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Recovery Plan for The Blue Whale (*Balaenoptera musculus*)

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Office of Protected Resources
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Approved: ____
Assistant Administrator for Fisheries

Date: ____________________

Recovery plans identify reasonable actions which are believed to be required to recover and/or protect endangered species. Plans are prepared by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) and sometimes with the assistance of recovery teams, contractors, State agencies, and others. This plan was prepared by Randall R. Reeves, Phillip J. Clapham, Robert L. Brownell, Jr., and Gregory K. Silber for NMFS. Recovery plans do not necessarily represent the views nor the official positions or approvals of any individuals or agencies, other than those of NMFS, and they represent the views of NMFS only after they have been approved by the Assistant Administrator for Fisheries. Objectives will only be attained and funds expended contingent upon appropriations, priorities, and other budgetary constraints. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks described in the plan.

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PREFACE

Congress passed the Endangered Species Act of 1973 (16 USC 1531 *et seq*) (ESA) to protect species of plants and animals endangered or threatened with extinction. NMFS and the U.S. Fish and Wildlife Service (FWS) share responsibility for the administration of the Act. NMFS is responsible for most marine mammals including the blue whale. This Plan was written at the request of the Assistant Administrator for Fisheries to promote the conservation of blue whales.

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

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EXECUTIVE SUMMARY

The world's stocks of blue whales, *Balaenoptera musculus,* were depleted by modern whaling, and the number of blue whales in the world's oceans is now only a small fraction of what it was early in the 20th century. Since gaining complete legal protection from commercial whaling in 1966, some populations have shown signs of recovery; others have not been adequately monitored to determine their status. Blue whales are listed as endangered under the Endangered Species Act.

Although the species is often found in coastal waters, blue whales are thought to occur generally more offshore than northern right (*Eubalaena glacialis*) and humpback (*Megaptera novaeangliae*) whales. Perhaps largely because of its offshore distribution, the blue whale seems less prone, although not immune, to lethal entanglements in fishing gear and lethal strikes by vessels. Moreover, its principal prey, euphausiids, are not commercially exploited on a large scale in the Northern Hemisphere.

Collisions with vessels, entanglement in fishing gear, reduced zooplankton production due to habitat degradation, and disturbance from low-frequency noise are the most obvious potential indirect threats. Thus, unlike the more piscivorous baleen whales (e.g., the humpback whale, fin whale, *Balaenoptera physalus,* minke whale, *B. acutorostrata,* and Bryde's whale, *B. edeni*), the blue whale in the Northern Hemisphere is probably not yet competing directly with humans for prey resources.

The long-term goal of this Plan is to promote the recovery of blue whale populations so that it becomes appropriate to remove them from the list of Endangered and Threatened Wildlife under the Endangered Species Act. The Plan identifies measures that must be taken to protect and monitor the recovery of blue whale populations in the North Atlantic and North Pacific oceans. The key recommended actions of the proposed recovery program for the blue whale are to: (1) determine population structure of blue whales, (2) estimate population size and monitor trends in abundance, (3) identify and protect essential habitats, (4) minimize or eliminate human-caused injury and mortality, (5) coordinate state, federal, and international actions to implement recovery efforts, (6) determine and minimize any detrimental effects of directed vessel[1] and aircraft interactions, and (7) maximize efforts to acquire scientific information from dead, stranded, and entangled animals. Criteria for delisting or downlisting recovering blue whale populations do not exist and developing them is one of the recommended actions.

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[1] Vessel includes every description of water craft, including nondisplacement craft and seaplanes, used or capable of being used as a means of transportation on water.

I. BACKGROUND

A. Species Description and Taxonomy

The blue whale, *Balaenoptera musculus* (Linnaeus 1758), is a cosmopolitan species of baleen whale (Gambell 1979; Yochem and Leatherwood 1985; Mead and Brownell 1993). It is the largest animal ever known to have lived on Earth: adults in the Antarctic have reached a maximum body length of about 33 m and can weigh more than 150,000 kg. Blue whales in the Northern Hemisphere are generally smaller than those in the Southern Ocean. True (1904), for example, concluded that maximum body length in the North Atlantic was about 27 m (89 ft) (although a 28.1 m [92 ft] blue whale is reported in whaling statistics from Davis Strait; R. Sears, pers. comm., October 1997). The largest blue whales reported from the North Pacific are a female that measured 26.8 m (88 ft) taken at Port Hobron in 1932 (Reeves *et al.* 1985) and a 27.1 m (89 ft) female taken by Japanese pelagic whaling operations in 1959 (J. Gilpatrick, pers. comm., June 1998). As is true of other baleen whale species, female blue whales are somewhat larger than males (Ralls 1976).

Blue whales are long-bodied and slender in comparison, for example, to right whales. The dorsal fin is proportionately smaller than those of other balaenopterid whales. It is also set far back, nearer to the tail flukes than to the middle of the body. Viewed from above, the blue whale has a broad, flat rostrum. When a blue whale is feeding, its pleated throat and chest area expands to accommodate the enormous intake of seawater and food. As the water is expelled and the filtered zooplankton are swallowed, the body outline returns to its characteristically slender shape. Blue whales have a mottled gray color pattern which appears light blue when seen through the water. The background color can be dark gray, interrupted by irregular light gray markings, with dark gray splotches.

Studies of intraspecific variability have led to the designation of three subspecies (Rice 1977): *B. m. musculus* in the Northern Hemisphere; the somewhat larger *B. m. intermedia* from the Antarctic; and *B. m. brevicauda*, the so-called "pygmy" blue whale, a significantly smaller and morphologically distinct form found in the subantarctic zone of the southern Indian Ocean and southwestern Pacific Ocean (Ichihara 1966). There is also a "resident" population of blue whales (of unknown taxonomic status) in the northern Indian Ocean from the Gulf of Aden east at least to the Bay of Bengal. This population was named *Balaenoptera indica* by Anderson (1879). Some of the uncertainty regarding the blue whale's conservation status, as a species, resides in the problem of distinguishing among the subspecies and populations. Obviously, when the current numbers of all three subspecies are combined, the total world population of blue whales is larger than if one refers only to the numbers of one subspecies or population.

B. Zoogeography

Although the populations of blue whales were severely depleted by whaling, no evidence is available to suggest that this exploitation resulted in a major change in their distribution during modern times. Possible exceptions are in the eastern North Atlantic (Christensen et al. 1992a) and western North Pacific (Forney and Brownell 1997; see below). It is assumed that blue whale distribution is governed largely by food requirements and that populations are seasonally migratory. Poleward movements in spring allow the whales to take advantage of high zooplankton production in summer. Movement toward the subtropics in the fall allows blue whales to reduce their energy expenditure while fasting, avoid ice entrapment in some areas, and engage in reproductive activities in warmer waters of lower latitudes.

Separate summaries of natural history and human impacts are provided in this Plan for blue whales in the North Atlantic and North Pacific oceans. However, since management needs in the two ocean basins are similar, the Plan treats the two areas together when summarizing conservation efforts and recommended actions.

C. Protective Legislation

Blue whales were only occasionally hunted by the sailing-vessel whalers of the 19th century (e.g., see Scammon 1874). The introduction of steam power in the second half of that century made it possible for boats to overtake the large, fast-swimming blue whales and other rorquals; yet it remained for deck-mounted harpoon cannons to be developed for killing and securing them on an industrial scale. Most of the technology for "modern" whaling was available by the early 1870s, and factory ships were added in the early 20th century (Tønnessen and Johnsen 1982). Thus, from the turn of the century until the mid-1960s, blue whales from various stocks were intensively hunted in all the world's oceans.

Blue whales were protected in portions of the Southern Hemisphere beginning in 1939. In 1955 they were given complete protection in the North Atlantic under the International Convention for the Regulation of Whaling; this protection was extended to the Antarctic in 1965 and the North Pacific in 1966 (Gambell 1979; Best 1993). The protected status of North Atlantic blue whales was not recognized by Iceland until 1960 (Sigurjónsson 1988).

Blue whales are protected under both the Endangered Species Act (ESA) (as an endangered species) and the Marine Mammal Protection Act (MMPA). The IUCN Red List of Threatened Animals (Baillie and Groombridge 1996) lists three geographical populations of blue whales, as follows: Antarctic stock as "endangered," North Pacific stock as "low risk, conservation dependent," and North Atlantic stock as "vulnerable." The pygmy blue whale is classified as "data deficient" meaning that, although it may be threatened, too little is known to decide how it should be listed.

Only a few illegal kills of blue whales have been documented in the Northern Hemisphere, including three at Canadian east-coast whaling stations during 1966-69 (Mitchell 1974), some at shore stations in Spain during the late 1950s to early 1970s (Aguilar and Lens 1981; Sanpera and Aguilar 1992), and at least two by "pirate" whalers in the eastern North Atlantic in 1978 (Best 1992). Some illegal whaling by the USSR also occurred in the North Pacific (Yablokov 1994); it is likely that blue whales were among the species taken by these operations, but the extent of the catches is not known.

II. NORTH ATLANTIC POPULATION

A. Natural History

1. Stocks. Gambell (1979) identified ten putative stocks of blue whales in the world's oceans, including two (western and eastern) in the North Atlantic. This distinction has been adopted by others (e.g., Best 1993); however, no rigorous discussion of blue whale stock boundaries has occurred in the International Whaling Commission (IWC) (Donovan 1991), and hypotheses regarding stock structure in this species have yet to be tested with molecular or other pertinent analyses.

Murray and Hjort (1912: 714) cited the finding of American-made bomb lances in two blue whales killed in the Barents Sea as evidence that these animals had "migrated" between there and the coast of North America. However, this conclusion did not take into account the fact that an American whaler had shot experimental bomb lances into "hundreds" of blue whales off Iceland during the 1860s (see Schmitt *et al.* 1980: 101-113). One of three blue whales photo-identified off West Greenland in July-August 1988 had been photographed in the Gulf of St. Lawrence in August 1984 and August 1985 (Anon. 1990). This suggests that blue whales in Davis Strait and the Gulf of St. Lawrence belong to the same population. On the basis of catch timing and trends, Jonsgård (1955) argued that the blue whales hunted along the coasts of Newfoundland and Labrador belonged to the same stock as those hunted in Davis Strait as far north as Disko Island. Blue whales photo-identified on the Scotian Shelf and in the Gulf of Maine were also photo-identified in the St. Lawrence (Wenzel *et al.* 1988; Sears *et al.* 1990).

Sigurjónsson and Gunnlaugsson (1990a; following Jonsgård 1955; Christensen 1955) inferred from catch data and trends in sightings off Iceland that blue whales occur in "relatively discrete feeding populations." This concept of "feeding substocks" is generally accepted as applying to humpback whales in the North Atlantic (Katona and Beard 1990) and may be appropriate for blue whales as well, as originally suggested by Jonsgård (1955).

Previous assumptions about stock identity of blue whales were recently called into question by acoustic evidence from the North Atlantic. Acoustic tracking of individual blue whales has led to speculation that they may range over the entire ocean basin (Clark 1994). This could mean that the blue whales of the North Atlantic comprise a single panmictic stock (a concept anticipated by Thompson 1928). However, genetic analyses are required to elucidate this issue.

2. Distribution and Habitat Use. The overall range of blue whales in the North Atlantic extends from the subtropics north to Baffin Bay and the Greenland Sea (Jongsård 1955; Yochem and Leatherwood 1985). The species was regularly hunted from land stations in Newfoundland and Labrador, the Gulf of St. Lawrence, West Greenland, Iceland, Norway, Ireland, and the islands of Shetland, the Hebrides and the Faroes (True 1904; Thompson 1928; Sergeant 1953, 1966; Jonsgård 1955, 1977; Kapel 1979; Sigurjónsson and Gunnlaugsson 1990a).

Blue whales are rare in the shelf waters of the eastern United States. Occasional sightings of individuals have been made off Cape Cod, Massachusetts, in summer and fall (Wenzel *et al.* 1988). Farther north in Canadian waters, a few sightings have been made on the Scotian Shelf (CETAP 1982, Sutcliffe and Brodie 1977), and two blue whales were sighted in August 1995 in the lower Bay of Fundy (newspaper reports). A stranding at Ocean City, Maryland, in October 1891 (True 1904) is the southernmost confirmed record on the east coast. Several records (pre-1970) of blue whale strandings in the Gulf of Mexico (J. G. Mead, pers. comm., 27 October 1997) suggest occasional straying into that area. A large blue whale was killed at Cristobal, Panama, in the Caribbean Sea entrance to the Panama Canal in January 1922 (Harmer 1923).

In the 1960s, whalers regularly observed blue whales on the Scotian Shelf from May to November, with most sightings between July and October (Sutcliffe and Brodie 1977). Off the northern Newfoundland and southern Labrador coasts, including the Strait of Belle Isle, catches were made mainly in June and July (Jonsgård 1955; Sergeant 1953, 1966).

Blue whales are present in the Gulf of St. Lawrence for most of the year (records are for March to February according to R. Sears, pers. comm., October 1997), but most leave by early winter to avoid ice entrapment and do not return until the ice breaks up in spring. Two peaks or pulses of sightings occur in most years along the north shore of the Gulf: one in April to early June, the other from August into at least late October (R. Sears, pers. comm., August 1995). Blue whales are especially common along the north shore during the summer and fall feeding season, with a peak in sightings from June to November (Sears *et al.* 1987; R. Sears, pers. comm., October 1997) Whaling records suggest that the occurrence of blue whales is seasonal in most areas, but the lack of whaling effort during the period from late fall to spring may explain the lack of records in those seasons (e.g., see Thompson 1928).

In the Gulf of St. Lawrence, individual blue whales rarely spend more than about ten days in a particular area, and they have been described as "very nomadic, with generally low local resident times" (Sears *et al.* 1990). Four individuals were documented to have traveled more than 400 km in a two-week period during the summer and fall (Sears *et al.* 1990). However, some individuals have been documented as remaining in the same area for a month or more (R. Sears, pers. comm., August 1995). The main sighting areas are off the Gaspé Peninsula, along the Quebec north shore of the Gulf, around Anticosti Island, and in the St. Lawrence River estuary to as far upriver as Tadoussac (R. Sears, pers. comm., October 1997).

The paucity of sightings during recent surveys along the coasts of Finnmark and on the banks west of Bear Island and Svalbard, where blue whales were common in the late 1800s and early 1900s, has been interpreted to mean that the historic distribution and migratory pattern of the species in the eastern North Atlantic may have changed (Christensen *et al.* 1992a). However, it could also indicate depletion of the population by whaling.

3. <u>Feeding and Prey Selection</u>. Based on stomach content analysis, the food of blue whales in the North Atlantic has been reported to consist entirely of “krill,” i.e., relatively large euphausiid

crustaceans (Jonsgård 1955; Sergeant 1966; Christensen *et al.* 1992b). The species *Thysanoëssa inermis* and *Meganyctiphanes norvegica* are particularly important in the eastern North Atlantic (Hjort and Ruud 1929; Christensen *et al.* 1992b). The species *T. raschii* and *M. norvegica* are said to represent important food sources of blue whales in the Gulf of St. Lawrence, based on observations of feeding whales and sampling of the nearby water column (Sears *et al.* 1987). Some other prey species, including fish and copepods, have been mentioned in the literature (e.g., see the review by Kawamura 1980), but these are not likely to contribute significantly to the diet of blue whales. Sears *et al.* (1987) suggested that the whales' apparent preference for the 100 m contour during daylight hours along the north shore of the Gulf of St. Lawrence is explained by krill concentrations found regularly at depths of 90-120 m.

4. <u>Competition</u>. The question of whether blue whales are food-limited in the Northern Hemisphere has not been addressed. All baleen whale species that are sympatric with the blue whale eat euphausiids to some extent and are, therefore, potential competitors (Nemoto 1970). However, there is currently little or no direct evidence for interspecific competition involving blue whales anywhere (Clapham & Brownell 1996), and it seems unlikely that resource competition would be an important factor in preventing the recovery of blue whale stocks. The high mobility of blue whales should enable them to take advantage of transitory concentrations of prey over a very large area.

5. <u>Reproduction</u>. The gestation period is approximately 10-12 months, and blue whale calves are nursed for about 6-7 months. Most reproductive activity, including births and mating, takes place in the winter season. Weaning probably occurs on, or en route to, the summer feeding areas. The average calving interval is probably two to three years. The age at attainment of sexual maturity is uncertain but is thought to be 5-15 years (Mizroch *et al.* 1984; Yochem and Leatherwood 1985).

Only nine blue whales classified as "calves" were observed during 19 seasons of observations along the north shore of the Gulf of St. Lawrence (R. Sears, pers. comm., October 1997). Either blue whale populations are segregated in such a way that lactating females reside mainly in areas other than those in which observations have been made, or weaning occurs prior to their arrival in these areas, or (as suggested by R. Sears, pers. comm., October 1997) relatively few calves are being produced by this population.

6. <u>Natural Mortality</u>. Little is known about natural mortality of blue whales in the North Atlantic. Ice entrapment is known to injure and kill some blue whales, particularly along the southwest coast of Newfoundland during late winter and early spring (Beamish 1979; Sergeant 1982). Scarring on the dorsal surface of some whales in the St. Lawrence is thought to be from contact with ice (Sears *et al.* 1987, 1990). Two blue whales in the Gulf of St. Lawrence bore rake-like markings assumed to be from the teeth of killer whales (*Orcinus orca*) (Sears *et al.* 1990), but no direct evidence of predation on blue whales has been reported from this area.

7. <u>Abundance and Trends</u>. No good estimates of pre-exploitation population size are available. Sergeant (1966) guessed that approximately 1,500 blue whales were present in eastern Canadian waters when modern whaling began there in 1898, based on cumulative catches between 1898 and

1915. Allen (1970) used a less direct approach to infer an eastern Canadian population in 1903 of somewhat more than 1,100. All authors have agreed that the western North Atlantic stock of blue whales was severely depleted by the time that legal protection was introduced in 1955. This is also true of the stock(s) in the eastern and central North Atlantic (Jonsgård 1955). Klinowska (1991), citing FAO (1978) and Yochem and Leatherwood (1985), suggested that about 15,000 blue whales inhabited the North Atlantic when whaling began. This estimate may be too high. Regardless, it should be treated skeptically in the absence of a detailed explanation of how it was derived.

Mitchell (1974) judged from "cumulative sightings recorded by whale catchers" (see Sutcliffe and Brodie 1977) and his own surveys that the population of blue whales in the western North Atlantic during the late 1960s and early 1970s was in the "very low hundreds, at most."

More than 320 individual blue whales had been photo-identified in the Gulf of St. Lawrence from 1979 to the summer of 1995 (Sears *et al.* 1990; R. Sears, pers. comm., August 1995). The total number of photo-identified individuals for eastern Canada and New England was 352 through autumn 1997 (R. Sears, pers. comm., October 1997). Exploratory analysis of the photo-identification data from this region determined that they could not be used for a mark-recapture (i.e., sight-resight) population estimate (Hammond *et al.* 1990).

Sighting data from whaling vessels operating off the west and southwest coasts of Iceland have been interpreted as demonstrating a trend of increase, at about five percent per year, in the number of blue whales since the late 1960s (Sigurjónsson and Gunnlaugsson 1990a). This increasing trend is considered to apply specifically to the whale population in these waters, and not necessarily to the North Atlantic as a whole. An estimate of 442 blue whales in Icelandic waters (no CV calculated) was presented by Gunnlaugsson and Sigurjónsson (1990), based on the results of a shipboard survey in June-July 1987. These authors referred to the estimate as "a probable upper bound for the abundance of this species in the survey area" (p. 577). Elsewhere, however, the same authors, citing Gunnlaugsson and Sigurjónsson (1990), indicated that the blue whale population in Icelandic and neighboring waters "may number at least in the high hundreds" (Sigurjónsson and Gunnlaugsson 1990a: 548). Christensen *et al.* (1992a) suggested that surveys in 1989, once fully analyzed, would produce an estimate greater than 1,000 for Icelandic waters (see Sigurjónsson and Gunnlaugsson 1990b). There is no current estimate for the number of blue whales in eastern North Atlantic waters. As of autumn 1997, 32 individuals had been photo-identified in Icelandic waters (R. Sears, pers. comm., October 1997).

B. Human Impacts

1. <u>Vessel interactions</u>.

a. Collisions with ships

Blue whales are at least occasionally injured or killed by ship collisions. A juvenile male blue whale was reportedly struck and killed by a commercial vessel in March 1998 and was carried on the bow of the ship into Narragansett, Rhode Island. The necropsy indicated that death occurred as a result of a ship strike, including bone fractures at several locations along one side of its body.

Most of one fluke of an individual in the western North Atlantic catalog was missing, apparently having been amputated by a ship's propeller (Sears *et al.* 1987, 1990). Deep gashes in the caudal peduncle are also assumed to have been made by the propellers of large ships. At least 9 percent of the whales in the Gulf of St. Lawrence have injuries or scars attributed to contact with ships (Sears *et al.* 1990); another estimate has been provided of 25% (n=355) of the blue whales in the Gulf of St. Lawrence bearing vessel contact scars (R. Sears, pers. comm., October 1997). The St. Lawrence Seaway has heavy ship traffic during the time of year when blue whales are relatively abundant there.

b. Disturbance by vessels

Since the early 1980s, blue whales have been among the main attractions for whalewatching along the north shore of the Gulf of St. Lawrence and in the St. Lawrence estuary. Although no direct evidence is available to demonstrate that persistent close approaches by tour boats have a negative effect on the whales, there is concern about such a possibility. The Canadian Government has a "code of ethics" for whalewatching; also, according to the Marine Mammal Regulations under the Canadian Fisheries Act, it is illegal to "disturb" whales (Fisheries and Oceans 1995). There is no whalewatching that targets blue whales along the eastern seaboard of the United States. Blue whales have been observed occasionally, however, during whalewatching cruises in the Gulf of Maine (Wenzel *et al.* 1988).

2. Entrapment and Entanglement in Fishing Gear. At least one blue whale found dead in the Gulf of St. Lawrence in recent years apparently died from the effects of entanglement in fishing gear (R. Sears, pers. comm., August 1995). A blue whale was observed on Stellwagen Bank, north of Cape Cod, Massachusetts in August 1987 trailing fishing gear, including what appeared to be a lobster pot buoy, from one pectoral fin (D.K. Mattila, pers. comm., February 1998).

The lack of more evidence that blue whales become entrapped or entangled in fishing gear in the western North Atlantic may be due to incomplete reporting. In addition, the large size of the animals makes it more likely that blue whales will break through nets, or carry gear away with them. In the latter case, undetected mortality may result from starvation due to interference with feeding, as sometimes occurs in humpback and northern right whales.

3. Habitat Degradation. At least some of the areas used by North Atlantic blue whales (e.g., the St. Lawrence River and Gulf) have been degraded by acoustic and chemical pollution. However, no specific evidence is available to describe or quantify the impacts of this degradation on the blue whale population. R. Sears (pers. comm., October 1997) reported having evidence that blue whales from the St. Lawrence River estuary carry substantial body burdens of chemical contaminants, including PCB's and pesticides such as DDT. However, the data have not been published.

4. Military Operations. There is currently no evidence to indicate that military activities in the North Atlantic have had an impact on blue whales. However, concern about the potential for injury or disturbance to blue whales (and other cetaceans) influenced the siting and timing of Canadian ship-shock trials on the Scotian Shelf in November 1994 (see Reeves and Brown 1994). A monitoring program was undertaken by the Canadian Department of Defense to ensure that whales were clear of the area during the blasting, and no direct effects on blue whales were documented (R. Sears, pers. comm., August 1995).

5. Hunting. Deliberate killing has had a severe effect on the status of blue whales in the North Atlantic (Jonsgård 1955). At least 11,000 were taken (all whaling areas, combined) from the late 19th to mid 20th centuries (Sigurjónsson and Gunnlaugsson 1990a).

Blue whales are not known to have been subjected to hunting anywhere in the western North Atlantic since the 1960s. Whalers who hunt humpback whales in the Lesser Antilles under the aboriginal exemption in the IWC Schedule (and other cetaceans, including sperm whales, *Physeter macrocephalus*, and pilot whales, *Globicephala macrorhynchus*) apparently do not see or attempt to take blue whales (cf. Price 1985). Similarly, the "aboriginal subsistence" whaling off the coasts of Greenland legally involves only fin and minke whales (*B. physalus* and *B. acutorostrata*, respectively) at present, and only humpback whales have been reported as having been taken illegally in recent years (e.g., see Anon. 1993). Blue whales were not reported as taken from Icelandic shore stations after 1960, but at least three "fin" whales landed in Iceland during the 1980s were fin-blue whale hybrids (Spilliaert *et al.* 1991; Árnason *et al.* 1991). Another fin-blue whale hybrid was killed by a Spanish whaling operation in 1984 (Bérubé and Aguilar 1998). Currently, Norwegian whaling operations target only minke whales, and the commercial whaling stations in Iceland, Spain, and the Portugese islands of the Azores and Madeira remain officially closed.

III. NORTH PACIFIC POPULATION

A. Natural History

1. Stocks. Little information has been available for evaluating stock differences of blue whales in the North Pacific. Although Gambell (1979) suggested that there were three stocks in the North Pacific - west, central, and east, the IWC has considered there to be a single panmictic stock in this ocean basin (Donovan 1991; also see Best 1993). A blue whale tagged in the Okhotsk Sea under the "Discovery" tagging program was reported as having been killed in waters east of Kodiak Island (Ivashin and Rovnin 1967). If this record is reliable, it indicates that considerable trans-oceanic movement occurs at least occasionally, and that North Pacific subpopulations may not be entirely discrete.

Rice (1974) hypothesized that blue whales from Baja California, Mexico, migrated far offshore to feed near the eastern Aleutians or in the Gulf of Alaska and returned to feed in California waters. However, he recently concluded, based on the presence of rare epizoites on blue whales which were not found on other species known to migrate north, that the California population is separate from that in the Gulf of Alaska and eastern Aleutians (Rice 1992). This latter view is supported by the recent work of Calambokidis *et al.* (1995) and by length frequency analysis (Gilpatrick *et al.* 1996). The agreement between estimates of abundance calculated from line-transect surveys off California (Barlow 1995) and from sight-resight (photo-identification) data from California (Calambokidis and Steiger 1995) provides further support to the hypothesis that the blue whales off Mexico and California belong to a different stock from those in Alaskan waters. If whales observed off California in summer were merely migrating to Alaska, the sight-resight estimates are likely much higher than those derived from line-transect surveys.

Whaling catch data indicate that animals believed to belong to the central stock (as defined by Gambell 1979) feed off the Aleutian Islands in summer. The prime period for blue whale catches (made in various years between 1912 and 1939) was June through August (Reeves *et al*. 1985). "Discovery" tag returns indicate that this population ranges further to the east, with movements from the Gulf of Alaska to the Aleutian Islands, and from off Vancouver Island to the Gulf of Alaska (Omura and Ohsumi 1964; Ohsumi and Masaki 1975; Ivashin and Rovnin 1967). Migratory destinations of whales in this region are largely unknown, although it is possible that sightings of blue whales in offshore waters north of the Hawaiian Islands reflect the winter range of this stock (Berzin and Rovnin 1966). Blue whale calls detected by seafloor-mounted hydrophone arrays approximately 500 km offshore from Astoria, Oregon, in August 1990 (McDonald *et al.* 1995) and blue whales sighted off the southern Oregon coast in 1996 (J. Barlow, unpublished data) are of unknown stock origin.

In the western North Pacific, blue whales have been found offshore from Kamchatka and the Kuril Islands (Russia) in summer to Japanese waters in winter (Nishiwaki 1966; Ohsumi and Wada 1972; Fujise *et al.* 1995, 1996). Forney and Brownell (1997) analyzed locations of catches and length frequency data for blue whales taken in the North Pacific by both shore stations and pelagic operations from 1929-1965. They concluded that the western stock is separate from the population that was exploited in the Aleutian Islands area (the central stock). Furthermore, the virtual disappearance of blue whales from the area off southern Japan where they were heavily exploited (Kasaharu 1950) suggests that this area may have hosted another population that was largely separate from that found off northern Japan and Kamchatka.

Another major area of concentration for blue whales is in the eastern tropical Pacific Ocean around the Costa Rican Dome, where sightings have been recorded throughout the year. It is not clear whether this represents a single year round population or alternating seasonal use of the region by two (or more) populations (Reilly and Thayer 1990).

In conclusion, whaling and sighting data suggest the existence of at least five subpopulations of blue whales in the North Pacific, with an unknown degree of mixing among them: (i) southern Japan (which appears to have been virtually extirpated by whaling); (ii) northern Japan/Kurils/Kamchatka; (iii) Aleutian Islands (the central stock, which may winter in deep water north of Hawaii); (iv) eastern Gulf of Alaska; and (v) California/Mexico. The relationship between any of these sub-populations and the whales that occur around the Costa Rican Dome is unclear.

2. Distribution and Habitat Use. The range of the blue whale is known to encompass much of the North Pacific Ocean, from Kamchatka to southern Japan in the west, and from the Gulf of Alaska and California south to at least Costa Rica in the east. The species is found primarily south of the Aleutian Islands and the Bering Sea (Nishiwaki 1966; Reeves *et al.* 1985). Small numbers have been observed as far north as the Chukchi Sea (Yochem and Leatherwood 1985; Rice 1986), but the reliability of these reports have been questioned (D. W. Rice, pers. comm., September 1997). The only (presumably) reliable sighting report of this species in the vicinity of the Hawaiian Islands is that of Berzin and Rovnin (1966), who noted that blue whales were observed from scientific research vessels about 400 km northeast of Hawaii in January 1964. Recordings of blue whale calls off Oahu and Midway (Northrop *et al.* 1971; Thompson and Friedl 1982) provide additional evidence that they occur within several hundred km of these islands (see Barlow *et al.* 1997).

Overall, it is clear that this species inhabits and feeds in both coastal and pelagic environments. Blue whales are frequently found on the continental shelf (e.g., in areas off the California coast, Calambokidis *et al.* 1990; Fiedler *et al.* 1998) and also far offshore in deep water (e.g., in the northeastern tropical Pacific, Wade and Friedrichsen 1979).

Knowledge concerning distribution and movement varies with area. The species appears to undertake seasonal movements in many places. Summer feeding concentrations were exploited by pelagic whalers in three areas (Rice 1974): (i) the eastern Gulf of Alaska between 130°W and 140°W, (ii) south of the eastern Aleutians between 160°W and 180°W, and (iii) from the far western Aleutians to Kamchatka, between 170°E and 160°E. It is noteworthy that, while the second of these three areas was documented to have relatively large concentrations of blue whales in the 1970s (Berzin and Vladimirov 1981), the species appears rare there today, suggesting that illegal and unreported whaling depleted the population (Stewart *et al.* 1987; Forney and Brownell 1997). Blue whales were also taken in May-October from shore stations on the eastern Aleutians and Kodiak Island through the 1930s (Reeves *et al.* 1985; Brueggeman *et al.* 1985).

In the western North Pacific, blue whale catches from shore stations were made off the southern portion of the main Japanese islands in winter, off Hokkaido in spring and early summer, and in summer off Kamchatka, the Kurils and the western Aleutians (Kasaharu 1950). This pattern could be interpreted as evidence of a seasonal progression northward, but the lack of blue whales off southern Japan today suggests that the animals of this region constituted a separate stock that has been extirpated. Japanese pelagic operations in the North Pacific took blue whales between 1952 and 1965, with the largest catches along the south side of the Aleutians (Ohsumi and Wada 1972).

Blue whales were taken off the west coast of Baja California as early as the mid-19th century (Scammon 1874). Extensive catches were made by factory ships operating in 1913/1914, from 1924 to 1930, and in 1935 (Rice 1974; Tønnessen and Johnsen 1982). The timing varied, but whalers found few whales from December through February. A similar pattern has been observed in recent years (Sears 1990; Calambokidis *et al.* 1990; Calambokidis 1995). Ingebrigtsen (1929) reported that blue whales appeared off the Baja California coast "from the north" in October and traveled southward along the shore, returning north in April, May, and June. It is possible that the migratory destination of these whales was the Costa Rican Dome, which shows a seasonal increase in sightings in winter (Reilly and Thayer 1990).

Recently, some blue whales have been seen along the west coast of Baja California between March and July (Gendron and Zavala-Hernàndez 1995). They are first observed in Monterey Bay, around the Channel Islands, and in the Gulf of the Farallons in June and July (Calambokidis *et al.* 1990; Calambokidis 1995). They are fairly widespread and unpredictable in their areas of concentration from August to November. Individuals have been shown to move among the Gulf of the Farallons, Monterey Bay, and Point Arena, California, within years. Also, some of the whales that spend the summer and fall (August-October) off the California coast migrate to Mexican waters, where they have been re-identified by photographs in spring (March-April) (Calambokidis *et al.* 1990).

As noted below, there is evidence for blue whale distributional shifts related to prey abundance and oceanographic conditions. The appearance of numerous blue whales off the Farallon Islands is noteworthy in light of their rarity in that region prior to the late 1970s (Calambokidis *et al.* 1990). Similarly, shore-based whaling data from Moss Landing and Trinidad, California, for the period 1919-26 indicate that the species was (unlike today) extremely uncommon in this region (Clapham *et al.* 1997). Calambokidis (1995) concluded that such changes in distribution reflect a shift in feeding from the more offshore euphausiid, *Euphausia pacifica*, to the primarily neritic euphausiid, *Thysanoëssa spinifera*.

3. Feeding and Prey Selection. Blue whales off California and elsewhere in the North Pacific are said to prey mainly on *Euphausia pacifica*, and secondarily on the somewhat larger species *Thysanoëssa spinifera* (Rice 1986). However, recent studies in the coastal waters of California have found blue whales feeding primarily on the latter (Schoenherr 1991, Kieckhefer *et al.* 1995, Fiedler *et al.* 1998).

The species *Thysanoëssa inermis*, *Thysanoëssa longipes*, *Thysanoëssa raschii*, and *Nematoscelis megalops* have also been listed as prey of blue whales in the North Pacific (Kawamura 1980; Yochem and Leatherwood 1985). Although some stomachs of blue whales have been found to contain a mixture of euphausiids and copepods or amphipods (Nemoto 1957; Nemoto and Kawamura 1977), it is likely that the copepods and amphipods were consumed adventitiously or incidentally. One exception to their near-total dependence on euphausiid prey is that blue whales have been observed feeding on pelagic red crabs, *Pleuroncodes planipes*, off Baja California (Rice 1974, 1986), although these observations have not been confirmed by subsequent observations or other analyses (e.g., fecal analysis). Reports that they feed on small schooling fish and squid in the western Pacific (Mizue 1951; Sleptsov 1955) have been interpreted as suggesting that the preferred zooplankton are less available there (Nemoto 1957). Between February and April, blue whales in the Gulf of California, Mexico, have been observed feeding on euphausiid surface swarms (Sears 1990) consisting mainly of *Nyctiphanes simplex* engaged in reproductive activities (Gendron 1990, 1992).

Sears (1990) regarded *Nyctiphanes simplex* as the principal prey of blue whales in the region, and results from recent fecal analyses confirmed this assertion (Gendron and Del Angel-Rodriguez 1997). However, this phenomenon appears to be strongly influenced by the occurrence of El Niño Southern Oscillation (ENSO) events (Gendron and Sears 1993).

4. Competition. As in the North Atlantic, the trophic interactions of blue whales with other krill consumers are not well understood. The comments in Section II.A.4 apply here as well.

5. Reproduction. No differences in the reproductive biology of blue whales in the North Pacific and North Atlantic are known or suspected. Thus, the general comments in Section II.A.5 apply here as well.

Blue whales accompanied by young calves have been observed often in the Gulf of California from December through March, and thus at least some calves may be born in or near the Gulf (Sears 1990). Therefore, this area is probably an important nursing and calving area for the species. One female that was seen with a calf in March 1988 was resighted in March 1990 with another (Sears 1990), supporting the general belief that females of this species give birth in alternate years (Lockyer 1984).

Observations of females with calves off California occur primarily in June and July. Photogrammetric observations of small whales in late summer support the idea that weaning occurs at approximately six months of age (J. Gilpatrick, pers. comm., May 1997).

6. Natural Mortality. A well-documented observation of killer whales attacking a blue whale off Baja California proves that blue whales are at least occasionally vulnerable to these predators (Tarpy 1979). A high proportion of the blue whales in the Gulf of California bear injuries or rake-like scars that are the result of encounters with killer whales (Sears 1990), although the extent to which such attacks are fatal is unknown. Unlike in the western North Atlantic, injury or suffocation from ice entrapment is not known to be a factor in the natural mortality of blue whales in the North Pacific.

7. Abundance and Trends. With the exception of the population that summers off California, there are no reliable estimates of abundance for blue whales in the North Pacific.

A reported total of 9,500 blue whales were killed by commercial whalers in the North Pacific between 1910 and 1965 (Ohsumi and Wada 1972). This includes at least 1,378 taken by factory ships off California and Baja California between 1913 and 1937 (Rice 1992), and 48 taken by land-based whalers off central California between 1958 and 1965 (Rice 1974).

From a crude analysis of catch statistics and whaling effort, Rice (1974) concluded that the population of blue whales in the eastern North Pacific (Baja California to Alaska) was large enough to sustain an average kill of 289 per year from 1924/25 to 1928/29. Assuming an annual net recruitment rate of about 0.05, he reasoned that the initial (1924) population size would have had to be about 6,000 whales; this contrasts with the "initial stock size" of 4,900 for the entire North Pacific estimated by Omura and Ohsumi (1974). Rice (1974) guessed that the total population of blue whales in the eastern North Pacific in the early 1970s was 2,000 or less. However, Rice's calculations assumed the existence of a single blue whale population in the eastern North Pacific, an assumption which recent findings strongly suggest is not correct.

Although they have been cited as abundance estimates (e.g., by Wade and Gerrodette 1993), the figures for blue whales in the North Pacific published by Omura and Ohsumi (1974) and by Wada (1975) were actually indices of abundance based on sightings from Japanese whaling catcher boats. The data were not collected or analyzed in the same ways as those from more recent sighting cruises, nor did the area of coverage include several well-known centers of blue whale abundance in the North Pacific (cf. Wada 1975, Figures 1-2, compared with Reilly and Thayer 1990, Figures 1, 3). It is therefore not possible to evaluate trends by comparing the Japanese "indices" from the 1960s and 1970s with the more recent abundance estimates from sighting cruises and photo-identification studies. Similarly, a widely cited figure of 1,600 blue whales (e.g., Gambell 1979) was based on data derived from a combination of very different methods and first presented in an unreviewed, unpublished manuscript (by Ohsumi and Wada). This estimate must be considered unreliable.

Russian scientists inferred from sightings made during whaling and research cruises in the 1970s that blue whale numbers were increasing throughout the North Pacific, with a particular concentration in the offshore area between 37°N-45°N and 177°E-150°W (Berzin and Vladimirov 1981). Berzin and Vladimirov (1981) estimated a pre-exploitation population size of 5,000 and a present size of 1,400-1,900, but they gave no details of how these figures were derived. An aerial survey of the former Akutan whaling grounds around the eastern Aleutians in 1984 produced no sightings of blue whales, suggesting that the population remained severely depleted (Stewart *et al.* 1987). In the early 1980s blue whales in the North Pacific were thought to be at about one-third of the historical carrying capacity stock size (1,600 out of 4,900; Mizroch *et al.* 1984), but in view of the many uncertainties, this estimate must likewise be considered questionable. Also, no blue whales were sighted during a marine mammal survey south of the Aleutian Islands in 1994 (Forney and Brownell 1997).

More than 700 individual blue whales had been photo-identified in Californian and Mexican coastal waters through 1993 (Calambokidis 1995). Ship surveys of the eastern tropical Pacific during 1986-1990 resulted in an estimate of 1,415 (95% CI 1,078-2,501) blue whales in that area (Wade and Gerrodette 1993). A ship survey at the same time of year off the California coast in 1991 produced an estimate of 2,250 (CV=0.38) for this area (Barlow 1995). Barlow (1997) reported a revised estimate of 1,927 (CV=0.16) based on a weighted average of data from 1991, 1993, and 1996 surveys off the California coast. Another estimate is available for the Mexico/California stock from mark-recapture analyses: 2,038 (CV=0.33) based on photographs of left sides and 1,997 (CV=0.42) based on right sides (Calambokidis and Steiger 1995). The best estimate of the California/Mexico stock, calculated as the average of the line-transect and mark-recapture estimates, weighted by their variances, is 2,134 (CV=0.27). By combining this estimate with that from the eastern tropical Pacific, the total eastern North Pacific population south of Oregon can be estimated at about 3,500 whales. Given our current view of stock structure within the North Pacific, this figure almost certainly does not include all of the whales that feed in summer off Alaska and British Columbia (and possibly also Washington and Oregon).

The abundance of blue whales along the California coast has clearly been increasing during the past two decades (Calambokidis *et al.* 1990; Barlow 1994; Calambokidis 1995). The magnitude of this increase is considered too large to be explained by population growth alone, and it is therefore assumed that a shift in distribution has occurred. The evident scarcity of blue whales in areas of former abundance (e.g., Gulf of Alaska and near the Aleutian Islands; see Calambokidis *et al.* 1990) suggests that the increasing trend does not apply to the species' entire range in the eastern North Pacific.

B. Human Impacts

1. Vessel Interactions.

a. Collisions with ships

Ship strikes were implicated in the deaths of at least four and possibly six blue whales off California between 1980 and 1993 (Barlow *et al.* 1995; Barlow *et al.* 1997). The average number of blue whale mortalities in California attributed to ship strikes was 0.2 per year from 1991-1995 (Barlow *et al.* 1997). Further mortalities of this nature probably have occurred without being reported. Several of the whales photo-identified off California had large gashes on the dorsal body surface that were thought to have been caused by collisions with vessels (Calambokidis 1995).

b. Disturbance from vessels

In most years since the mid 1980s, blue whales have been commonly found during summer and early fall in nearshore waters along the coast of southern California, especially around the Channel Islands. Thus, some whalewatching focused on blue whales has developed in recent years, notably in the Santa Barbara Channel where the species has occurred with regularity in July and August. Sporadic whalewatching on blue whales occurs in winter off Baja California. Whalewatching has no known impact on this species. Major shipping lanes pass through, or near, whalewatching areas, and underwater noise produced by commercial ship traffic may have a much greater impact than that produced by whalewatching. However, little is known about whether, or how, vessel noise affects blue whales.

2. Entrapment and Entanglement in Fishing Gear. No definite evidence of blue whales being taken in fishing gear in the North Pacific is available. Heyning and Lewis (1990) made a crude estimate that about 73 rorquals were killed annually in the offshore southern California drift gillnet fishery during the 1980s, and at least some of these could have been blue whales. Heyning and Lewis suggested that most whales killed by offshore fishing gear do not drift far enough to strand on beaches or to be detected floating in the nearshore corridor where most whalewatching occurs. Thus, the lack of documentation of blue whale entanglements should not be interpreted to mean that none

occur. The drift gillnet fisheries for swordfish and sharks off California and Baja California represent a potential threat to blue whales of the Mexico/California stock. Observer coverage in such fisheries was relatively low in the past (Barlow *et al.* 1995) but increased to 10-18 percent in 1991-1995 (Barlow *et al.* 1997). In the observed fisheries, no blue whale mortalities were documented. However, entanglement rates may be underestimated inasmuch as blue whales may break through or carry away fishing gear, perhaps suffering unrecorded subsequent mortalities.

3. Habitat Degradation. The planktivorous diet of blue whales makes them less susceptible than piscivorous baleen whales to the accumulation of organochlorine and metal contaminants in their tissue. In any event, there is no reason to suspect that levels of these substances in any baleen whales are presently high enough to cause toxic or other effects (O'Shea and Brownell 1994), although possible long-term or transgenerational impacts are unstudied.

Anthropogenic noise may affect blue whales. Short-term changes in the behavior of a blue whale, interpreted as possibly a "startle response," were observed in the southern Indian Ocean during the experimental transmission of low-frequency, high-intensity underwater sounds (Bowles *et al.* 1994). Concern has been expressed about the potential impacts on blue (and other) whales of a more extensive study involving underwater sound transmission (Acoustic Thermometry of Ocean Climate, ATOC) in the North Pacific (Schmidt 1994). Studies of the responses of several whale species to the ATOC signal at Pioneer Seamount off Half Moon Bay is being concluded. Preliminary analysis shows that whales observed during trials were distributed slightly farther from the source when it was activated compared to when it was not. No other changes in behavior or distribution were observed.

4. Military Operations. Ship shock trials were conducted by the U.S. Navy approximately 90 miles southwest of San Nicolas Island, California, in late June 1994. Associated monitoring activities detected two blue whales in the vicinity, causing a relocation of the trials to an area nine miles from the animals (J. Carretta, pers. comm., June 1997).

A study to assess the impact of loud low-frequency active sonar signals by the U.S. Navy is underway. The Navy has completed a three-phase research program as the basis for an Environmental Impact Statement (EIS) on their Low-Frequency Active (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 off California, and phase III focused on its effects on breeding humpback whales off Hawaii. The EIS planning and writing are underway, and the draft EIS is expected to be completed in late 1998 or early 1999.

In addition to the potential effects from sonar and other sounds and from ordnance drops associated with training activities, military traffic contributes to the overall problem of vessel traffic (see above).

5. Hunting. As indicated above, there is no doubt that hunting had a severe impact on blue whales in the North Pacific. Areas of former abundance, notably off Japan and the Aleutian Islands, are currently host to very few blue whales (Stewart *et al.* 1987; Miyashita *et al.* 1995), strongly

suggesting that whaling gravely depleted the populations concerned.

According to Yablokov (1994), citing Zemsky and Shazhinov (1982), "It was ... well known in the Soviet Union that blue whales continued to be killed [in the Southern Hemisphere] after they were protected by the IWC." Details of these illegal kills have been reported recently (Zemsky *et al.* 1995a, 1995b). Although Yablokov (1994) stated that Russia also made illegal catches in the North Pacific from both land stations and pelagic operations, no information on these takes has been published. If these unreported catches included large numbers of blue whales, they would almost certainly have had a significant negative impact on the recovery of the species in this region.

IV. RECOVERY ACTIONS AND IMPLEMENTATION

Given the similar management and research needs involved, the North Atlantic and North Pacific blue whale populations are treated together in this section rather than separately. Accordingly, the summary of conservation efforts and recommended actions given below is applicable to both oceanic populations, except where indicated.

No whaling (either "aboriginal subsistence" or commercial) for blue whales occurs at present. Moratoria on the deliberate killing of blue whales have been in force for several decades, and these have undoubtedly had a positive effect on the species' conservation. The threat of renewed commercial whaling was one of the primary factors in the decision to add blue whales to the list of Endangered and Threatened Wildlife. For now, and presumably for the foreseeable future, this threat is not likely to recur.

The regulation of whalewatching activities in the River and Gulf of St. Lawrence, Canada (see above), and to a much lesser extent in the northeastern United States, can be viewed as providing some benefits to blue whales. There are currently no whalewatching or vessel approach regulations in U.S. or Mexican waters except those explicitly directed at protecting North Atlantic right whales in U.S. waters. Whale watching guidelines have been issued by NMFS for other endangered species and there are general prohibitions on harassment of marine mammals.

A. Goals and Objectives

The overall long-range goal of this Recovery Plan is to promote recovery of blue whale populations 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, 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."

The primary purpose of the Plan is to identify a set of actions that will minimize or eliminate effects from human activities that are detrimental to the recovery of blue whale populations. Immediate objectives are to identify factors that may be limiting the populations and actions necessary to allow the populations to increase.

Since blue whales move freely across international borders, it is not reasonable to confine recovery efforts to U.S. waters, and this Plan stresses the importance of a multi-national approach to blue whale protection. The Plan recognizes limits imposed by the national nature of protective legislation; however, as demonstrated by recent work on humpback whales (Palsbøll *et al.* 1997), considerably more information becomes available for management of human activities affecting whale populations when actions are taken based on biological rather than political divisions, and through international cooperation leading to research and conservation at oceanic rather than national levels.

Tasks required to achieve the objectives of this Plan are listed in the step-down outline below.

B. Stepdown Outline

Items in this outline are not in order of priority. Priorities are identified in Appendix A.

1.0. Determine Stock Structure of Blue Whale Populations Occurring in U.S. Waters and Elsewhere.

1.1 Determine stock structure of blue whales using genetic analyses.

1.2 Assess daily and seasonal movements and inter-area exchange, using telemetry.

2.0. Estimate the Size and Monitor Trends in Abundance of Blue Whale Populations.

2.1 Conduct surveys to estimate the size and monitor trends in abundance of populations.

2.2 Conduct annual independent photo-identification surveys.

2.3 Maintain existing blue whale photo-identification catalogs and sighting databases, and establish others as required.

2.4 Promote international efforts to estimate abundance and investigate stock structure of blue whales in non-U.S. waters.

3.0. Identify and Protect Habitat Essential to the Survival and Recovery of Blue Whale Populations.

3.1 Promote action to protect areas of importance in U.S. waters.

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

3.3 Improve knowledge of blue whale feeding ecology.

3.4 Improve knowledge of the characteristics of important blue whale habitat, and of how blue whales use such habitat.

4.0. Reduce or Eliminate Human-caused Injury and Mortality of Blue Whales.

4.1 Identify areas where ship collisions with blue whales might occur, and areas where concentrations of blue whales coincide with significant levels of maritime traffic or pollution.

4.2 Identify and implement methods to reduce ship collisions with blue whales.

4.3 Reduce or eliminate injury and mortality caused by fisheries and fishing gear.

4.4 Conduct studies of environmental pollution that may affect blue whale populations and their habitat.

5.0. Minimize Detrimental Effects of Directed Vessel Interactions with Blue Whales.

5.1 Investigate the potential effects of whale watching on blue whales.

5.2 Implement appropriate protective measures on any such activities which may be detrimental to blue whales.

6.0. Maximize Efforts to Acquire Scientific Information from Dead, Stranded, and Entangled Blue Whales.

6.1 Improve and maintain the system for reporting dead or entangled blue whales.

6.2 Improve and maintain existing programs to collect data from dead blue whales.

7.0. Coordinate State, Federal, and International Efforts to Implement Recovery Actions for Blue Whales.

7.1 Designate an implementation coordinator to facilitate Recovery Plan implementation.

7.2 Identify, at an appropriate time, representatives of the scientific community, private, state, and federal agencies (and international agencies where applicable) to periodically review and update this Recovery Plan.

7.3 Support a continued international ban on commercial hunting and other directed lethal take of blue whales, and encourage international efforts to detect and prevent illegal whaling.

8.0. Establish Criteria for Deciding Whether to Delist or Downlist Blue Whales.

8.1 Establish criteria for delisting or downlisting blue whale populations.

C. Narrative

Data collected through any research identified in this Plan should be analyzed and reported in a timely manner. Reports should be thoroughly referenced and follow standards of organization to facilitate comparison with other reports. 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 commentary.

To the maximum extent possible, ongoing and future data collection should be done such that recent data can be compared with historical data. Studies may need to be conducted to calibrate results from newly developed techniques with those obtained by previous methods. Data analyses should examine trends over time and attempt to correlate observed changes with physical, biological, or human-induced changes in the environment.

1.0. Determine Stock Structure of Blue Whale Populations Occurring in U.S. Waters and Elsewhere.

Existing knowledge of the population structure of blue whales is insufficient, and a more comprehensive understanding is essential to developing effective strategies to promote recovery.

1.1 <u>Determine stock structure of blue whales using genetic analyses.</u>

A comprehensive program of biopsy sampling of blue whales should be implemented that focuses on current and historically important blue whale habitat in both U.S. waters and elsewhere. Ideally, this would be a collaborative multi-national effort with standardized sampling protocols. Using the resulting samples, population structure can be investigated through analyses of mitochondrial and nuclear DNA. In addition, the sexual composition of each population should be assessed through molecular determination of the sex of all sampled whales. All biopsy samples should be preserved in such a way that the accompanying blubber can be utilized for contaminant analyses (item 4.4 below). The genetics work should be complemented by a thorough review of existing data (from whaling catches and other sources) on inter-area differences in morphology and meristics of blue whales. An ancillary objective of genetic studies might be to evaluate genetic variability within populations or stocks of blue whales. A comparative approach, examining differences in genetic variability between recovering versus non-recovering groups of blue whales, could prove informative.

1.2 <u>Assess daily and seasonal movements and inter-area exchange, using telemetry.</u>

Telemetry studies (notably those using satellite-monitored radio tags) should be conducted to gather information on patterns and ranges of daily and seasonal movement of individual blue whales. These studies also have the potential to address the question of exchange between subpopulations.

2.0. Estimate the Size and Monitor Trends in Abundance of Blue Whale Populations.

Estimation of abundance, and of trends in abundance, is vital to assessing the recovery of blue whale populations, yet reliable data for such estimation exist only for the California/Mexico population (see III.A.7, above). Given the known range of the blue whale, a multinational effort is essential to achieve this goal.

2.1 <u>Conduct surveys to estimate the size and monitor trends in abundance of populations.</u>

Surveys using line-transect and photo-identification methods should be conducted to assess abundance in present or historic blue whale habitat. In U.S. waters, this includes the entire west coast and the Aleutian Islands region. Collaborative multinational efforts with standardized sampling protocols should be developed to integrate such studies with others conducted off Mexico, Canada (both Pacific and Atlantic coasts) and areas more remote from U.S. waters. Knowledge derived from the population structure studies outlined above would be used to assist in interpretation of the results of this work. Because of the relatively long generation time of blue whales, and the time scales on which environmental factors affecting their distribution may operate, programs to monitor trends in blue whale abundance must be long-term efforts.

2.2 Conduct annual independent photo-identification surveys.

Photographic identification of individual blue and other large whales has proven to be a valuable tool for estimating abundance, determining vital rates, investigating population structure, and studying a variety of other aspects of biology and behavior. A long-term collaborative photo-identification effort in the California/Mexico region has yielded considerable information on this population. The continuation of such surveys is very important to the monitoring of this stock. In addition, international efforts to support photo-identification studies in other blue whale habitats should be encouraged. The photo-identification studies would also complement the continued maintenance of photo-identification catalogs (item 2.3, below).

2.3 Maintain existing blue whale photo-identification catalogs and sighting databases, and establish others as required.

The three existing blue whale photo-identification catalogs include blue whales identified (i) off California, Mexico and adjacent regions; (ii) in the western North Atlantic, with an emphasis on the Gulf of St. Lawrence; and (iii) in waters of Baja California including inshore and offshore areas of both coasts of the Peninsula. Continued support for these catalogs is essential to improving knowledge of the status and basic biology of this species. When other concentrations of blue whales are located during the survey work recommended above, as many animals as possible should be photo-identified and new regional catalogs established. A network should also be formed to examine inter-area movements of individually identified blue whales to increase knowledge of population structure, and to integrate the results of genetic and sex-determination analyses with photo-identification studies.

Centralization of these databases would promote efficiency in addressing questions related to occurrence and habitat use. Sighting data would complement information from photo-identification catalogs and other sources.

2.4 Promote international efforts to estimate abundance and investigate stock structure of blue whales in non-U.S. waters.

As noted above, a multinational collaborative scientific effort will be required for understanding blue whale population structure and abundance at oceanic scales. Effective conservation and recovery of the species can occur only if this broad-scale approach is taken.

3.0. Identify and Protect Habitat Essential to the Survival and Recovery of Blue Whale Populations.

Some areas are known to be important habitat for blue whales; others may be discovered during the course of the studies recommended above. Protection of these areas is essential to population recovery.

3.1 Promote action to protect areas of importance in U.S. waters.

Areas of known importance include the waters off California and, historically, the Alaska/Aleutian Island region, although as noted above, blue whales may no longer be abundant in the latter region. The U.S. east coast does not appear to be a region of importance to blue whales; only occasional sightings and strandings are reported there.

It is also important to identify and protect other habitats essential to the survival and recovery of blue whales. Identification of such habitat would be accomplished using information gained from studies conducted under item 3.4 below.

3.2 Promote action to protect known areas of importance in foreign waters

Efforts should be made to encourage the governments of Canada, Mexico, and other relevant countries to protect blue whale habitat, and to join multi-national efforts of this nature. In Canada, areas important to blue whales include the Gulf of St. Lawrence, coastal waters of Newfoundland, the Scotian Shelf in the North Atlantic, and the eastern Gulf of Alaska in the North Pacific. In Mexico, the waters of Baja California, particularly the southwestern portion of the Gulf of California where nursing, feeding, and probably calving occurs, are clearly of great importance to many eastern North Pacific blue whales, including whales that spend part of the year in U.S. waters. Other areas of known importance (past or present) include the waters of Costa Rica, Iceland, Norway, Japan, and the Russian Far East.

3.3 Improve knowledge of blue whale feeding ecology.

Studies designed to improve knowledge of blue whale prey type, dietary requirements, and energetics are needed for a better understanding of both habitat use and recovery potential. This is particularly true in light of the blue whale's nearly total dependence on euphausiids, which makes it vulnerable to environmental or other catastrophes resulting in major declines in krill abundance. An avenue of research that could be pursued is to compare features of areas where blue whales appear to be recovering (e.g., Iceland, California/Mexico) with areas where they seem not to be (e.g., off Norway, south of the Aleutian Islands). A testable hypothesis might be that populations with slow recovery rates feed on pelagic aggregations of euphausiids, which tend to be less dense and more patchy than those in nearshore areas, on which the strongly recovering blue whale populations feed (D. Croll and B. Tershy, pers. comm., August 1997).

3.4 Improve knowledge of the characteristics of important blue whale habitat, and of how blue whales use such habitat.

Characterization of habitat used by blue whales is essential to identifying other potentially important areas, and to future assessments of the health of the environments on which blue whales depend. Such characterizations would include prey type and abundance, and associated oceanographic features. Studies to determine interannual variability in habitat characteristics, and in blue whale habitat use, are important components of such work. The end-goal should be to develop a predictive framework for identifying other potentially important blue whale habitat.

4.0. Reduce or Eliminate Human-caused Injury and Mortality of Blue Whales.

Vessel strikes and entanglement in fishing gear are known to kill and injure blue whales. The frequency and significance to the population need to be studied. Implementation of appropriate measures designed to reduce or eliminate such problems are essential to recovery.

4.1 Identify areas where ship collisions with blue whales might occur, and areas where concentrations of blue whales coincide with significant levels of maritime traffic or pollution.

Research on the frequency with which shipping-related mortalities occur in blue whales is desirable, given that mortalities from this source are known, and others have almost certainly gone unrecorded. Studies to quantify the volume and type of shipping traffic in areas known to be important to blue whales are also required. This task will be assisted by efforts to improve detection and reporting of blue whale mortalities (item 6.1 below).

4.2 Identify and implement methods to reduce ship collisions with blue whales.

The practicality and effectiveness of measures to reduce ship strike mortalities should be assessed.

4.3 Reduce or eliminate injury and mortality caused by fisheries and fishing gear.

If observations from fishery observer programs, whalewatching vessels, researchers, or other sources indicate that entanglement represents a serious threat to the recovery of blue whales, actions should be taken to reduce or eliminate deaths from this cause.

4.4 Conduct studies of environmental pollution that may affect blue whale populations and their habitat.

Baleen whales (including blue whales) generally have lower levels of contaminants than odontocetes. However, nothing is known about the effects of pollutants on blue whales, notably regarding long-term impacts, transgenerational 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 effect of sex, age, reproductive condition and geographic origin on contaminant burdens. Biopsy samples collected under item 1.1 will be usable for much of this work. Studies should also be conducted to examine the impact on blue whales or blue whale habitat of point-source and other types of pollution, including low-frequency noise.

5.0. Minimize Detrimental Effects of Directed Vessel Interactions with Blue Whales.

An active whalewatching industry targeting blue whales has already developed in California, yet the impact of such activities is unknown. Excessive directed activity (whether from commercial vessels, private boats or aircraft) could potentially disrupt vital behavior such as feeding or nursing.

5.1 Investigate the potential effects of whale watching on blue whales.

Studies should be conducted to assess the effects of directed vessel and aircraft interactions on blue whale behavior.

5.2 Implement appropriate protective measures on any such activities which may be detrimental to blue whales.

If the studies recommended in item 5.1 indicate that certain types or numbers of boat or aircraft approaches adversely affect blue whales, appropriate measures should be developed and implemented.

6.0. Maximize Efforts to Acquire Scientific Information from Dead, Stranded, and Entangled Blue Whales.

Assessments of the causes and frequency of mortality (either natural or anthropogenic) are extremely important to understanding blue whale population dynamics and the threats that may impede recovery. However, the discovery of a blue whale carcass in circumstances in which it can be examined closely is a rare event. Accordingly, efforts to detect and investigate blue whale mortalities should be made as efficient as possible. Live entanglements of blue whales are rarely observed, but better reporting might provide rescue opportunities.

6.1 Improve and maintain the system for reporting dead or entangled blue whales.

In order to optimize detection and reporting of dead blue whales (whether stranded or observed at sea), the Large Whale Recovery Program coordinator should work with representatives of local, state and federal agencies, private organizations, and regional and national stranding networks to facilitate efficient observer coverage and information exchange. In addition, prompt reporting of live entanglements might provide opportunities for disentanglement rescue teams to release whales or remove gear being towed.

6.2 Improve and maintain existing programs to collect data from dead blue whales.

Each blue whale carcass represents an opportunity for scientific investigation of the cause of mortality, as well as of numerous other questions relating 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. Stranding network coordinators and the implementation coordinator should work with relevant agencies, organizations, and individuals to ensure that, when a blue whale carcass is reported and secured: (i) necropsy is performed as rapidly and as thoroughly as possible by qualified individuals selected to gather information regarding cause of death; (ii) samples are taken and optimally preserved for studies of genetics, toxicology, pathology, histology, and other subjects; and (iii) funding is available to rapidly notify and transport appropriate experts to the site and to distribute tissue samples to appropriate locations for analysis or storage. In addition, the implementation coordinator should work with stranding networks and the scientific community to develop and maintain lists of tissue samples requested by various qualified individuals and agencies, and ensure that these samples are routinely collected from each carcass and stored in appropriate locations or distributed to appropriate researchers for analysis. It is recognized that extensive development of stranding networks has already taken place along much of the U.S. coastline. Existing protocols should be maintained indefinitely and improved where necessary to meet the requirements listed above.

Rapid detection of blue whale carcasses, and notification and transport of qualified personnel, are vital to ensuring that the maximum amount of information is obtained. Adequate funding is imperative.

7.0. Coordinate State, Federal, and International Efforts to Implement Recovery Actions for Blue Whales.

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

7.1 Designate an implementation coordinator to facilitate Recovery Plan implementation.

Many of the tasks identified in this Plan would best be accomplished by an implementation coordinator or coordinators with responsibility for overseeing the various aspects of the recovery plan process. Tasks include developing (with appropriate input from others) and administering research contracts, participating in interagency consultations under the ESA, and helping to develop, evaluate, and implement protection measures.

7.2 Identify, at an appropriate time, representatives of the scientific community, private, state, and federal agencies (and international agencies where applicable) to periodically review and update this Recovery Plan.

As the Plan is implemented, new information will be obtained and the priorities of the Recovery Plan will accordingly require periodic review and revision. Representatives of the relevant agencies and the scientific community should be appointed to review and revise the Plan every five years for the first 15 years of implementation, and every ten years thereafter. This schedule would, of course, be subject to change in the event of resumed whaling for blue whales or the occurrence of an environmental catastrophe causing significant blue whale mortality.

7.3 Support a continued international ban on commercial hunting and other directed lethal take of blue whales, and encourage international efforts to detect and prevent illegal whaling.

The international ban on the hunting of blue whales has been vital to recovery efforts. In light of the continued low abundance of blue whales in most areas, continuation of this ban is essential. While there is currently no known illegal whaling of blue whales, it is important that international efforts to detect any future infractions be supported.

8.0. Establish Criteria for Deciding Whether to Delist or Downlist Blue Whales.

Development of scientifically defensible criteria for eventual downlisting or delisting of any endangered species is an essential part of recovery plan implementation. However, any application of such criteria requires good information about the discreteness of populations, population sizes and trends in abundance, and the nature and magnitude of threats; thus, the criteria cannot be reasonably developed prior to the acquisition of such information.

8.1 Establish criteria for delisting or downlisting blue whale populations.

A de/downlisting criteria workshop should be convened at such time as the implementation team judges that sufficient information has been gained about blue whales to develop such criteria. The workshop should include representatives of relevant agencies as well as acknowledged experts on blue whales and individuals with expertise in scientific and statistical fields essential to the success of the workshop.

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APPENDIX A

Blue Whale Recovery Plan Implementation Schedule and Cost Estimates

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 prioritizes individual tasks to emphasize their importance in the recovery effort. The priority system and the criteria for each priority is based on an established NMFS policy (55 CFR 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 blue whale recovery tasks. Also, identification of cost estimates does not assign responsibility for providing support to NMFS or any other agency or group. The costs associated with the various recovery tasks listed below are for those to be implemented in U.S. waters only. Costs associated with promotion of international action have not been estimated.