DRAFT

RECOVERY PLAN FOR

THE FIN WHALE *(BALAENOPTERA PHYSALUS)*

Office of Protected Resources
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
Silver Spring, Maryland

June 2006

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Cover photograph of fin whale by Gregory K. Silber

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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 still tens of thousands of fin whales worldwide. 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 and subject to catch limits under the International Whaling Commission's "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 Oceans. 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.

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. Japan has started killing fin whales in its scientific whaling program (10 killed in 2005-6, in the Antarctic). Numbers of whales killed in this program has steadily increased. Although the main direct threat to fin whales was addressed by the International Whaling Commission whaling moratorium, several potential threats remain. Among the current potential threats are collisions with vessels, entanglement in fishing gear, reduced prey abundance due to overfishing, habitat degradation, disturbance from low-frequency noise and the possibility that illegal whaling or resumed legal whaling will cause removals at biologically unsustainable rates. Although possible effects of pollution in the ocean environment on fin whales remain poorly understood, published evidence indicates that the fin whale body burdens of most contaminants (e.g., organochlorines and heavy metals) are lower than those of many toothed-whale species. Schooling fish constitute a large proportion of the fin whale's diet in many areas of the North Atlantic. Thus, 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.

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 Oceans. Key elements of the proposed recovery program for this species are 1) continued effective international regulation of whaling , 2) identifying and minimizing human-caused injury and mortality, 3) determining population structure and discreteness, and 4) estimating population sizes and monitoring trends in abundance. Doing all of the above will entail coordination with state, federal, and international partners.

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.

Downlisting Criteria include the following:

1a. The overall population in each ocean basin (North Atlantic, North Pacific and Southern Oceans) has remained stable or increased for at least 26 years (1.5 generations assumed generation time is 17 years); **or**

1b. Given current and projected threats and environmental conditions, the overall fin whale population in each ocean basin in which it occurs (North Atlantic, North Pacific and Southern Oceans) satisfies the risk analysis standard for threatened status (has no more than a 1% chance of quasi-extinction in 100 years);

and

2. Factors that may limit population growth 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)(1) of the ESA are being or have been addressed:

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

- Fishing gear interactions have been identified and action is being taken to address problems, where necessary. Fishing gear interactions to be investigated include interactions with drift gillnet, trawl, longline trap/pot gear, sink gillnet, and any other gear determined to have an effect on fin whale populations.
- Effects of reduced prey abundance are identified, and action is being taken to address the issue, if necessary.
- Effects of vessel interactions (ship collisions, noise, pollution, disturbance) have been identified and actions are being or have been taken to address the issues, where necessary.
- Effects of anthropogenic noise have been investigated and actions taken to minimize potential effects.

Factor B: Overutilization for commercial, recreational or educational purposes

- Directed human kills (commercial, subsistence and scientific) are being managed on a sustainable basis by the International Whaling Commission (IWC).

Factor C: Disease or Predation

- Disease and predation have been investigated and determined not to be appreciably affecting the recovery of the species.

Factor D: The inadequacy of existing regulatory mechanisms

- The IWC is continuing to regulate the directed take of whales on a sustainable basis. The ESA, MMPA, and other applicable laws (e.g., other U.S. laws and laws of other nations that regulate take within their EEZ) are adequately regulating takes of whales caused by vessel collisions and fishing interactions.

Factor E: Other natural or manmade [sic] factors affecting its continued existence

- Other natural or anthropogenic factors have been investigated and determined not to be limiting the recovery of the species.

Delisting Criteria include the following:

1a. The overall population in each ocean basin (North Atlantic, North Pacific and Southern Oceans) is determined to have been stable or increased for at least 51 years (3 generations); **or**

1b. Given current and projected threats and environmental conditions, the overall fin whale population in each ocean basin in which it occurs (North Atlantic, North Pacific and Southern Hemisphere Oceans) satisfies the risk analysis standard for unlisted status (has less than a 10% probability of becoming endangered in 20 years);

and

2. Factors that may limit population growth 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)(1) of the ESA are being or have been addressed:

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

- Fishing gear interactions have been identified and actions taken to address the problems have been proven effective, in that they allow for continued growth of the population. Fishing gear interactions to be investigated include interactions with drift gillnet, trawl, longline trap/pot gear, sink gillnet, and any other gear determined to have an effect on fin whale populations.
- Effects of reduced prey abundance have been identified, and actions taken to address the issue are shown to be effective, i.e., reduced prey abundance is determined not to affect fin whale populations.
- Effects of vessel interactions (ship collisions, noise, pollution, disturbance) have been identified and actions being or having been taken to address the issues shown to be effective, i.e., have been determined not to have an effect on fin whale populations.
- Effects of anthropogenic noise have been investigated and actions being or having been taken to minimize potential effects proven effective, allowing for the continued growth of the population.

Factor B: Overutilization for commercial, recreational or educational purposes

- Whaling and subsistence take is managed on a sustainable basis by the IWC and directed take in U.S. waters is in accordance with the MMPA, i.e., managed for Optimum Sustainable Populations.

Factor C: Disease or Predation

- Disease and predation have been investigated and determined not to be appreciably affecting the recovery of the species.

Factor D: The inadequacy of existing regulatory mechanisms

- The IWC is continuing to regulate directed take of whales on a sustainable basis. The MMPA and other applicable laws (e.g., other U.S. laws and laws of other nations that regulate take within their EEZ) are adequately regulating takes of whales caused by vessel collisions and fishing interactions.

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

- Other natural or anthropogenic factors have been investigated and determined not to be limiting the recovery of the species.

Actions Needed:

Actions necessary to achieve recovery include:

1. Maintain International Regulation of Whaling for Fin Whales

2. Determine Population Discreteness and Structure of Fin Whales

3. Estimate Population Size and Monitor Trends in Abundance

4. Conduct a Risk Analysis

5. Identify and Protect Habitat Essential to the Survival and Recovery of Fin Whale Populations in U.S. Waters and Elsewhere

6. Reduce or Eliminate Human-Caused Injury and Mortality of Fin Whales

7. Determine and Minimize Any Detrimental Effects of Human-Generated Underwater Noise on Fin Whales

8. Develop Post-Delisting Monitoring Plan

Estimated cost of recovery efforts:

The cost of actions necessary to achieve recovery, as identified in the previous section, are estimated in the following table. (Estimates are in thousands of dollars.)

Year	Action 1	Action 2	Action 3	Action 4	Action 5	Action 6	Action 7	Action 8	Total
N. Atl. (2012)	301	267	2150	100	225	1625	787	75	5,530
N. Pac. (2012)	101	366	1500	100	225	1625	788	75	4,780
S. Ocean (2026)	523	667	18000	200	500				23,140
Totals	**925**	**1,300**	**21,650**	**400**	**950**	**3,250**	**1,575**	**150**	**30,200**

Estimated Date of Recovery: It is impossible to estimate the precise date of recovery for fin whales at this time. The global status of the species is unknown, and although populations are expected to be recovering, we do not yet know the rate of population growth. 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.

Under criterion 1a), if we assume recovery at 5%/year and the precision achieved in coastal Pacific waters (coefficient of variation = 0.3), then approximately 25 years would be needed to detect the increase (assuming $\alpha = \beta = 0.1$). Delisting criterion 1a) requires 51 years (3 generations). In both the North Pacific and North Atlantic there are approximately 20 years worth of data in hand. Criterion 1a) would therefore require a minimum of 30 further years of data for the North Pacific and North Atlantic, at which point trends and population structure should be well documented. However, the timeline for recovery of the global species is likely controlled or limited by the least well documented area: the Southern Oceans. The three generation timeframe for criterion 1a) should be sufficient to determine trends and structure making the 2057 date relevant for all three ocean basins.

Criterion 1b) would require further population structure work and ocean-basin wide surveys in the North Atlantic and North Pacific, which are estimated to take 6 years. Approximate costs for these ocean basins, assuming recovery has been occurring, would be $3 million dollars per ocean basin with a minimum time to recovery in 6 years (2012). The substantial abundance of fin whales combined with trend data are very likely to result in a probability of extinction much less than 1% in 100 years. In the Southern Ocean, criterion 1b) (as opposed to criterion 1a) could substantially reduce the required time to demonstrate a recovery *if* one were occurring but information is still needed on population structure and abundance estimates for populations occurring in more temperate waters, should they exist. Give these uncertainties, 20 years is a possible time frame resulting in a potential minimum time to recovery in 2026 for the Southern Oceans and hence fin whales globally.

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I. BACKGROUND

A. Brief Overview

Fin whales, *Balaenoptera physalus*, have been listed as "endangered" since 1970 under the precursor to the Endangered Species Act (ESA) and the remained on the list of threatened and endangered species after the passage of the ESA in 1973 (35 FR 8491; June 2, 1970). Fin whales are widely distributed throughout the world's oceans. Although most populations were depleted by modern whaling in the mid-twentieth century, there are still tens of thousands of fin whales worldwide. 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. 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 Oceans. 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 International Whaling Commission whaling moratorium, several potential threats remain. Among the current potential threats are collisions with vessels, entanglement in fishing gear, reduced prey abundance due to overfishing, habitat degradation, disturbance from low-frequency noise and the possibility that illegal whaling or resumed legal whaling will cause removals at biologically unsustainable rates. The possible effects of pollution on fin whales remain poorly understood. However, published evidence indicates that the fin whale body burdens of most contaminants (e.g., organochlorines and heavy metals) are lower than those of many toothed-whale species. Schooling fish constitute a large proportion of the fin whale's diet in many areas. Thus, 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.

B. Species Description, Taxonomy and Population Structure

The fin whale, *Balaenoptera physalus* (Linnaeus 1758), is a well-defined, cosmopolitan species of baleen whale (Gambell 1985). 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).

Fin whales are the second-largest whale species by length. Fin whales 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).

At present, there are two named subspecies, *B. p. physalus* (Linnaeus 1758) in the North Atlantic and *B. p. quoyi* (Fischer 1829) in the southern oceans. 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 Ocean probably mix rarely (if at all), and there are geographical populations within these ocean basins. Hatch (2004) reported differences in fin whale vocalizations between the North Atlantic and North Pacific, as well as regional differences within the North Atlantic. In addition there are morphological distinctions between these three groups. 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 24.7m (81ft) female and a 22.9m (75ft) male, during 1919-1926 (Clapham et al. 1997). As with other baleen whales, female fin whales grow to a larger size than males (Aguilar and Lockyer 1987).

From a U.S. perspective, fin whales are managed under three constructs, all with different objectives and therefore, different resolutions of population structure: the MMPA, the

IWC, and the ESA. Roughly, the MMPA protects marine mammal species with a goal of maintaining marine mammal populations stocks as a functioning element of their ecosystem, the IWC manages whales with a goal of maintaining healthy stocks while authorizing harvest to meet aboriginal needs, scientific research and related purposes, and the ESA seeks to avoid extinction and recover depleted species to a point at which they no longer need ESA protections. The level of population structure appropriate to meet the objectives of these three constructs is roughly hierarchical with the finest structure needed to meet MMPA goals, that level or larger to meet IWC goals, and the largest resolution to meet ESA goals (Taylor 2005). Both the MMPA and the IWC use the term "stocks" to refer to these units to conserve. We reserve the use of the term "stocks" in the context of MMPA or IWC stocks and instead use the more generic term "populations" 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.

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 large Southern Hemisphere form and a smaller Northern Hemisphere form, have been recognized by some authorities (Tomilin 1946, 1967; Sokolov and Arsen'ev 1994; Rice 1998).

D. Life History - North Atlantic Fin Whales

D.1 Current Management Units

Fin whales in the North Atlantic are defined in 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 Sigurjónsson 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 these as biological populations was initially 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 Sigurjónsson 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.

Recent genetic analyses confirm that there is structuring within the North Atlantic population along the lines suggested by Ingebrigtsen (1929) and Kellogg (1929). Significant heterogeneity in mtDNA was found 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). 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).

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 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 Distinct Population Segments (DPSs) for fin whales. In order to qualify as DPS, a unit must first be distinct and second, significant (61 FR 4722). It is unlikely that the seven IWC stocks would all qualify as DPSs. This is not inappropriate as the IWC has different objectives than the ESA. 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, but has not yet been defined.

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, but 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 200m isobath (Rørvik et al. 1976). In contrast, off the eastern United States they are centered along the 100m 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 Jeffreys 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 Sigurjónsson 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 inermis*) 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.”

D.4 Competition

There has been considerable discussion of interspecific competition among mysticete whales, but no conclusive evidence has been adduced to demonstrate that it occurs (Clapham and Brownell 1996). The substantial dietary overlap among the balaenopterids (Nemoto 1970; Kawamura 1980) establishes the potential for interference competition. 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

The gestation period is probably somewhat less than a year, and fin whale calves are nursed for 6-7 months (Haug 1981; Gambell 1985). Most reproductive activity, including births and mating, 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 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). 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 populations can mature as early as six or seven years of age (Gambell 1985). 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).

The gross annual reproductive rate of fin whales in the Gulf of Maine (calves as a percentage of the total population) was about 8% during the 1980s (Agler et al. 1993). Sigurjónsson (1995) gave the range of pregnancy rates for the species (proportion of adult females pregnant in a given year) as 0.36-0.47.

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). Sigurjónsson (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 “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 minimum population estimate for North Atlantic fin whales is 2,362 (NMFS 2006).

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; Table 1). 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 strip survey estimates of 340 fin whales (of all sizes) for the Gulf of St. Lawrence and 2,800 for “the remainder of the Nova Scotian 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, August 1980 (Hay 1982) and a few hundred in the northern and central Gulf of St. Lawrence, August 1995−96 (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 Sigurjónsson 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).

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 estimated total 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, 1992b).

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 Fin Whales

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 management units of some kind. 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. (1984) 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,and the eastern tropical Pacific. Tissue samples (from biopsies) are archived at the Southwest Fisheries Science Center, but not analyzed to assess population structure questions for much of the eastern North Pacific (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 Japan.

Based on a “conservative management approach,” NMFS recognizes three populations 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 Distinct Population Segments (DPSs) for fin whales. In order to qualify as DPS, a unit must first be distinct and second, significant (61 FR 4722). 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 Pacific.

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).

In recent years, fin whales have 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) (Figure 1). Their regular summer occurrence has also been noted in recent years around the Pribilof Islands in the northern Bering Sea (Baretta and Hunt 1994).

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 Kaua'i (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

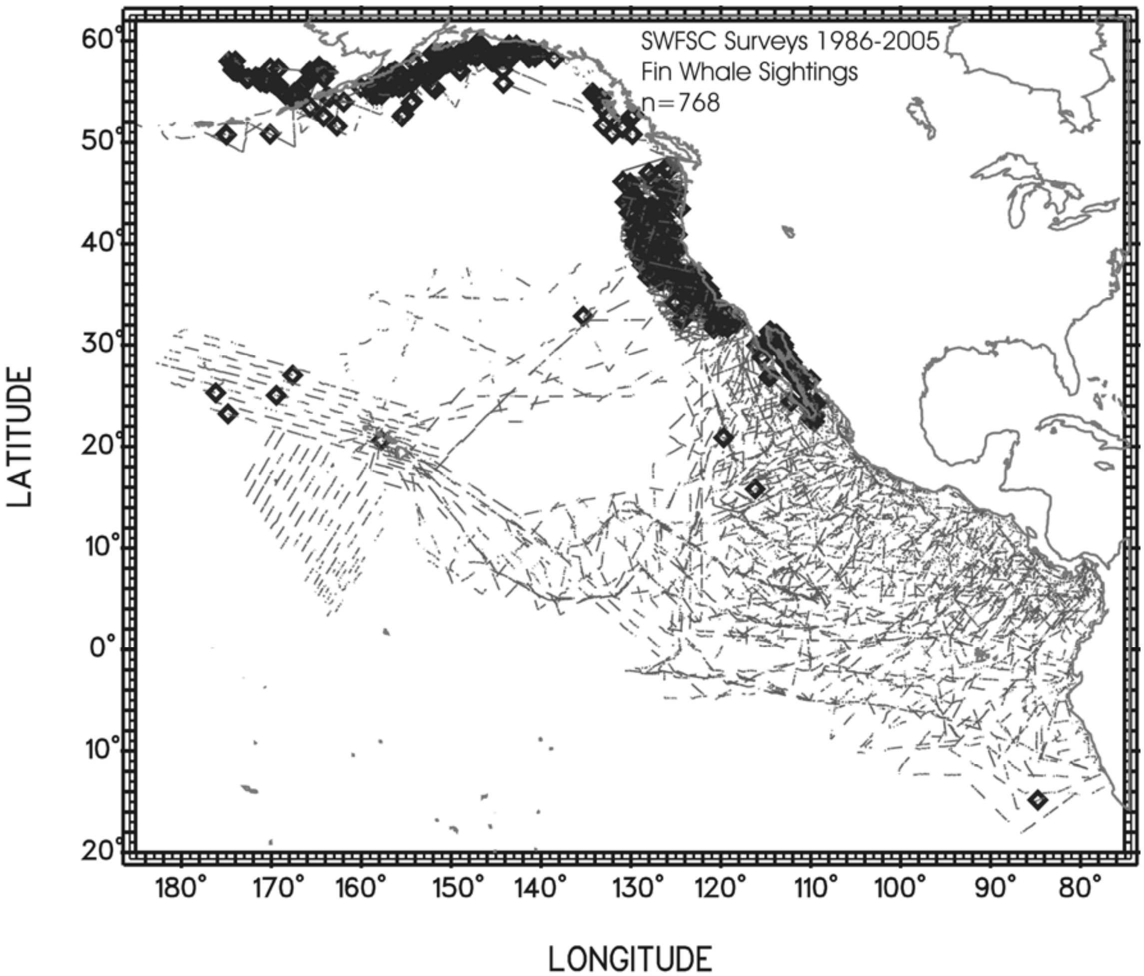

Figure 1. Location of fin whales (◊) seen on Southwest Fisheries Science Center surveys in the eastern North Pacific (1986-2005). Fine lines represent tracklines surveyed during those years.

into Hawaiian waters mainly in fall and winter, based on acoustic recordings off Oahu and Midway Islands. Recently, McDonald and Fox (1999) reported calling fin whales about 16km off the north shore of Oahu, based on passive acoustic recordings.

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 (*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 Competition

The prey species taken by fin whales are also taken by other baleen whales. Thus, competitive interactions are possible and some kind of partitioning must occur. However, as discussed in Section I.D.4, above, there is no conclusive evidence of interference competition among the baleen whales.

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 I.D.5, above). 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 I.D.6, above). 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 minimum estimate for the California-Oregon-Washington stock, as defined in the *U.S. Pacific Marine Mammal Stock Assessments: 2005*, is about 2,500 (Carretta et al. 2006). An increasing trend between 1979/80 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 on a humpback whale survey in 2004 (Jay Barlow, pers. comm.). 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).

F. Life History – Antarctic Fin Whales

F.1 Population Structure

A separate subspecies (*B. p. quoyi* Fischer 1829) is recognized in the Southern Hemisphere and is 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 (Fig. 9) (Donovan, 1991). These areas may loosely correspond to fin whale stocks, but there is 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* (Antenzana 1970, Perez et al. 2006).

F.4 Competition

There is some speculation, because of the sharing of the Antarctic krill resource between both whale and nonwhale predators, 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 I.D.5, above).

F.6 Natural Mortality

Killer whales presumably attack fin whales at least occasionally. Shark attacks likely occur on young or sick fin whales, although such events have not been documented.

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 Oceans 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 U.S.S.R. in southern waters between 1947 and 1980 (Zemsky et al. 1995). The U.S.S.R. previously reported 52,931 whales caught, whereas the new data indicates that only 41,984 were taken. Fin whales were over-reported to hide the illegal catches in terms of other species like pygmy blue whales in terms of reported oil yield.

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 lat. 30°S by combining data from Japan Scouting Vessels (JSV) and IWC/IDCR 1978–88 ship-based estimated to contain 400,000 fin whales (IWC, 1979). 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 backcalculation was based on historical catches known to be seriously flawed. There are no currently accepted estimates of trends in abundance.

Fin whales are a target species for Japanese Antarctic Special Permit whaling for the 2005/2006 and 2006/2007 seasons at 10/year. The proposal for the next 12 years includes 50 fin whales/year starting in the 2007-2008 season.

G. Threats

Threats to fin whale recovery have been identified, and are discussed in this section. Table 1 lists each threat and the associated source, severity, level of uncertainty, and relative impact to recovery. These threats are then discussed in more detail following the table.

Table 1. Fin Whale Threats Analysis Table.

Population	Stress/Threat	Source of Stress	Severity	Uncertainty	Relative Impact to Recovery
			(Unknown, Low, Med, High, V. High)	(Unknown, Low, Med, High, V. High)	(Unknown, Low, Med, High, V. High)
	Fishery Interactions:				
CA/OR/WA	Injury from drift gillnet entanglement	CA/OR thresher shark/swordfish gillnet ($\geq$14 in. mesh)	Low	Low	Low
Northeast Pacific	Injury from trawl entanglement	AK Gulf of Alaska pollock trawl	Low	Low	Low
Hawaiian	Injury from longline	Hawaii-based longline fishery	Low	Low	Low
Hawaiian	Injury from trap/pot gear entanglement	Hawaii-based trap/pot fishery	Low	Low	Low

Western North Atlantic	Injury from trap/pot gear entanglement	Northeast/Mid-Atlantic American lobster trap/pot fishery	Low	Low	Low
Western North Atlantic	Injury from sink gillnet entanglement	Northeast sink gillnet fishery	Low	Low	Low
Western North Atlantic	Injury from trap/pot gear entanglement	Atlantic mixed species trap/pot fishery	Low	Low	Low
Nova Scotia	Injury from trap/pot gear entanglement	American lobster trap/pot fishery	Low	Low	Low
Nova Scotia	Injury from sink gillnet entanglement	Sink gillnet fishery	Low	Low	Low
Nova Scotia	Injury from trap/pot gear entanglement	Atlantic mixed species trap/pot fishery	Low	Low	Low
Global	Injury from gillnet gear entanglement	Gillnet fisheries	Low	Medium	Low
	Injury from trawl gear entanglement	Trawl fisheries	Low	Medium	Low
	Injury from longline gear entanglement	Longline fisheries	Low	Medium	Low
	Injury from trap/pot gear entanglement	Trap/pot fisheries	Low	Medium	Low
	Injury from sink gillnet entanglement	Sink gillnet fisheries	Low	Medium	Low
	Injury from purse seine gear entanglement	Purse seine fisheries	Low	Medium	Low
Global	Anthropogenic Noise:	Low-frequency Sources	Unknown	High	Unknown

Global	Vessel Interactions:				
	Ship Strikes	Areas of high vessel traffic and/or high speed vessel traffic	Medium	Medium	Medium
	Disturbance from Vessels and Tourism	Ships, boats, aircraft	Low	Medium	Low
Global	Construction Noise:	Coastal Development	Low	Low	Low
Global	Contaminants and Pollutants:	Organochlorines, organotins, heavy metals	Low	Medium	Low
Global	Disease:	Parasites and other disease vectors	Low	Medium	Low
Global	Injury from marine debris:	Plastic garbage from land, lost/abandoned fishing gear, non-biodegradable garbage from ships	Low	Medium	Low
Global	Oil and Gas Exploration and Development and Other Industrial Activities:	Offshore oil exploration, LNG facilities	Unknown	High	Unknown
Global	Military Operations:	Airplanes, missile launches, ship shock trials; Low-frequency active sonar	Unknown	High	Unknown
Global	Research:	Oceanographic surveys, and genetic, photographic and acoustic studies	Low	Medium	Low
Global	Predation and Natural Mortality:	Killer whales, sharks	Low	Medium	Low
Global	Direct Harvest:	Greenland (sanctioned) whaling, possible pirate whaling	Medium	Medium	Medium

Global	Competition for Resources:	Competition with other baleen whales, fishery-caused reductions in prey	Medium	Medium	Medium
Global	Climate and Ecosystem Change:	Changes in global temperatures	Medium	High	Medium

G.1 Fishery Interactions

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.

Fin whales are occasionally killed or injured by inshore fishing gear (e.g., gillnets and lobster lines) off of eastern Canada and the United States (Read 1994; Lien 1994; Waring et al. 1997). Although the mortality from entanglement is thought to be much less, in proportion to population abundance, for fin whales than it is for humpback, right, and minke (*B. acutorostrata*) whales, more information is needed to evaluate this supposition. Fin whales apparently are entangled in inshore fishing gear in the North Pacific, but only very rarely (Barlow et al. 1994, 1997).

In the North Atlantic, there were 7 confirmed entanglements of fin whales from 1999-2003; two of these resulted in mortalities (Cole et al. 2005).

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 for sharks and swordfish along the Pacific coast of Baja California, Mexico (Barlow et al. 1997). Based on the most recent observer data, the average fin whale bycatch in the California/Oregon offshore drift gillnet fishery was approximately one per year from 1997-2001 (Carretta et al. 2006). 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 documentation should not be interpreted to mean that entanglement in fishing gear is an insignificant cause of mortality.

G.2 Anthropogenic Noise

High-energy, low-frequency underwater sound transmissions, such as those produced by industrial and military activities, ship traffic, and scientific experimentation (e.g., Acoustic Thermometry of Ocean Climate (ATOC) experiments in the North Pacific; Frankel and Clark 1998), have the potential to disturb whales. Sound transmissions in the marine environment may impact fin whales by causing damage to body tissue or gross damage to ears, causing a permanent threshold shift or a temporary threshold shift. 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 occurs when noise interferes with a marine animal's ability to hear a sound of interest (Richardson et al. 1995). Animals may adapt to shift vocalizations and interruption of normal behavior could be acutely changed for a period of time or slightly modified which could have efficiency and energetic consequences. If the noise is chronic, individuals may have an increased vulnerability to disease or increased potential for negative cumulative effects, such as chemical pollution combined with noise-induced stress. Sensitization to noise could also exacerbate other effects and habituation to chronic noise could cause animals to remain close to damaging noise. 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 collisions with ships, fishing gear, predation, etc. (Richardson et al. 1995).

It is important to recognize the difficulty of measuring behavioral or stress responses in free-ranging whales. The cumulative effects of habitat degradation are difficult to define and almost impossible to evaluate. For more specific information on potential noise impacts associated with military activities, coastal development, oil and gas exploration, and research, see sections below.

Ambient noise is background noise, and in the ocean, such noise arises from wind, waves, organisms, fishing boats, etc. Man-made noise can interfere with detection of acoustic signals, such as communication calls, echolocation sounds, and environmental sounds important to fin whales. If the noise is strong enough relative to the received signal, the signal will be "masked" and undetectable. 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). Sounds may be transient (pulsed), of relatively short duration having an obvious start and end (explosions, sonars, etc.), or they may be continuous, seeming to go on and on (e.g., an operating drillship). An animal's response to a pulsed sound with a particular peak level can be quite different than its response to a continuous sound at the same level.

Marine mammal hearing has been reviewed by several authors, notably Popper (1980a,b), Fobes and Smock (1981), Schusterman (1981), Ridgway (1983), Watkins and Wartzok (1985), C.S. Johnson (1986), Nachtigall (1986), Moore and Schusterman (1987), Au (1993), and Richardson et al. (1995). Auditory thresholds at various frequencies can be determined either by tests with trained captive animals or by electro-physiological tests on captive or beached animals. The former method results in behavioral audiograms showing the estimated absolute auditory threshold versus frequency. The latter method estimates relative sensitivity to different frequencies. Hearing abilities have been studied in some toothed whales, hair seals and eared seals; however, direct measurements of the hearing sensitivity of baleen whales are lacking. Most of the available data on underwater hearing deal with frequencies of 1 kHz or greater, and many relate to frequencies above 20 kHz.

As mentioned previously, there is no direct information about the hearing abilities of baleen whales. Baleen whale calls are predominantly at low frequencies, mainly below 1 kHz (Richardson et al. 1995), and their hearing is presumably good at corresponding frequencies. The anatomy of the baleen whale inner ear seems to be well-adapted for detection of low-frequency sounds (Ketten, 1991, 1992, 1994). 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. Baleen whales are known to detect the low-frequency sound pulses emitted by airguns and have been observed reacting to sounds at 3.5 kHz when received levels were 80-90 dB re 1µPa (Todd et al. 1992). They also react to pingers at frequencies of 15 Hz to 28 kHz, but they do not react to higher frequencies (30 to 60 kHz) generated by pingers and sonars (Watkins, 1986). Specific concerns of the impacts of noise on fin whales include continuous or impulse noise effects on the whales.

G.3 Vessel Interactions

G.3.1 Ship Strikes

Laist et al. (2001) compiled information available worldwide regarding documented collisions between ships and large whales (baleen whales and sperm whale) and found that fin whales were struck most frequently. In some areas studied, one-third of all fin whale strandings appeared to involve ship strikes. Fin whales are occasionally injured or killed by ship strikes off the east coast (Waring et al. 1997) and west coast of the United States. At least one, and probably more, fin whales were killed by collisions with ships off California in the early 1990s (Barlow et al. 1997), and three fin whales were documented as killed due to ship strikes off California; one in 1997 and two between the period 2000-2005 (Carretta et al. 2006; California Marine Mammal Stranding Network Database, U.S. Department of Commerce 2006). 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.). Off Alaska, one fin whale was struck by a vessel in Uyak Bay, during the period 1997-2001 (Angliss and Outlaw 2005). In the western North Atlantic, from 1999-2003, it was confirmed that 5 fin whales were killed due to collisions with ships (Cole et al. 2005). The difficulty of documenting mortality at sea is discussed under section G.3.2.

G.3.2 Disturbance from Vessels and Tourism

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.

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 since then they 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 much less often subject to whale watching in the eastern North Pacific than in the western North Atlantic. Thus, disturbance in the Pacific is more likely to come from the abundant 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 loud noise from ships, seismic testing, explosives, and other sources. In a study off Oregon, however, fin whales continued to produce their normal sounds despite the presence of seismic air gun pulses (McDonald et al. 1993).

G.4 Coastal Development

Anthropogenic noise associated with construction (i.e., pile driving, blasting, or explosives) could impact fin whales. Seasonal areas or migration routes where animals concentrate, could be compromised.

G.5 Contaminants and Pollutants

No major habitat pollutants have been identified for fin whales in either the North Atlantic or the North Pacific. There is no evidence that levels of organochlorines, organotins, or heavy metals in baleen whales generally are high enough to cause toxic or other damaging effects (O'Shea and Brownell 1995). It should be emphasized, however, that very little is known about the possible long-term and trans-generational effects of exposure to pollutants. It is not known if high levels of heavy metals, PCBs, and organochlorines found in prey species accumulate with age and are transferred through nursing, as demonstrated in other marine mammals, such as killer whales. A study of Mediterranean cetaceans found high percentage levels of DDT in fin whale samples, which could have an effect on reproductive rates of this species, warranting further study (Fossi et al. 2003).

G.6 Disease

Disease presumably plays a role in natural mortality of fin whales, but little is known. However, Lambertsen (1986) indicated that crassicaudiosis in the urinary ttract was a primary cause of natural mortality in North Atlantic fin whales. The potential for parasitism to have a population level effect on fin whales is largely unknown. Although parasites may have little effect on otherwise healthy animals, effects could become significant if combined with other stresses.

G.7 Injury from Marine Debris

Harmful marine debris consists of plastic garbage washed or blown from land into the sea, fishing gear abandoned by recreational and commercial fishers (see section G.1), 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. Given the limited knowledge about the impacts of marine debris on fin whales, it is difficult to determine the extent of the threat to this species.

G.8 Oil and Gas Exploration and Other Industrial Activities

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 sea states of three or above. The strongest tones were at very low frequencies near 5 hertz, and received levels of these tones at nearfield locations were 119-127 decibels re 1μPa (Richardson et al. 1995).

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 much more 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. However, all these systems require a vessel platform (or several vessels) which themselves may impact whales. Additionally, while baleen whales appear to call and hear at low frequencies, they may detect and react to higher frequencies if they are produced at high levels (sound energy).

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, as well as by bottom characteristics and other factors. Generally, the greater the altitude of the aircraft, the lower the sound level received underwater.

Oil spills that occurred 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).

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 marine mammals migrating through the area.

G.9 Military Operations

No evidence is available to indicate that military activities in the North Atlantic have had an impact on fin whale populations. However, concern about the potential for injury or disturbance to cetaceans influenced the siting and timing of ship-shock trials on the Scotian Shelf in November 1994 (Reeves and Brown 1994), and off the California coast in June 1994. Monitoring programs were undertaken by the Canadian Department of Defense and the U.S. Navy to ensure that whales were clear of the area during the blasting (Parsons 1995, Naval Air Warfare Center 1994). Recent military activities are not known to have had impacts on fin whales in the North Pacific. However, the large scale and diverse nature of military activities in this ocean basin indicates that there is always potential for disturbing, injuring, or killing these and other whales.

Studies to assess the impact of loud low-frequency active sonar signals by the U.S. Navy continues under its Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar program. The U.S. Navy completed a three-phase research program as the basis for an Environmental Impact Statement (EIS) on their SURTASS LFA sonar system. Phase I focused on the effects of the LFA signal on foraging blue whales in California; Phase II focused on the effects on migrating gray whales (*Eschrichtius robustus*) off California; and Phase III focused on its effects on humpback whales off Hawaii. These studies found that marine mammals exposed to the sound demonstrated no biologically significant response to the LFA sonar. A draft EIS was released for public comment in March, 1999, and a final EIS was released in January, 2001. A draft Supplemental EIS was released for public comment in November, 2005, and a final Supplemental EIS is expected to be released in the last quarter of 2006. NMFS expects to reassess marine mammal impacts based on information contained in the Supplemental EIS in the next several months (Kenneth Hollingshead, pers. comm.).

G.10 Research

Research activities may sometimes result in disturbance, but activities are closely monitored and evaluated, in an attempt to minimize any impact of research necessary to the recovery of fin whales. Research is likely to continue and increase in the future on fin whales, especially for oceanographic surveys, the collection of genetic information, photographic studies, and acoustic studies. For example, studies of the responses of several whale species to the Acoustic Thermometry of Ocean Climate (ATOC) signal at Pioneer Seamount off Half Moon Bay, California, have been concluded. The ATOC project has been renamed the North Pacific Acoustics Lab (NPAL) and was authorized (in 2002) to operate an underwater sound source from Kaua'i, Hawaii for a period of five years (Federal Register: February 11, 2002, Volume 67, Number 28). Preliminary analysis of data from Pioneer Seamount shows that whales observed during trials were distributed slightly farther from the source when it was activated, compared with when it was not. No other significant changes in behavior or distribution were observed.

G.11 Predation and Natural Mortality

Although killer whales presumably attack fin whales, there is little evidence of such predation from the North Pacific (Tomilin 1967) or Antarctic, but evidence was reported from the North Atlantic (Mitchell and Reeves 1988). 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.

G.12 Direct Harvest

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 existing moratorium on the commercial hunting of fin whales in most of their range has been in force for two decades, and it has almost certainly had a positive effect on the species' recovery. There is currently no legal whaling for fin whales in the Northern Hemisphere, apart from the annual take of up to about 20 fin whales in Greenland, 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 (Sigurjónsson 1989) and has recently re-joined the IWC. Iceland and Norway are not bound by IWC's moratorium on commercial whaling because both countries filed objections to that moratorium. 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 a strong 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.

G.12.1 Fin Whale: 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: 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: Table 5-7), 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.

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).

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; Sigurjónnson 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 (Sigurjónnson 1988; IWC 1988). In 1987–89 Iceland took an additional 216 fin whales under a national scientific research permit (IWC 1989a, 1990, 1991). Sigurjónsson (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).

Fin whales are presently hunted legally 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). Iceland and Norway are not bound by IWC's moratorium on commercial whaling because both countries filed objections to that moratorium. Iceland is expected to resume whaling on fin whales within a few years.

G.12.2 Fin Whale: North Pacific

Fin whales were hunted at shore 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.

G.12.3 Fin Whale: Antarctic

From 1904 to 1975, there were 703,693 fin whales taken in Antarctic whaling operations (IWC 1990). Whaling in the Southern Oceans 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.

Fin whales are a target species for Japanese Antarctic Special Permit whaling for the 2005/2006 and 2006/2007 seasons at 10 whales/year. The proposal for the next 12 years includes 50 fin whales/year, starting in the 2007-2008 season.

G.13 Competition for Resources

The prey species taken by fin whales are also taken by other baleen whales. Thus competitive interactions are possible, however, there is no conclusive evidence of interference or competition among baleen whales. 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).

G.14 Climate and Ecosystem Change

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 Decadel 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, is 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. The potential impacts of climate and oceanographic change on fin whales will like impact 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 habitats areas unsuitable. Changes to climate and oceanographic processes may also lead to decreased productivity in different patters of prey distribution and availability. Such changes could affect fin whales that are dependent on those prey.

H. Protective Legislation

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 (Sigurjónsson 1988). The fin whale was given full protection from commercial whaling 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 is expected to resume commercial whaling of fin whales under a formal objection to IWC's ban on commercial whaling.

The fin whale is protected 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.

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). 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, blue, and humpback whales). Catch data from the North Pacific have yet to be revised and validated, but judging from the Southern Hemisphere example, it seems certain that the officially reported data for the North Pacific, will prove to be equally unreliable.

II. RECOVERY STRATEGY

The main direct threat to fin whales was addressed by the International Whaling Commission 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.

Another element of the strategy is to identify factors that may limit population growth and determine actions necessary to allow the populations to increase. Potential threats to fin whale populations include collisions with vessels, entanglement in fishing gear, reduced prey abundance due to overfishing, habitat degradation, and disturbance from low-frequency noise. In addition, the possible effects of pollution on fin whales should be identified, as they remain poorly understood.

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. The plan recognizes the limits imposed by the national nature of protective legislation. As demonstrated by recent work on humpback whales, Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH) 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, the Plan is also expected to help achieve the MMPA’s purpose of maintaining marine mammal populations at optimum sustainable levels.

III. RECOVERY GOALS AND CRITERIA

A. Goals

The goal of this 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 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. Criteria

Recovery criteria take two forms: (1) criteria that indicate effective management and elimination of threats, and (2) criteria that reflect the status of the species itself. The latter criteria may include population numbers, sizes, trends, distribution, recruitment rates, and other population information, or they may explicitly state a certain risk of extinction as a threshold for downlisting or delisting and use models to assess whether this threshold has been reached. In this recovery plan, we have provided options for using available population levels and trend information (1a) or a model such as a PVA to assess risk extinction (1b). Because fin whales currently occur in large numbers but it is unlikely that they are near pre-exploitation estimates, the trend required for the first recovery criterion (1a) is that the whales are stable or increasing. This approach is believed to be reasonable because a stable population would be indicative of species health and viability, yet increases in numbers are possible as it is unlikely fin whales are near carrying capacity based on pre-exploitation estimates (although their prey base may limit such growth). For either the PVA-based criteria or the population trend criteria, we require that the analysis be done and the criteria met for each ocean basin within which fin whales occur, i.e., Atlantic, Pacific and Southern Oceans. This should ensure that the species will persist within a significant portion of its range, thus meeting the intent of the ESA.

Guidance on appropriate levels of risk for listing and down-listing decisions was developed in a workshop for large cetaceans. This guidance was employed in the North Atlantic Right Whale Recovery Plan criteria and is also appropriate here. A probabilistic framework was suggested as follows: A large cetacean species shall no longer be considered endangered when, given current and projected conditions, the probability of extinction is less than 1% in 100 years; and 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, with the period depending on the volatility of the dynamics of the population, the power of monitoring to detect changes and the expected response time of the management agency (Angliss et al. 2002).

B.1 Downlisting Criteria

1a. The overall population in each ocean basin (North Atlantic, North Pacific and Southern Oceans) has remained stable or increased for at least 26 years (1.5 generations); **or**

1b. Given current and projected threats and environmental conditions, the overall fin whale population in each ocean basin in which it occurs (North Atlantic, North Pacific and Southern Oceans) satisfies the risk analysis standard for threatened status (has no more than a 1% chance of quasi-extinction in 100 years). These analyses should expressly indicate the assumptions, goals, uncertainties and approximations of the models used, and include sensitivity analyses of parameters and assumptions. The analyses should be peer reviewed before being accepted as criteria;

and

2. Factors that may limit population growth 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)(1) of the ESA are being or have been addressed:

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

- Fishing gear interactions have been identified and action is being taken to address problems, where necessary. Fishing gear interactions to be investigated include interactions with drift gillnet, trawl, longline trap/pot gear, sink gillnet, and any other gear determined to have an effect on fin whale populations.
- Effects of reduced prey abundance are identified, and action is being taken to address the issue, if necessary.
- Effects of vessel interactions (ship collisions, noise, pollution, disturbance) have been identified and actions are being or have been taken to address the issues, where necessary.
- Effects of anthropogenic noise are being or have been have been investigated and actions taken to minimize potential effects.

Factor B: Overutilization for commercial, recreational or educational purposes

- Directed human kills (commercial, subsistence and scientific) are being managed on a sustainable basis by the International Whaling Commission (IWC).

Factor C: Disease or Predation

- Disease and predation have been investigated and determined not to be appreciably affecting the recovery of the species.

Factor D: The inadequacy of existing regulatory mechanisms

- The IWC is continuing to regulate the directed take of whales on a sustainable basis.

The ESA, MMPA, and other applicable laws (e.g., other U.S. laws and laws of other nations that regulate take within their EEZ) are adequately regulating takes of whales caused by vessel collisions and fishing interactions.

Factor E: Other natural or manmade [sic] factors affecting its continued existence

- Other natural or anthropogenic factors have been investigated and determined not to be limiting to the recovery of the species.

B.2 Delisting Criteria

1a. The overall population in each ocean basin (North Atlantic, North Pacific and Southern Oceans) is determined to be stable or increased for at least 51 years (3 generations); **or**

1b. Given current and projected threats and environmental conditions, the overall fin whale population in each ocean basin in which it occurs (North Atlantic, North Pacific and Southern Hemisphere Oceans) satisfies the risk analysis standard for unlisted status (has less than a 10% probability of becoming endangered in 20 years). These analyses should expressly indicate the assumptions, goals, uncertainties and approximations of the models used, and include sensitivity analyses of parameters and assumptions. These analyses should be peer reviewed before being accepted as criteria.;

and

2. Factors that may limit population growth 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)(1) of the ESA are being or have been addressed:

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

- Fishing gear interactions have been identified and actions taken to address the problems have been proven effective, in that they allow for continued growth of the population. Fishing gear interactions to be investigated include interactions with drift gillnet, trawl, longline trap/pot gear, sink gillnet, and any other gear determined to have an effect on fin whale populations.
- Effects of reduced prey abundance have been identified, and actions taken to address the issue are shown to be effective, i.e., reduced prey abundance is determined not to affect fin whale populations.
- Effects of vessel interactions (ship collisions, noise, pollution, disturbance) have been identified and actions being or have been taken to address the issues shown to be effective, i.e., have been determined not to have an effect on fin whale populations.
- Effects of anthropogenic noise have been investigated and actions being or have been taken to minimize potential effects proven effective, allowing for the continued growth of the population.

Factor B: Overutilization for commercial, recreational or educational purposes

- Whaling and subsistence take is managed on a sustainable basis by the IWC and directed take is U.S. waters is in accordance with the MMPA, i.e., managed for Optimum Sustainable Populations.

Factor C: Disease or Predation

- Disease and predation have been investigated and determined not to be appreciably affecting the recovery of the species.

Factor D: The inadequacy of existing regulatory mechanisms

- The IWC is continuing to regulate directed take of whales on a sustainable basis. The MMPA and other applicable laws (e.g., other U.S. laws and laws of other nations that regulate take within their EEZ) are adequately regulating takes of whales caused by vessel collisions and fishing interactions.

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

- Other natural or anthropogenic factors have been investigated and determined not to be limiting to the recovery of the species.

IV. RECOVERY PROGRAM

A. Recovery Action Outline

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

1.0 Maintain international regulation of whaling for fin whales

1.1 *Cooperate with the IWC to ensure that any resumption of commercial whaling on fin whales is conducted on a sustainable basis and that all whaling activity is conducted within the purview of the IWC (i.e., there is no pirate whaling).*

1.2 *Develop methods for defining "the population level below which aboriginal harvests should not be allowed," as required in Paragraph 13 in the IWC Schedule of Whaling Regulations.*

2.0 Determine Population Discreteness and Structure of Fin Whales

2.1 *Support existing studies and initiate new studies to investigate population discreteness and significance including genetic analyses.*

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

2.3 *If necessary, designate Distinct Population Segments of fin whales using data from 2.1 and 2.2 above and 3.2 below.*

3.0 Estimate Population Size and Monitor Trends in Abundance

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

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

3.3 Maintain existing fin whale photo-identification catalogs.

4.0 Conduct Risk Analyses

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

4.2 *Conduct risk analyses for Southern Oceans.*

5.0 Identify and Protect Habitat Essential to the Survival and Recovery of Fin

Whale Populations in U.S. Waters and Elsewhere

5.1 *Promote action to protect known areas of importance in U.S. waters.*

5.2 *Promote action to protect known areas of importance in foreign waters.*

5.3 *Improve knowledge of fin whale feeding ecology.*

5.4 *Improve knowledge on the characteristics of important fin whale habitat, and how fin whales use such areas.*

6.0 Reduce or Eliminate Human-Caused Injury and Mortality of Fin Whales

6.1. *Review existing photographic databases for evidence of injuries to fin whales caused by ship strikes or encounters with fishing gear.*

6.2 *Identify areas where concentrations of fin whales coincide with significant levels of maritime traffic, fishing, or pollution.*

6.3 *Identify and implement measures to reduce the frequency and severity of ship collisions and gear interactions with fin whales.*

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

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

6.5.1 *Maintain the system for reporting dead, entangled, or entrapped fin whales*.

6.5.2 *Improve the existing program to maximize data collected from dead fin whales.*

7.0 Determine and Minimize Any Detrimental Effects of Human-Generated Underwater Noise on Fin Whales

7.1 *Investigate the potential effects of underwater noise on fin whales.*

7.2 *Implement appropriate measures to reduce the exposure of fin whales to human-generated noise judged to be potentially detrimental.*

8.0 Develop Post-Delisting Monitoring Plan

B. Recovery Action Narrative

1.0 Maintain international regulation of whaling for fin whales

1.1 *Cooperate with the IWC to ensure that any resumption of commercial whaling on fin whales is conducted 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 commercial whaling is vital to the recovery of 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.

1.2 *Develop methods for defining "the population level below which aboriginal harvests should not be allowed," as required in Paragraph 13 in the IWC Schedule of Whaling Regulations.*

For a number of years, the IWC and its Scientific Committee have been attempting to develop an appropriate procedure for managing aboriginal subsistence whaling. This work is of immediate relevance to management of the West Greenland "stock" of fin whales, which is exploited by aboriginal Greenlanders for subsistence (i.e., for sale only within the Greenland economy; Kapel and Petersen 1982; Caulfield 1993). The concern about authorized take levels, repeatedly expressed by the IWC Scientific Committee, can be properly addressed only after the long-awaited revised management procedure for aboriginal subsistence whaling is in place (see Gambell 1993).

2.0 Determine Population Discreteness and Structure of Fin Whales

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 Distinct Population Segment 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 three recognized sub-species of fin whales, it is almost certain that the global listing inadequately captures the current levels of population structure. Because threats and levels of past exploitation differ at least at the Ocean Basin level, defining DPSs should promote more appropriate recovery actions and allow more efficient future considerations of whether fin whales should be down- or de-listed. Existing knowledge of the population discreteness is insufficient, and a more nearly comprehensive understanding is essential for classifying fin whale DPSs, according to their recovery status, and developing strategies to promote recovery, where necessary.

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.

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

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, but 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.

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

Telemetry studies using satellite-linked and VHF 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.

2.3 *If necessary, designate Distinct Population Segments of fin whales using data from 2.1 and 2.2 above and 3.2 below.*

Given the current recognition of the existence of separate subspecies, NMFS should consider dividing the listing of fin whales on an ocean basin basis, listing each sub species separately. After assessing population discreteness and structure, and identifying trends in abundance within ocean basins, it may be appropriate to further refine listing units into DPSs.

3.0 Estimate Population Size and Monitor Trends in Abundance

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 *Develop an intensive and geographically broadscale 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.

3.2 *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.

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

The existing photo-identification catalogs for fin whales at the College of the Atlantic (Agler 1992; Agler et al. 1990) and elsewhere 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.). 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 Sigurjónsson 1990).

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.

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 included known population structure. Much of the needed data gathering has been done for the comprehensive assessment of North Atlantic fin whales expected to be complete in 2007. 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 2010.

4.2 *Conduct risk analyses for Southern Oceans*

Analysis of risks in the Southern Oceans 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 and Protect Habitat Essential to the Survival and Recovery of Fin Whale Populations in U.S. Waters and Elsewhere

Some areas are known to be important habitat for fin whales; others may be discovered during survey work discussed in items 2.0 and 3.0, above. Protection of such areas is essential to the full recovery of fin whale populations.

5.1 *Promote action to protect known areas of importance in U.S. waters.*

These areas are well defined on both the Atlantic and Pacific coasts from past survey work. There is considerable overlap in the distributions of fin whales with those of other cetacean species listed as “endangered” (e.g., blue, sperm, sei, humpback, right, bowhead, and killer whales). Such overlap should enhance the feasibility of using carefully planned management measures to provide meaningful protection to several species at once.

5.2 *Promote action to protect known areas of importance in foreign waters.*

Efforts should be made to encourage the governments of Canada, Mexico, Greenland, Iceland, and other countries to protect fin whale habitat within their national borders, and to join multinational efforts on behalf of marine habitat protection.

5.3 *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.

5.4 *Improve knowledge about the characteristics of important fin whale habitat, and how these whales use such areas.*

Characterization of habitat that is used intensively by fin whales, or alternatively is used infrequently or for short periods but for purposes linked to population fitness, is essential. Only with information on the ecological needs of the species will managers be able to provide necessary protection. Such characterization would include prey types, densities, and abundances along with the associated oceanographic and hydrographic features. Studies to determine inter-annual variability in fin whale habitat use and habitat characteristics are an important component of such research. Ultimately, the goal should be to develop a predictive framework for identifying potentially important fin whale habitat.

6.0 Reduce or Eliminate Human-Caused Injury and Mortality of Fin Whales

Known or suspected types of anthropogenic mortality in fin whales include vessel strikes and entanglement or entrapment in fishing gear. 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. *Review existing photographic databases for evidence of injuries to fin whales caused by ship strikes or encounters with fishing gear.*

Existing databases, especially those with extensive photographic records of fin whale observations, should be searched for evidence of ship strikes or encounters with fishing gear. 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 or fishing gear that are particularly troublesome.

6.2 *Identify areas where concentrations of fin whales coincide with significant levels of maritime traffic, fishing, or pollution.*

Research on the frequency with which shipping-related and fishery-related mortality or injury occurs is desirable, although it must be acknowledged that present evidence does not indicate that such mortality and injury are affecting the recovery of fin whale populations. Studies to quantify the volume and type of ship traffic, fisheries, and pollution sources in areas known to be important to fin whales, might provide a useful perspective on the potential seriousness of the problem.

6.3 *Identify and implement measures to reduce the frequency and severity of ship collisions and gear interactions with fin whales.*

If research suggests that ship strikes or entanglements and entrapments in fishing gear represent a serious threat to the recovery of fin whales, actions should be taken to reduce the incidence of such events. This will require an evaluation of the practicality and effectiveness of various options.

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. However, nothing is known about the effects of pollutants on baleen whales, notably regarding long-term impacts, trans-generational effects, and impacts on prey resources. Studies should be conducted to improve knowledge of these topics, and to examine related issues such as metabolic pathways and the effects of sex, age, reproductive condition, and geographic origin of contaminant burdens. Biopsy samples collected under item 3.1, above, will be usable for much of this work. Studies should also be conducted of the impact on fin whales, or on their prey and habitat, of point-source and other types of pollution, including low-frequency noise.

6.5 *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 fin whale population dynamics and the threats that may impede population recovery. However, the ability to analyze a fin whale carcass in a timely and rigorous manner is difficult, since strandings of fin whales is a rare occurrence. In addition, since many fin whales are injured or killed far out at sea, by the time the carcass is discovered on shore, it is no longer in a condition where it can be analyzed for many research studies. Accordingly, efforts to detect and investigate fin whale deaths should be made as efficient as possible. Strandings or entanglements of live individuals are even rarer; improved reporting might provide opportunities for rescue attempts.

6.5.1 *Maintain the system for reporting dead, entangled, or entrapped fin whales*.

The detection and reporting of dead fin whales, whether stranded or floating at sea, should 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 ensure efficiency in detecting, reporting, and investigating strandings and to facilitate the exchange of information.

6.5.2 *Improve the existing program to maximize data collected from* *dead fin whales.*

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.

7.0 Determine and Minimize Any Detrimental Effects of Human-Generated Underwater Noise on Fin Whales

There is a potential that underwater noise will have both short- and long-term effects on fin whales. Of particular concern is the possibility that low-frequency noise generated by ships, industrial and military activity, and scientific experimentation will cause whales to change their behavior (e.g., vary their migratory routing, avoid prime feeding or breeding grounds), affect their hearing (either by masking their sounds or by damaging their auditory organ systems), or add physiological stress to their lives. It is important that the effects of underwater noise on baleen whales become better understood and that appropriate measures be taken to minimize any such adverse effects.

7.1 *Investigate the potential effects of underwater noise on fin whales.*

The difficulties of establishing cause-and-effect relationships between underwater noise and the behavior, health, and condition of large whales are enormous. Nevertheless, it is important that serious efforts be made, through controlled field studies, playback experiments, simulation exercises, necropsies, and perhaps even laboratory studies with surrogate species, to improve understanding of the effects of sound on baleen whales.

7.2 *Implement appropriate measures to reduce the exposure of fin whales to human-generated noise judged to be potentially detrimental to fin whales, until otherwise demonstrated.*

If studies of the kind mentioned in item 7.1 indicate that particular types of underwater noise have adverse effects on fin whales, appropriate measures should be developed and implemented to minimize or eliminate such noise in areas where fin whales are likely to be affected.

8.0 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 prior to delisting, and will continue for a minimum of 1.5 generations, although it may be continued for longer.

V. IMPLEMENTATION SCHEDULE

An implementation schedule is used to direct and monitor implementation and completion of recovery tasks. Priorities in column 3 of the following 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 impacts short of extinction.

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

This implementation schedule sets priorities for individual tasks to emphasize their importance in the recovery effort. The priority system and the criteria for each priority are based on the established NMFS policy (55 FR 24296). 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. Therefore, some plans will have no Priority 1 tasks. In general, Priority 1 tasks only apply to a species facing a high magnitude of threat. This allows NMFS to set priorities for allocation of available resources among different recovery plans.

Funding is estimated according to the number of years necessary to complete the task once implementation has begun. The provision of cost estimates is not meant to imply that appropriate levels of funding will necessarily be available for all recovery tasks. Also, identification of cost estimates does not assign responsibility for providing support to NMFS or any other agency or group.

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 plan. This schedule indicates action priorities, action numbers, action descriptions, 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. When more than one party has been identified, the proposed lead party is indicated by an asterisk (*). 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 Atl. (2012)	**North Pac. (2012)**	**South. Ocean (2026)**	**Tot.**
Objective 1	***Maintain international regulation of whaling for fin whales***							
1.1	Cooperate with the IWC 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	1	Ongoing	NMFS, IWC, DOS	101	101	523	724
1.2	Develop methods for defining "the population level below which aboriginal harvests should not be allowed," as required in Para. 13 of the IWC Schedule of Whaling Regulations	2	2	NMFS, IWC	200			200
Objective 2	***Determine Population Discreteness and Structure of Fin Whales***							
2.1	Support existing studies and initiate new studies to investigate population discreteness and structure of fin whales using genetic analyses	2	3	NMFS	100	200	500	800
2.2	Assess daily and seasonal movements and inter-area exchange using telemetry and photo-identification	2	5	NMFS	167	166	167	500
2.3	If necessary, designate Distinct Population Segments of fin whales using data from 2.1, 2.2 and 3.2				TBD	TBD	TBD	TBD

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 Atl. (2012)	**North Pac. (2012)**	**South. Ocean (2026)**	**Tot.**
Objective 3	***Estimate Population Size and Monitor Trends in Abundance***							
3.1	Develop an intensive, geographically broad scale program to obtain biopsies of fin whales for mark-recapture abundance estimation	2	2	NMFS	200			200
3.2	Conduct surveys to estimate abundance and monitor trends in fin whale populations	2	2	NMFS	1500	1500	18000	21000
3.3	Maintain existing fin whale photo-identification catalogs	2	Ongoing	NMFS	450			450
Objective 4	***Conduct risk analyses***							
4.1	Conduct risk analyses in the North Atlantic and North Pacific	2 (1?)		NMFS	100	100		200
4.2	Conduct risk analyses in the Southern Oceans	2		NMFS			200	200
Objective 5	***Identify and Protect Habitat Essential to the Survival and Recovery of Fin Whale Populations in U.S. Waters and Elsewhere***							
5.1	Promote action to protect known areas of importance in U.S. waters	2 (1?)	Ongoing?	NMFS, States, NOS	75	75		150
5.2	Promote action to protect known areas of importance in foreign waters	2	Ongoing?	NMFS, DOS			500	500
5.3	Improve knowledge of fin whale	2	Ongoing?	NMFS	75	75		150

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 Atl. (2012)	**North Pac. (2012)**	**South. Ocean (2026)**	**Tot.**
	feeding ecology							
5.4	Improve knowledge about the characteristics of important fin whale habitat, and how fin whales use such areas	2	Ongoing?	NMFS	75	75		150
Objective 6	***Reduce or Eliminate Human-Caused Injury and Mortality of Fin Whales***							
6.1	Review existing photographic databases for evidence of injuries to fin whales caused by ship strikes or encounters with fishing gear	2	Ongoing	NMFS	75	75		150
6.2	Identify areas where concentrations of fin whales coincide with significant levels of maritime traffic, fishing, or pollution	2	5	NMFS, USCG, NOS	75	75		150
6.3	Identify and implement measures to reduce the frequency and severity of ship collisions and gear interactions with fin whale	1	5	NMFS, USCG, States	50	50		100
6.4	Conduct studies of environmental pollution that may affect fin whale populations and their prey	2	5	EPA, NMFS	375	375		750
6.5	Maximize efforts to acquire scientific information from dead, stranded, and entangled or entrapped fin whales		Ongoing					

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 Atl. (2012)	**North Pac. (2012)**	**South. Ocean (2026)**	**Tot.**
6.5.1	Maintain the system for reporting dead, entangled, or entrapped fin whales		Ongoing		750	750		1500
6.5.2	Improve the existing program to maximize data collected from dead fin whales		Ongoing		300	300		600
Objective 7	***Determine and Minimize Any Detrimental Effects of Human-Generated Underwater Noise on Fin Whales***							
7.1	Investigate the potential effects of underwater noise on fin whales	3	5	NMFS, USN	750	750		1500
7.2	Implement appropriate measures to reduce the exposure of fin whales to human-generated noise judged to be potentially detrimental	3	5	NMFS, ACOE, USN, USCG, MMS	37	38		75
Objective 8	***Develop Post-Delisting Monitoring Plan***				75	75		150

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