in the Northern Hemisphere where fin whales have been hunted legally is Greenland. There, a take of about 19 fin whales per year has been authorized under the IWC's aboriginal subsistence whaling scheme (Gambell 1993; Caulfield 1993). Iceland does not adhere to the IWC moratorium and resumed commercial whaling of fin whales in 2006.

The fin whale is protected in the U.S. under both the ESA (listed as endangered) and the MMPA. It is listed as endangered by the World Conservation Union (known as the IUCN) (Baillie and Groombridge 1996) and is listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (known as CITES). The CITES classification is intended to ensure that no commercial trade in the products of fin whales occurs across international borders.

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II. RECOVERY STRATEGY

The primary purpose of this Recovery Plan is to identify actions that will minimize or eliminate effects of human activities that are detrimental to the recovery of fin whale populations. Immediate objectives are to identify factors that may be limiting abundance/recovery/productivity, and cite actions necessary to allow the populations to increase. The main threats to fin whale populations include collisions with vessels, direct harvest, and possibly competition for resources, loss of prey base due to climate change, and disturbance from anthropogenic noise. Other potential (but likely low impact) threats include entanglement in fishing gear, disturbance from vessels and tourism, contaminants and pollutants, disease, injury from marine debris, disturbance due to research, and predation and natural mortality (see Table 1).

The original direct threat to fin whales was addressed by the IWC's whaling moratorium, and an important element in the strategy to protect fin whale populations is to continue the effective international regulation of whaling.

Another important component of this recovery program is to determine population structure of the species and population discreteness. This would be a first step in estimating population size, monitoring trends in abundance, and enabling an assessment of the species throughout its range.

Because fin whales move freely across international borders, it would be unreasonable to confine recovery efforts to U.S. waters, and this plan stresses the importance of a multinational approach to management. This Recovery Plan recognizes the limits imposed by the national nature of protective legislation. As demonstrated by recent work on humpback whales, SPLASH (Calambokidis *et al.* 2008) and the Year of the North Atlantic Humpback (YONAH), involving a number of researchers from different countries (Palsbøll *et al.* 1997; Smith *et al.* 1999), considerably more information is gathered for management of whale populations when research is conducted on the basis of biological, rather than political, divisions and through multilateral cooperation. Ideally, both research and conservation should be undertaken at oceanic rather than national levels.

Although not an explicit goal, this Recovery Plan is also expected to help achieve the MMPA's purpose of maintaining marine mammal populations at optimum sustainable levels.

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III. RECOVERY GOALS, OBJECTIVES, AND CRITERIA

A. Goals

The goal of this Recovery Plan is to promote recovery of fin whales to levels at which it becomes appropriate to "downlist" them from endangered to threatened status, and ultimately to "de-list", or remove them from the list of Endangered and Threatened Wildlife and Plants, under the provisions of the ESA. The Act defines an "endangered species" as "any species which is in danger of extinction throughout all or a significant portion of its range." A "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."

B. Objectives and Criteria

The two main objectives for fin whales are to 1) achieve sufficient and viable populations in all ocean basins, and 2) ensure significant threats are addressed. Likewise, recovery criteria take two forms: 1) those that reflect the status of the species itself and 2) those that indicate effective management or elimination of threats. The former criterion may explicitly state a certain risk of extinction as a threshold for downlisting or delisting and uses models based on at least abundance and trends in abundance to assess whether this threshold has been reached. Since fin whales are currently globally listed, all ocean basins where fin whales occur would need to meet these criteria.

Guidance on appropriate levels of risk for down-listing and de-listing decisions was developed in a workshop for large cetaceans (Angliss *et al.* 2002). This guidance was employed in the North Atlantic Right Whale Recovery Plan criteria (NMFS 2005) and is also appropriate here. The following framework was suggested:

- A large cetacean species shall no longer be considered endangered when, given current and projected conditions, the probability of quasi-extinction is less than 1% in 100 years;
- A large cetacean species shall no longer be considered threatened when, given current and projected conditions, the probability of becoming endangered is less than 10% in a period of time no shorter than 10 years and no longer than 25 years (in the case of the fin whale the period of 25 years is considered necessary given imprecise abundance estimates); and
- Recurrence of threats that brought the species to the point that warranted listing and current threats to the species have been addressed.

B.1 Downlisting Objectives and Criteria

Objective 1: Achieve sufficient and viable population in all ocean basins

Criterion: 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 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.

Objective 2: Ensure significant threats are addressed

Criteria: Factors that may limit population growth, *i.e.*, those that are identified in the threats analysis under relative impact to recovery as high or medium or unknown, 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.
- Effects of reduced prey abundance due to climate change continue to be investigated and action is being taken to address the issue, as necessary.
- Effects of anthropogenic noise continue to be investigated and actions taken to minimize potential effects, as necessary.

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.

Factor C: Disease or Predation.

There are no criteria for this factor because there are no data to indicate that disease or predation are threats.

Factor D: The inadequacy of existing regulatory mechanisms.

- Ship collisions continue to be investigated and actions taken to minimize potential effects, as necessary.

Direct harvest addressed under Factor B.

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

No other factors are known to be limiting threats.

B.2 Delisting Objectives and Criteria

Objective 1: Achieve sufficient and viable population in all ocean basins

Criterion: 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 Southern Hemisphere) satisfies the risk analysis standard for unlisted status (has less than a 10% probability of becoming endangered (has more than a 1% chance of extinction in 100 years) in 20 years). 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 delisting takes place.

Objective 2: Ensure significant threats are addressed

Criteria: Factors that may limit population growth (those that are identified in the threats analysis as high or medium or unknown) 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 continues to be addressed through fishery management plans and other measures or is no longer believed to be a threat.
- Effects of reduced prey abundance due to climate change have continued to be investigated and any necessary actions being taken to address the issue are shown to be effective or this is no longer believed to be a threat.
- Effects of anthropogenic noise have continued to be investigated and any necessary actions being taken to address the issue are shown to be effective or this is no longer believed to be a threat.

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.

Factor C: Disease or Predation.

There are no criteria for this factor because there are no data to indicate that disease or predation are threats.

Factor D: The inadequacy of existing regulatory mechanisms.

- Ship collisions have been investigated and actions being taken to address the issue are shown to be effective or this is no longer believed to be a threat.

Direct harvest is identified as a medium threat in the threats analysis and is addressed under Factor B.

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

No other factors are known to be threats.

IV. RECOVERY PROGRAM

A. Recovery Action Outline

Items in this outline are not in order of priority. Priorities are identified in the Implementation Schedule below.

1.0 Coordinate State, Federal, and International Actions to Implement Recovery Actions and Maintain International Regulation of Whaling for Fin Whales.

2.0 Determine Population Discreteness and Population Structure of Fin Whales.

2.1 *Support existing studies and initiate new studies to investigate population discreteness and population structure of fin whales using genetic analyses.*

2.2 *Assess daily and seasonal movements and inter-area exchange, using telemetry and photo-identification.*

3.0 Develop and Apply Methods to Estimate Population Size and Monitor Trends in Abundance.

3.1 *Determine the best methods for assessing fin whale status and trends.*

3.2 *Conduct surveys to estimate abundance and monitor trends in fin whale populations worldwide.*

3.3 *Develop an intensive and geographically broad scale program to obtain biopsies of fin whales for mark-recapture abundance estimation.*

3.4 *Maintain existing fin whale photo-identification catalogs.*

4.0 Conduct Risk Analyses.

4.1 *Conduct risk analyses for North Atlantic and North Pacific Oceans.*

4.2 *Conduct risk analyses for the Southern Hemisphere.*

5.0 Identify, Characterize, Protect, and Monitor Habitat Important to Fin Whale Populations in U.S. Waters and Elsewhere.

5.1 *Characterize Fin Whale Habitat.*

5.2 *Monitor important habitat features and fin whale use patterns to assess potentially detrimental shifts in these features that might reflect disturbance or degradation of habitat.*

5.3 *Promote actions to protect important habitat in U.S. waters.*

5.4 *Promote actions to define, identify, and protect important habitat in foreign or international waters.*

5.5 *Improve knowledge of fin whale feeding ecology.*

5.6 *Conduct research and perform analyses to understand the impacts of climate change on fin whales and seek strategies to reduce these impacts.*

6.0 Investigate Causes and Reduce the Frequency and Severity of Human-caused Injury and Mortality.

6.1 *Identify areas where concentrations of fin whales coincide with significant levels of maritime traffic, fishing, or pollution (including marine debris).*

6.2 *Reduce injury and mortality caused by fisheries and fishing equipment.*

6.2.1 Conduct a systematic review of data on fin whale interactions with fishing operations.

6.2.2 Review existing photographic databases for evidence of injuries to fin whales caused by encounters with fishing gear to better characterize and understand fishing gear interactions.

6.2.3 Investigate the development of a deterrence system to non-lethally deter fin whales from fishing gear.

6.2.4 Conduct studies of gear modifications that reduce the likelihood of entanglement, mitigate the effects of entanglements, and enhance the possibility of disentanglement. Determine whether measures to reduce entanglements are effective.

6.2.5 Develop and implement schemes to reduce the rate at which gear is lost, and improve the reporting of lost gear, in conjunction with studies in 6.2.3, 6.2.4, and 6.2.6.

6.2.6 Continue to review, evaluate, and act upon reports from fisherman and fishery observers of fishery interactions with fin whales.

6.3 *Investigate and reduce mortality and serious injury from vessel collisions.*

6.3.1 Identify specific areas where recorded ship strikes of fin whales have occurred and conduct studies to identify ecosystem-based traits that could support an assemblage of predictive tools.

6.3.2 Once areas in 5.0 and 6.1 are identified, and in conjunction with information derived and resulting predictive tools from 6.3.1, conduct analyses of shipping routes and important fin whale habitat areas, to determine the risk of ship collisions with fin whales.

6.3.3 Develop a system to encourage, collect, and appropriately analyze opportunistic sightings of fin whales from fishing vessels, whale watching vessels, charter vessels, etc.

6.3.4 Work with mariners, the shipping industry, and appropriate State, Federal, and International agencies to develop and implement regionally-based measures to reduce the threat of ship strikes. Assess the effectiveness of ship strike measures and adjust, as necessary.

6.3.5 Explore possible mechanisms to encourage vessels that have struck a whale to report the incident.

6.3.6 Review existing photographic databases for evidence of injuries to fin whales caused by ships to better characterize and understand vessel collisions.

6.4 *Conduct studies of environmental pollution that may affect fin whale populations and their prey.*

6.4.1 Conduct studies on individual health and body condition as they may be related to accumulated contaminants.

6.4.2 Take steps to minimize adverse effects from pollutants, if necessary.

7.0 Determine and Minimize Any Detrimental Effects of Anthropogenic Noise in the Oceans.

7.1 *Conduct studies to assess the effects of anthropogenic noise on the distribution, behavior, and productivity of fin whales.*

7.2 *Take steps to minimize anthropogenic noises that are found to be potentially detrimental to fin whales.*

8.0 Maximize Efforts to Acquire Scientific Information from Dead, Stranded, and Entangled or Entrapped Fin Whales.

8.1 *Respond effectively to strandings of fin whales in U.S. waters.*

8.1.1 Continue and improve program to maximize data collected from necropsy of fin whale carcasses.

8.1.2 Maintain and review, and if needed improve, the system for reporting dead, entangled, or entrapped fin whales.

8.1.3 Improve, or as necessary, develop and implement protocols for securing and retrieving stranded (on land) or floating (at sea) fin whale carcasses.

8.2 *Review, analyze, and summarize data on stranded fin whales on an annual basis.*

8.3 *Develop protocols for handling live-stranded fin whales.*

8.4 *Establish reliable sources of funding for rescue, necropsy, and tissue collection and analysis efforts.*

9.0 Develop Post-Delisting Monitoring Plan.

B. Recovery Action Narrative

1.0 Coordinate State, Federal, and International Actions to Implement Recovery Actions and Maintain International Regulation of Whaling for Fin Whales.

A coordinated approach to the tasks described in this Recovery Plan would greatly facilitate their completion. The establishment of a team charged with coordinating state and federal implementation efforts, and with pursuing international cooperative efforts, is highly desirable. Liaison efforts between the team and the lead agency would be the responsibility of the designated individual from the latter body.

Cooperate with the IWC (and other relevant international bodies or agreements) to ensure that any resumption of commercial whaling on fin whales is prosecuted on a sustainable basis and that all whaling activity is conducted within the purview of the IWC (*i.e.*, there is no “pirate” whaling).

The international regulation of whaling is vital to the recovery of whale populations. This is particularly true for fin whales because of their wide distribution, far-ranging movements, and high commercial value. The IWC’s Revised Management Procedure was developed for use with baleen whale populations. With the possible exception of the central and eastern North Atlantic, there is no area in the Northern Hemisphere where enough is known about the recent and current status of fin whale populations to justify the resumption of exploitation. Even in the case of the central and eastern North Atlantic, great uncertainty remains about population structure, particularly when compared with the whales occurring seasonally off eastern North America, Greenland, and Iceland. The possibility that fin whales found around Greenland, Iceland, and the Faroe Islands, belong to the same populations as those found off the eastern United States and Canada, cannot be ruled out. Thus, any whaling in the central or eastern North Atlantic, could directly affect recovery of the populations in the western North Atlantic.

2.0 Determine Population Discreteness and Population Structure of Fin Whales.

Existing knowledge of the population structure of fin whales is insufficient, and a more comprehensive understanding is essential for developing strategies to promote recovery and for classifying the populations according to their recovery status. Fin whales were listed as endangered under predecessor legislation to the ESA of 1973. In 1996, the Policy Regarding the Recognition of Distinct Vertebrate Population Segments (DPS) (61 FR 4722), stated that "Any DPS of a vertebrate taxon that was listed prior to implementation of the DPS policy will be reevaluated on a case-by-case basis as recommendations are made to change the listing status for that distinct population segment." Given that there are two named, and possibly three recognized subspecies of fin whales, it is almost certain that the global listing inadequately captures the current population structure.

To the maximum extent possible, data should be collected in such a way that comparisons with historical data are practicable. It may be necessary to develop calibration methods so that results of studies using new or recent techniques can be compared with those obtained using more traditional methods. Analyses should be directed at examining trends over time, and attempts should be made to correlate observed changes in whale populations with physical, biological, or human-induced changes in the environment. As much as possible, data should be presented in peer-reviewed journals and other open publications to ensure that research programs benefit from regular peer scrutiny. Models of fin whale movement (2.2 below) are necessary to understand population structure determined genetically (2.1 below) and to manage the effects of human activities on this species. NMFS proposes two interrelated research initiatives to assess population structure described in detail below: the first, 2.1, uses genetic analysis to determine population structure and discreteness and the second, 2.2, uses telemetry and photo-identification to assess movement.

2.1 *Support existing studies and initiate new studies to investigate population discreteness and population structure of fin whales using genetic analyses.*

This is among the highest priority actions in this plan because it would improve understanding and management of the species; however, it cannot be given a

Priority 1 ranking as we do not believe we can make the case that it would prevent extinction.

Although fin whales are regularly observed on the continental shelf in U.S. waters, important questions concerning population discreteness and structure can only be addressed by reference to materials that include samples obtained in areas outside U.S. coastal waters. Researchers equipped to sample other whale species (*e.g.*, right and humpback whales) within U.S. waters, particularly in more remote areas where fin whale samples have not previously been obtained (*e.g.*, Oregon, Washington, and Alaska in the Pacific), should be encouraged to take advantage of opportunities to obtain samples from fin whales, on an opportunistic basis. Collaborative efforts with foreign (particularly Canadian, Mexican, Greenlandic, and Icelandic) agencies and researchers will probably be necessary to obtain sufficient samples over wide enough areas for conclusive analyses. Standard sampling protocols and analytical procedures should be used. All biopsy samples should be preserved in such a way that the accompanying blubber can be used for contaminant analyses (item 5.3, below). The genetics work should be complemented by a thorough review of existing data from whaling and other sources. This might include investigation of geographical variation in morphology and meristics of fin whales. New methods examining stable isotopes and fatty acids have also proven effective auxiliary data in cases where there is population mixing (*i.e.*, genetically distinct groupings mix spatially usually on the feeding grounds.) Any such methods that can assist in resolving population structure should be encouraged. See Action 3.2 for a discussion of cost estimates.

2.2 *Assess daily and seasonal movements and inter-area exchange using telemetry and photo-identification.*

Telemetry studies using satellite-linked and VHP radio tags are needed to investigate patterns and ranges of daily, seasonal, and longer-term movements of individual fin whales. Exchange rates between populations might also be addressed to some degree by telemetry studies. Long-term efforts at photo-identification should also be encouraged to continue. It may not be realistic to use photo-identification of fin whales in U.S. waters for mark-recapture population estimation, or even for detailed investigations of social organization and behavior. However, opportunistic efforts to photo-document sightings could contribute to knowledge of individual animal movements and residency times. A central repository for fin whale photographs, and a system for curating and analyzing them, should be established. Photographs should be supplemented whenever possible by tissue samples (whether sloughed skin or biopsies), for DNA fingerprinting (Amos and Hoelzel 1990).

3.0 Develop and Apply Methods to Estimate Population Size and Monitor Trends in Abundance.

Along with determining population structure, this is among the highest priority actions in this plan. Recovery of fin whale populations can only be assessed if reliable estimates of abundance are available, and if trends in abundance can be determined. Although abundance estimates are available for the species in portions of their range along both the Atlantic and Pacific coasts, these estimates are generally imprecise and refer to geographic areas rather than to well-founded population units (*i.e.,* populations or stocks).

3.1 *Determine the best methods for assessing fin whale status and trends.*

Considerable effort has been made to gather information on fin whales in the North Atlantic and North Pacific, but very little in the Southern Hemisphere. An assessment of the level and distribution of survey efforts required to achieve optimal assessment results for the three ocean basins is essential to ensure that the entire population of fin whales is surveyed and that field work is as efficient and cost-effective as possible. This may be achieved through a workshop or other means.

3.2 *Conduct surveys to estimate abundance and monitor trends in fin whale populations worldwide.*

Systematic surveys should be conducted to assess abundance in areas known, primarily from historic whaling data and large-scale sighting surveys, to have been inhabited regularly by fin whales in the past. The timing of such surveys would be critically important in view of these whales' migratory behavior. For meaningful estimates, it will be necessary for U.S. scientists to promote and participate in cooperative surveys with scientists from other countries. Findings from population structure studies identified in item 2.0, above, will be useful in interpreting survey results. Because of the relatively long generation times of fin whales and the time scales on which environmental factors affecting their distribution may operate, programs to monitor trends in their populations must involve long-term commitments and extended periods of ship-based surveys on large research vessels. A primary goal should be to foster an international collaboration and cooperation in the study and protection of the worldwide population of fin whales. Potential cost savings include combining this objective with other large ship-based research projects in the same area and other objectives listed in this Recovery Plan.[4]

[4] The daily cost of an ocean class University-National Oceanographic Laboratory System (UNOLS) ship was estimated to be about $35K per day. This estimate does not account for inflation factors such as fuel costs. It was also assumed that the cost of the ship would mainly be split between Actions 2.1, 3.2, and 5.1. These actions were assumed to be split in the following proportions for ship time: Action 3.2 at 80%, Action 5.1 at 15%, and Action 2.1 totaling 5%. The task duration was rounded up to the nearest 6 or 12 month period for ease of estimating costs. Action 3.2 represents the total cost for the ship time. Other actions items where ship time may be necessary are also included in the total cost, but determining what proportion of ship time would

3.3 *Develop an intensive and geographically broad scale program to obtain biopsies of fin whales for mark-recapture abundance estimation.*

The feasibility of using a genotype-based mark-recapture study to estimate abundance was demonstrated for North Atlantic humpbacks by Palsbøll *et al.* (1997). This approach uses microsatellite DNA to identify individuals unequivocally, without any of the challenges associated with obtaining photos for photo-identification studies. Microsatellite primers have already been developed for fin whales (Bérubé *et al.* 1998); however, fin whales are more difficult to biopsy than humpback whales. Given the likely large sizes of the fin whale populations involved, a great amount of effort will be required to sample a sufficient number of individuals to generate reasonably precise abundance estimates. In addition, the feasibility of large-scale programs should be investigated, particularly in areas where high recapture rates are anticipated and acceptable levels of precision are possible.

3.4 *Maintain existing fin whale photo-identification catalogs.*

The existing photo-identification catalogs for fin whales in (*e.g.*, Agler 1992; Agler *et al.* 1990) should be maintained. The scientific importance of such catalogs has been demonstrated with numerous species, and the possibilities for obtaining insights relevant to effectively managing the species will increase as more information is obtained.

It should be noted, however, that mark-recapture models for abundance estimation, using photo-identification as the marking and recapture method, will be more difficult to apply to fin whales than to humpback whales. There are two main reasons: (a) variation in natural markings in fin whales is not nearly as great (or as obvious) as in some other species (*e.g.*, humpback, right, and blue whales), and matching is therefore difficult and sometimes equivocal; and (b) many researchers who have worked with fin whales believe that the population contains significant numbers of unmarked animals, *i.e.*, whales that have so few markings that they are effectively unrecognizable from one encounter to the next (P.J. Clapham, pers. comm. 2006). From the standpoint of mark-recapture statistics, this creates the problem of potential false positives (two individuals wrongly identified as one animal), which is a much more serious source of bias than false negatives (an individual observed repeatedly but not matched) (Gunnlaugsson and Sigurjønsson 1990).

be used was less than what is reported here for action items 2.1, 3.2, and 5.1 and thus, those specific actions are not discussed in detail.

4.0 Conduct Risk Analyses.

Risk analyses incorporate known and projected risks into a population projection. Given the large uncertainties in abundance and population growth rate, such uncertainties should also be directly incorporated into population projections. The output will be the probability of extinction over time for use in the down- and delisting criteria. A workshop may be needed to address how to treat uncertainty in population structure in risk assessment.

4.1 *Conduct risk analyses for North Atlantic and North Pacific.*

Analyses will be based on time series of abundance estimates including uncertainty for a significant portion of each ocean basin and including known population structure. Some of the needed data gathering has been done for the comprehensive assessment of North Atlantic fin whales. The North Pacific requires more comprehensive abundance estimates (current estimates are for only portions of the range, such as the area off California/Oregon/Washington) and improved understanding of population structure (such as the connection between feeding aggregations in Alaska and other areas). Such an analysis could take place following this research as early as 2013.

4.2 *Conduct risk analyses for Southern Hemisphere.*

Analysis of risks in the Southern Hemisphere are anticipated to take much longer because of much greater uncertainties within this large region (including whether there are multiple subspecies present) and the potential of no abundance estimates for some areas and consequently great uncertainty about trends. Data gathering and analyses that are prerequisites to risk analysis make this effort impossible before 2020.

5.0 Identify, Characterize, Protect, and Monitor Habitat Important to Fin Whale Populations in U.S. Waters and Elsewhere.

Identifying important habitat and reducing direct and indirect threats to fin whale habitat is integral to recovery. Important habitat may or may not qualify as critical habitat under the ESA. Information is needed on environmental factors that influence fin whale distribution. In addition, adequate protective measures are needed to reduce or eliminate human-related impacts to fin whale habitat.

5.1 *Characterize Fin Whale Habitat.*

This is among the highest priority actions in this plan because it would improve understanding and management of the species; however, it cannot be given a Priority 1 ranking as we do not believe we can make the case that it would prevent extinction.

Areas where fin whales are consistently seen and heard are assumed to be important to their survival. Areas used infrequently or for short periods may also be linked to population fitness. Compile or collect relevant physical, chemical, biological, meteorological, fishery, and other data to characterize features of important habitats and potential sources of human-caused destruction and degradation of what are determined to be important areas for fin whales. Habitat characterization also involves, among other things, descriptions of prey types, densities, and abundances, and of associated oceanographic and hydrographic features. Inter-annual variability in habitat characteristics, and in fin whale habitat use, is an important component of habitat characterization. More research is needed to define rigorously and specifically, the environmental features that make an area important to fin whales. A predictive framework for identifying potentially important fin whale habitat would be a useful management tool. Some areas are known to be important habitat while others may be discovered during survey work discussed in sections 2.0 and 3.0, above. Only with information on the ecological needs of the species will managers be able to provide necessary protections.

5.2 *Monitor important habitat features and fin whale use patterns to assess potentially detrimental shifts in these features that might reflect disturbance or degradation of habitat.*

After baseline data are obtained and analyzed, ongoing studies should be done to determine if shifts are occurring in essential habitat components. Fin whale habitat should be assessed periodically through surveys and GIS analysis. Shifts in distribution or habitat use should be analyzed as potentially resulting from anthropogenic sources of habitat degradation or disturbance. If shifts are detected and are linked to human activities, actions may be taken to modify the activity to reduce or eliminate the cause.

5.3 *Promote actions to protect important habitat in U.S. waters.*

Support efforts to collect and compile data on habitat use patterns for the fin whale population in U.S. waters. Once 5.1 and 5.2 are determined, mitigate for those actions. Validate those areas where fin whales are thought to occur and determine if those areas are important areas warranting habitat protection.

5.4 *Promote actions to define, identify, and protect important habitat in foreign or international waters.*

Fin whale range is transboundary. Collaborative efforts should be made with foreign governments to protect fin whale habitat within their EEZ’s, and to join multi-national efforts on behalf of marine habitat protection. International efforts to collect and compile data on habitat use patterns for the fin whale population should be supported. Actions that have impacts on fin whales should be mitigated, and the U.S. should support and endorse such efforts. Validation of those areas where fin whales are thought to occur and protection of those areas that are determined as important areas warranting habitat protection should be supported. Due to the very wide-ranging movements of individual fin whales (demonstrated by tag returns) and the species' extensive distribution in both the North Pacific and North Atlantic, international initiatives to reduce pollution (see 6.4) and protect resources (such as 5.5) on the high seas may be key to the long-term conservation of fin whale populations.

5.5 *Improve knowledge of fin whale feeding ecology.*

Studies designed to improve knowledge of fin whale prey preferences, dietary requirements, and energetics will be important to understanding habitat use, impacts of fishery practices on whale populations (*e.g.,* food-web effects of factory-ship trawling for herring), and recovery potential. Consumption of finfish by fin whales suggests that they could interact in important ways with commercial fisheries in many areas, in addition to being affected by shifts in prey abundance and distribution, caused by climatic fluctuations.

5.6 *Conduct research and perform analyses to understand the impacts of climate change on fin whales and seek strategies to reduce these impacts.*

In addition to the information collected in 5.1, 5.2, and 5.5, improved knowledge of the effects of climate change on fin whale feeding ecology and habitat use would be informative for evaluating or predicting shifts in prey abundance or distribution caused by climatic fluctuations. Investigating the degree of overlap between distributions of different species, the environmental factors influencing their distributions, and the effect of spatial scale on the significance of different environmental predictors should be supported to improve knowledge on the potential effects of climate change on fin whales. Although the natural absorption of carbon dioxide (CO_2) by the world's oceans helps mitigate the climatic effects of anthropogenic emissions of CO_2, it is believed that the resulting decrease in pH will have negative consequences. While the full ecological consequences of these changes are not known, organisms, such as fin whales, may suffer adverse effects, either directly as reproductive or physiological effects or indirectly through negative impacts on their food resources. Strategies developed through international efforts to mitigate and minimize the effects of climate change should be followed for the benefit of fin whales as well as other ecosystem components.

6.0 Investigate Causes and Reduce the Frequency and Severity of Human-caused Injury and Mortality of Fin Whales.

Known or suspected causes of anthropogenic mortality in fin whales include vessel strikes and entanglement in fishing gear or marine debris. Studies of the circumstances leading to collisions with ships and fishing gear are required before measures can be developed and implemented to reduce the frequency of these harmful interactions.

6.1. *Identify areas where concentrations of fin whales coincide with significant levels of maritime traffic, fishing, or pollution (including marine debris).*

In an effort to reduce human-caused injury and mortality of fin whales, identification of the coincidence between fin whales and human activities identified below is necessary.

6.2. *Reduce injury and mortality caused by fisheries and fishing equipment.*

6.2.1 Conduct a systematic review of data on fin whale interactions with fishing operations.

From such a review, it should be possible to make a preliminary evaluation of what types of fisheries and fishing gear pose the greatest risk to fin whales. Data from areas outside U.S. waters could be useful for strengthening inferences and extrapolations.

6.2.2 Review existing photographic databases for evidence of injuries to fin whales caused by encounters with fishing gear to better characterize and understand fishing gear interactions.

Existing databases, especially those with extensive photographic records of fin whale observations, should be searched for evidence of encounters with fishing gear. Studies to quantify the volume and type of ship traffic, fisheries, and pollution in areas known to be important to fin whales would provide a useful perspective on the potential seriousness of these threats. Although it may prove impossible to derive quantitative measures of injury or mortality rates, such a review might at least help to identify areas where the risk is especially high, and the types fishing gear that are particularly troublesome.

6.2.3 Investigate the development of a deterrence system to non-lethally deter fin whales from fishing gear.

6.2.4 Conduct studies of gear modifications that reduce the likelihood of entanglement, mitigate the effects of entanglements, and enhance the possibility of disentanglement. Determine whether measures to reduce entanglements are effective.

Current and ongoing research on possible modifications to fishing gear that facilitate an entangled whale to free itself once entangled should be continued. These studies might include assessing the potential use of biodegradable lines, study ways to reduce the number and length of vertical lines in the water column, design breakaway lines for heavy gear, and research acoustic deterrents.

6.2.5 Develop and implement schemes to reduce the rate at which fishing gear is lost, and improve the reporting of lost gear, in conjunction with studies in 6.2.3, 6.2.4, and 6.2.6.

6.2.6 Continue to review, evaluate, and act upon reports from fisherman and fishery observers of fishery interactions with fin whales.

6.3 *Investigate and reduce mortality and serious injury from vessel collisions.*

6.3.1 Identify specific areas where recorded ship strikes of fin whales have occurred and conduct studies to identify ecosystem-based traits that could support an assemblage of predictive tools.

The above would assist in the determination of when fin whales may be present, why fin whales are present in the area at that time, and whether the presence of ships alter the ecosystem in such a way that fin whales become more susceptible to a strike.

6.3.2 Once areas in 5.0 and 6.1 are identified, and in conjunction with information derived and resulting predictive tools from 6.3.1, conduct analyses of shipping routes and important fin whale habitat areas, to determine the risk of ship collisions with fin whales.

6.3.3 Develop a system to encourage, collect, and appropriately analyze opportunistic sightings of fin whales from fishing vessels, whale watching vessels, charter vessels, etc.

6.3.4 Work with mariners, the shipping industry, and appropriate State, Federal, and International agencies to develop and implement regionally-based measures to reduce the threat of ship strikes. Assess the effectiveness of ship strike measures and adjust, as necessary.

The practicality and effectiveness of options to reduce ship strikes should be assessed. Methods and measures developed for other endangered whales (*e.g.*, right whales) should be considered for their possible application to fin whales.

6.3.5 Explore possible mechanisms to encourage vessels that have struck a whale to report the incident.

6.3.6 Review existing photographic databases for evidence of injuries to fin whales caused by ships to better characterize and understand vessel collisions.

Existing databases, especially those with extensive photographic records of fin whale observations, should be searched for evidence of ship strikes.

Studies to quantify the volume and type of ship traffic, fisheries, and pollution in areas known to be important to fin whales would provide a useful perspective on the potential seriousness of these threats. Although it may prove impossible to derive quantitative measures of injury or mortality rates, such a review might at least help to identify areas where the risk is especially high, and the types of vessel traffic that are particularly troublesome.

6.4 *Conduct studies of environmental pollution that may affect fin whale populations and their prey.*

In general, baleen whales have lower contaminant levels in their tissues than toothed whales. Research is needed on the long-term and trans-generational effects of various contaminants on the whales and on their prey. The inconclusive nature of studies related to contaminants in fin (and other baleen) whales makes it difficult to develop (and justify) measures to reduce their risks of exposure. Research should be extended to include studies of metabolic pathways and the influence on contaminant burdens of sex, reproductive condition, and geographic origin.

6.4.1 Conduct studies on individual health and body condition as they may be related to accumulated contaminants.

Biopsy samples collected under item 2.1 (above) will be usable for some of this work. Related studies of pollution sources and transport processes are necessary to provide the basis for management measures.

6.4.2 Take steps to minimize adverse effects from pollutants, if necessary.

If studies indicate that contaminants in the marine environment are adversely affecting fin whales, steps should be taken to reduce the sources of such contaminants.

7.0 Determine and Minimize Any Detrimental Effects of Anthropogenic Noise in the Oceans.

Fin whales are among the cetaceans likely to be sensitive to disturbance by loud or unfamiliar noise. Their deep-ocean distribution and far-ranging movements put them in potential conflict with a wide array of human activities, including mineral exploration and exploitation (*e.g.*, seismic surveys), military maneuvers, and research using acoustic methods. It is therefore important to understand and mitigate the effects of anthropogenic noise on these animals.

7.1 *Conduct studies to assess the effects of anthropogenic noise on the distribution, behavior, and productivity of fin whales.*

As discussed in section G.2, very little research has addressed questions about the effects of noise on fin whales, and there has been very little conclusive evidence in regard to the biological significance of observed effects. Studies are needed to assess potential adverse effects of underwater noise (including ship noise) on fin whales, including, but not limited to, disturbance of intraspecific communication, disruption of vital functions mediated by sound, distributional shifts, and stress from chronic or frequent exposure to loud sound. Noise sources studied should include, but not be limited to, industrial and shipping activities, oceanographic experiments, military related activities, and other human activities.

7.2 *Take steps to minimize anthropogenic noises that are found to be potentially detrimental to fin whales.*

If studies of the kind mentioned in item 7.1 indicate that particular types of underwater noise have adverse effects on fin whales (either by masking their sounds or by damaging their auditory organ systems), or add physiological stress to their lives, implement appropriate regulatory measures on sources of the threat. It is important that the effects of underwater noise on baleen whales become better understood.

8.0 Maximize Efforts to Acquire Scientific Information from Dead, Stranded, and Entangled or Entrapped Fin Whales.

Assessment of the causes and frequency of mortality (either natural or human-caused) is important to understanding population dynamics and the threats that may impede the recovery of fin whale populations. However, discovery of a carcass under circumstances allowing it to be examined in a timely and rigorous manner is a relatively rare event. Accordingly, efforts to detect and investigate fin whale deaths should be as efficient as possible.

8.1 *Respond effectively to strandings of fin whales in U.S. waters.*

8.1.1 Continue and improve program to maximize data collected from necropsy of fin whale carcasses.

Each fin whale carcass represents an opportunity for scientific investigation of the cause of death, as well as addressing other questions related to the biology of the species. Delays in attempts to secure or examine a carcass can result in the loss of valuable data, or even of the carcass itself. The Stranding Network coordinator should work with appropriate agencies, organizations, and individuals to ensure that, when a fin whale carcass is reported and secured: (i) a necropsy is performed as rapidly and as thoroughly as possible by qualified individuals to gather information regarding the cause of death; (ii) samples are taken and properly preserved for studies of genetics, toxicology, and pathology; and (iii) funding is available to notify and transport appropriate experts to the site rapidly and to distribute tissue samples to appropriate locations for analysis or storage. In addition, the coordinator should work with stranding networks and the scientific community, to develop and maintain lists of tissue samples requested by qualified individuals and agencies, and ensure that these samples are collected routinely from each carcass and stored in appropriate locations or distributed to appropriate researchers.

8.1.2 Maintain and review, and if needed improve, the system for reporting dead, entangled, or entrapped fin whales.

8.1.3 Improve, or as necessary, develop and implement protocols for securing and retrieving stranded (on land) or floating (at sea) fin whale carcasses.

The detection and reporting of dead fin whales, whether stranded or floating at sea, need to be encouraged. The Large Whale Recovery Program coordinator and the National Marine Mammal Stranding Network coordinator, should continue working with representatives of local, state, and federal agencies, private organizations, academic institutions, and regional and national stranding networks, to facilitate efficient observer coverage and information exchange. In areas where protocols do not exist, they should be developed. The responsibilities of all relevant agencies, organizations, and individuals should be clearly defined.

Fin whales may die at sea, but not be detected or reported. Mariners, including Navy and Coast Guard personnel, commercial and recreational boaters, and fishermen might observe carcasses at sea, but not recognize the importance of their observation. Mariners should be educated about the importance of reporting carcasses so that as much information as possible can be collected from them.

8.2 *Review, analyze, and summarize data on stranded fin whales on an annual basis.*

Current and complete data on stranding events and the data derived from them is essential to developing protective measures. Summaries should include, but not be limited to, assessments of the cause of death and, where applicable, the types of fishing gear, if fishing operations resulted in the death of the animal.

8.3 *Develop protocols for handling live-stranded fin whales.*

Disentanglement readiness, contingencies, and programs are essential. When feasible, and with maximum regard for human safety, efforts should be made to free entangled or entrapped whales. Therefore, clearly defined strategies should be in place. Disentanglement response teams should be trained and efforts to expand disentanglement response should be considered to ensure coverage is adequate. Studies of possible advances of disentanglement gear should be conducted to improve disentanglement efforts. Response teams should also be trained and efforts expanded to consider that coverage is adequate for an entrapped animal.

Rehabilitation of live-stranded fin whales may be feasible in very limited circumstances. Attempting and effecting rehabilitation requires advanced planning including decisions regarding appropriate facilities, logistics, and equipment to be used. These are likely regionally specific and should be developed in advance with responsibilities clearly defined.

8.4 *Establish reliable sources of funding for rescue, necropsy, and tissue collection and analysis efforts.*

As noted, collection of information from fin whale carcasses is essential to recovery efforts. Therefore, identifying and committing to predictable sources of funding for completing these tasks is also critical.

9.0 Develop Post-Delisting Monitoring Plan.

After populations have been identified, determined to be stable or increasing, and threats controlled, a monitoring plan should be developed to ensure that fin whales do not revert in abundance, or become subject to new threats that cause adverse effects. Normally, this monitoring plan will be a scaled-down version of the monitoring conducted prior to delisting, and will continue for a minimum of 1.5 generations, although it may be continued for longer.

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V. IMPLEMENTATION SCHEDULE

The implementation schedule that follows is used to estimate costs to direct and monitor implementation and completion of recovery tasks set forth in this Recovery Plan. It is a guide for meeting recovery goals outlined in this Recovery Plan. The Implementation Schedule indicates the action numbers, action descriptions, action priorities, duration of the action, the parties responsible for the actions, and estimated costs. Parties with authority, responsibility, or expressed interest to implement a specific recovery action are identified in the Implementation Schedule.

Priorities in column 3 of the implementation schedule are assigned as follows:

Priority 1 – An action that must be taken to prevent extinction or to identify those actions necessary to prevent extinction.

Priority 2 – An action that must be taken to prevent a significant decline in population numbers or habitat quality, or to prevent other significant negative trends short of extinction.

Priority 3 – All other actions necessary to provide for full recovery of the species.

This implementation schedule accords priorities to individual tasks to specify their importance in the recovery effort. It should be noted that even the highest-priority tasks within a plan are not given a Priority 1 ranking unless they are actions necessary to prevent extinction or to identify those actions necessary to prevent extinction.

Any action is listed under that section which best describes the intent of that action. However, a single action may have multiple consequences. For instance, many of the actions described in *Action 5* (*Identify, Characterize, Protect, and Monitor Habitat Important to Fin Whale Populations in U.S. Waters and Elsewhere*) also have an impact on the threats identified in *Action 6* (*Investigate Causes and Reduce the Frequency and Severity of Human-caused Injury and Mortality*) as important habitat areas may coincide with areas with significant human influences. While this is of little consequence to the overall goal of recovering fin whales, readers should note that because actions are linked, the total cost of achieving the single action will include the cost of actions completed in other sections. Hence, while the total cost of recovery described in the Implementation Schedule reflects the cost of recovering the species, individual actions, or the costs of completing the goals of individual actions, may be understated when actions are viewed in isolation. Funding is estimated in accordance with the number of years necessary to complete the task once implementation has begun. The provision of cost estimates does not mean to imply that appropriate levels of funding will necessarily be available for all fin whale recovery tasks. In addition, the listing party in the Implementation Schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s). The cost of actions within each category is assigned to the subsection of that action which encompasses those described under that subsection (*i.e.,* costs in subsection 6.2 include those costs incurred in actions 6.2.1, 6.2.2, 6.2.3, 6.2.4, and 6.2.5). For each, sub-totals are given as a whole in ***bold italics***. Some costs are listed as discrete (*e.g.*, 5 years) and some are until time to recovery (*i.e.*, "TBD" and "Ongoing"). Thus, "TBD" and "ongoing" were treated equally and both were assumed to equal the time to recovery for cost purposes (2020 for N. Atlantic Ocean and N. Pacific Ocean and 2030 for the Southern Hemisphere) and costs that were discrete, were calculated for that discrete time period.

DISCLAIMER

The Implementation Schedule that follows outlines actions and estimated costs for the recovery program for the fin whale, as set forth in this Recovery Plan. It is a guide for meeting the recovery goals outlined in this Recovery Plan. This schedule indicates action numbers, action descriptions, action priorities, duration of actions, the parties responsible for actions (either funding or carrying out), and estimated costs. Parties with authority, responsibility, or expressed interest to implement a specific recovery action are identified in the Implementation Schedule. The listing of a party in the Implementation Schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s).

FIN WHALE (*BALAENOPTERA PHYSALUS*) IMPLEMENTATION SCHEDULE									
Action Number	**Action Description**	**Priority**	**Task Duration (years)**	**Agencies/ Organizations Involved/ Potentially Involved**	**Cost Estimates by Ocean Basin (thousands of dollars)**				
					North Atlantic (2020)	**North Pacific (2020)**	**South. Hem. (2030)**	**Total**	**Total/yr. x Task Duration**
1	***Coordinate State, Federal, and International Actions to Implement Recovery Actions and Maintain International Regulation of Whaling for Fin Whales.***	1	Ongoing	NMFS, IWC, Department of State (DOS)	100	100	100	300	4,000
TOTAL 1					***100***	***100***	***100***	***300***	***4,000***
2	***Determine Population Discreteness and Population Structure of Fin Whales.***								
2.1 See text for explanation of costs	Support existing studies and initiate new studies to investigate population discreteness and population structure of fin whales using genetic analyses.	2	5	NMFS, IWC, International Partners	100	200	500	800	4,000

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
2.2 See text for explanation of costs	Assess daily and seasonal movements and inter-area exchange, using telemetry and photo-identification.	2	5	NMFS, International Partners	167	166	167	500	2,500
TOTAL 2					***267***	***266***	***667***	***1,300***	***6,500***
3	***Develop and Apply Methods to Estimate Population Size and Monitor Trends in Abundance.***								
3.1	Determine the best methods for assessing fin whale status and trends.	2	1	NMFS, International Partners				30	30

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
3.2	Conduct surveys to estimate abundance and monitor trends in fin whale populations worldwide.	2	One survey[5]	NMFS, International Partners	50,880[6]	15,072[7]	118,344[8]	184,296	184,296
3.3	Develop an intensive, geographically broad scale program to obtain biopsies of fin whales for mark-recapture abundance estimation.	2	2	NMFS, International Partners	200			200	400
3.4	Maintain existing fin whale photo-identification catalogs.	2	Ongoing	NMFS	40			40	400
TOTAL 3					***51,120***	***15,072***	***118,344***	***184,566***	***185,126***

[5] Using two ships for approximately 4.5 months/year. The task duration was rounded up to the nearest 6 or 12 month period for ease of estimating costs.
[6] In this case, the Task Duration is one survey and for the N. Atlantic Ocean, one survey is expected to last 5.3 years. Rounding the value up to coincide with the nearest 6th or 12th month, the total annual cost is the total cost in thousands ($50,880), divided by 5.5 years which is $9,251.
[7] In this case, the Task Duration is one survey and for the N. Pacific Ocean, one survey is expected to last 1.57 years. Rounding the value up to coincide with the nearest 6th or 12th month, the total annual cost is the total cost in thousands ($15,072), divided by 2 years which is $7,536.
[8] In this case, the Task Duration is one survey and for the S. Hemisphere, one survey is expected to last 12.3 years. Rounding the value up to coincide with the nearest 6th or 12th month, the total annual cost is the total cost in thousands ($18,344), divided by 12.5 years which is $9,468.

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
4	***Conduct risk analysis.***								
4.1	Conduct risk analysis in the North Atlantic and North Pacific.	2	2	NMFS	100	100		200	400
4.2	Conduct risk analysis in the Southern Hemisphere	2	2	NMFS			100	100	200
TOTAL 4					***100***	***100***	***100***	***300***	***600***
5	***Identify, Characterize, Protect, and Monitor Habitat Important to Fin Whale Populations in U.S. Waters and Elsewhere.***								
5.1 See text for explanation of cost	Characterize fin whale habitat.	2	5	NMFS	350	350	350	1,050	5,250

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
5.2 See 5.1 for costs	Monitor important habitat features and fin whale use patterns to assess potentially detrimental shifts in these features that might reflect disturbance or degradation of habitat.	2	Ongoing	NMFS, International Partners					
5.3	Promote actions to protect important habitat in U.S. waters.	3	Ongoing	NMFS, National Ocean Service (NOS)	*	*	*	*	*
5.4	Promote actions to define, identify, and protect important habitat in foreign or international waters.	3	Ongoing	NMFS, DOS, International Partners	*	*	*	*	*
5.5	Improve knowledge of fin whale feeding ecology.	2	10	NMFS	100	100	100	300	3,000

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
5.6	Conduct research and perform analyses to understand the impact of climate change on fin whales and seek strategies to reduce these impacts.	2	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TOTAL 5					***450***	***450***	***450***	***1,350***	***8,250***
6	***Investigate Causes and Reduce the Frequency and Severity of Human-caused Injury and Mortality.***								
6.1 See sections 6.2, 6.3, and 6.4 for details and costs	Identify areas where concentrations of fin whales coincide with significant levels of maritime traffic, fishing, or pollution (including marine debris).	2							
6.2	Reduce injury and mortality caused by fisheries and fishing equipment.	2	5	NMFS, USCG, NOS, DOS	150	150		300	1,500

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
6.2.1 See 6.2 for costs	A systematic review of data on fin whale interactions with fishing operations.	2	TBD	NMFS, DOS, International Partners					
6.2.2	Review existing photographic databases for evidence of injuries to fin whales caused by encounters with fishing gear to better characterize and understand fishing gear interactions.	2	TBD	NMFS	*	*	TBD	*	*
6.2.3 See 6.2 for costs	In conjunction with 6.2.2, investigate the development of a deterrence system to non-lethally deter fin whales from fishing gear.	2	TBD	TBD					

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
6.2.4 See 6.2 for costs	Conduct studies of gear modifications that reduce the likelihood of entanglement, mitigate the effects of entanglements, and enhance the possibility of disentanglement. Determine whether measures to reduce entanglements are effective.	2	TBD	TBD					
6.2.5 See 6.2 for costs	Develop and implement schemes to reduce the rate at which gear is lost, and improve the reporting of lost gear, in conjunction with studies in 6.2.3, 6.2.4, and 6.2.6.	2	TBD	TBD					

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
6.2.6	Continue to review, evaluate, and act upon reports from fisherman and fishery observers of fishery interactions with fin whales.	2	Ongoing	NMFS, States, USCG	*	*	TBD	*	*
6.3	Investigate and address the significance of mortality from serious injury from ship collisions.	2	5	NMFS, USCG, States	750	750	750	2,250	11,250
6.3.1 In conjunction with 3.2, 5.1, and 5.5. See 6.3 for costs	Identify specific areas where recorded ship strikes of fin whales have occurred and conduct studies to identify ecosystem-based traits that could support an assemblage of predictive tools.	2	5	NMFS, NOS, NOAA, States, International Partners					

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
6.3.2 See 6.3 for costs	Once areas in 5.0 and 6.1 are identified, and in conjunction with information derived and resulting predictive tools from 6.3.1, conduct analyses of shipping routes and important fin whale habitat areas, to determine the risk of ship strikes with fin whales.	2	TBD	NMFS, DOS, International Partners					
6.3.3 See 6.3 for costs	Develop a system to encourage, collect, and appropriately analyze opportunistic sightings of fin whales from fishing vessels, whale watching vessels, charter vessels, etc.	3	TBD	NMFS, USCG, NOS, International Partners					

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
6.3.4 See 6.3 for costs	Work with mariners, the shipping industry, and appropriate State, Federal, and International agencies to develop and implement regionally-based measures to reduce the threat of ship strikes. Assess the effectiveness of ship strike measures and adjust, as necessary.	2	TBD	NMFS, USCG, NOS, DOS, International Partners					
6.3.5 See 6.3 for costs	Explore possible mechanisms to encourage vessels that have struck a whale to report the incident.	3	Ongoing	NMFS, USCG, NOS, DOS, International Partners					
6.3.6	Review existing photographic databases for evidence of injuries to fin whales caused by ships.	2	TBD	NMFS	*	*	*	*	*

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South. Hem. (2030)	Total	Total/yr. x Task Duration
6.4	Conduct studies of environmental pollution that may affect fin whale populations and their prey.	3	5	Environmental Protection Agency, NMFS	375	375	100	850	4,250
6.4.1 See 6.4 and 8.0 for costs	Conduct studies on individual health and body condition as they may be related to accumulated contaminants.	3	Ongoing	NMFS, NOS, States, International Partners					
6.4.2 See 6.4 for costs	Take steps to minimize adverse effects from pollutants.	3	TBD	TBD					
TOTAL 6					***1,275***	***1,275***	***850***	***3,400***	***17,000***

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South Ocean (2030)	Total	Total/yr. x Task Duration
7	***Determine and Minimize Any Detrimental Effects of Anthropogenic Noise in the Oceans.***								
7.1	Conduct studies to assess the effects of anthropogenic noise on the distribution, behavior, and productivity of fin whales.	2	5	NMFS, U.S. Navy (USN), International Partners	750	750	400	1,900	9,500
7.2	Take steps to minimize anthropogenic noises that are found to be potentially detrimental to fin whales.	3	TBD	NMFS, Army Corps of Engineers, USN, USCG, Bureau of Ocean Energy Management, Regulation, and Enforcement	TBD	TBD	TBD	TBD	TBD
TOTAL 7					***750***	***750***	***400***	***1,900***	***9,500***

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South Ocean (2030)	Total	Total/yr. x Task Duration
8	***Maximize Efforts to Acquire Scientific Information from Dead, Stranded, and/or Entrapped Fin Whales.***								
8.1	Respond effectively to strandings of fin whales in U.S. waters.	2	Ongoing	NMFS, NOS, States	750	750		1,500	15,000
8.1.1 See 8.1 for costs	Continue and improve program to maximize data collected from necropsy of fin whale carcasses.	2	Ongoing	NMFS					
8.1.2	Maintain and review, and if needed improve, the system for reporting dead, entangled, or entrapped fin whales.	3	Ongoing	NMFS, States	*	*	TBD	*	*

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Involved/ Potentially Involved	Cost Estimates by Ocean Basin (thousands of dollars)				
					North Atlantic (2020)	North Pacific (2020)	South Ocean (2030)	Total	Total/yr. x Task Duration
8.1.3	Improve, or as necessary, develop and implement protocols for securing and retrieving stranded (on land) or floating (at sea) fin whale carcasses.	3	1	NMFS, NOS, States	*	*	TBD	*	*
8.2	Review, analyze, and summarize data on stranded fin whales on an annual basis.	3	Ongoing	NMFS, NOS, States	*	*	*	*	*
8.3	Develop protocols for handling live-stranded fin whales.	2	1	NMFS	2	2	TBD	4	4
8.4	Establish reliable sources of funding for rescue, necropsy, tissue collection, and analysis efforts.	2	Ongoing	NMFS	*	*	TBD	*	*
TOTAL 8					***752***	***752***		***1,504***	***15,004***
9	***Develop post-delisting monitoring plan.***	2	TBD	NMFS	*	*		*	*
TOTAL 9					*	*		*	*

* No cost associated, NMFS staff time

Estimated Cost of Action Items Listed as Priority 1, Priority 2, and Priority 3 in the Implementation Schedule above and are presented below in thousands. The cost below does not reflect task duration (*i.e.*, 5 years) rather all costs were estimated until time to recovery for all three ocean basins (2020 for the Atlantic Ocean and Pacific Ocean and 2030 for the Southern Hemisphere):

ACTION ITEMS LISTED AS:	TOTAL COST (in thousands)
PRIORITY 1	**$4,000**
PRIORITY 2	**$237,730**
PRIORITY 3	**$4,250**

Estimated Cost of Five-Year Recovery Efforts Including All Three Ocean Basins (Estimates are in thousands of dollars). The costs below do reflect task duration (*i.e.*, 5 years) and are included in the Fiscal Year when those tasks are anticipated to begin. If no start time was identified, we assumed the task started in FY1:

Action	FY1	FY2	FY3	FY4	FY5	Total
1	300	300	300	300	300	**1,500**
2	1,300	1,300	1,300	1,300	1,300	**6,500**
3	270	184,536	40	40	40	**184,926**[1]
4	n/a	n/a	n/a	200	200	**400**[2]
5	1,350	1,350	1,350	1,350	1,350	**6,750**
6	3,400	3,400	3,400	3,400	3,400	**17,000**
7	1,900	1,900	1,900	1,900	1,900	**9,500**
8	1,500	1,504	1,500	1,500	1,500	**7,504**[3]
9	*	*	*	*	*	*
Total	**10,020**	**194,290**	**9,790**	**9,990**	**9,990**	**234,080**

[1] This action is for one survey for each ocean basin. It was assumed that the surveys would begin in FY2 across ocean basins, thus cost is reflected in FY2 only (even though surveys in each of the ocean basins will be conducted for different lengths of time and it is likely the costs will be spread out over the length of the surveys rather than all at once).

[2] Should recovery occur in the minimum time of 6 years, then action 4 would likely occur for only the Atlantic Ocean/Mediterranean Sea and Pacific Ocean, cost reflected in Total. If efforts take longer to collect the data necessary for action item 4, then this action item would incur no cost during the first five years of recovery efforts for any ocean basin.

[3] Assumed that one time cost of $4K for action number 8.3 occurs in FY2.

[*] No cost associated, NMFS staff time.

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