DRAFT
RECOVERY PLAN FOR THE
NORTH PACIFIC RIGHT WHALE

(*Eubalaena japonica*)

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

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NOAA FISHERIES

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(*Eubalaena japonica*)

Prepared by:

Office of Protected Resources
National Marine Fisheries Service

Approved: ______________________
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Date: 1/16/13

PREFACE

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

The goals and objectives of the Plan can be achieved only if a long-term commitment is made to support the actions recommended herein. 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, tribal, and local governments, industry, academia, nongovernmental organizations, and individuals will be required throughout the recovery period.

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Cover photo of North Pacific right whale by Brenda Rone, Permit 982-1719, Courtesy of NMFS, National Marine Mammal Laboratory.

DISCLAIMER

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

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LIST OF TERMS AND ACRONYMS

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

CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CV	coefficient of variance
dB	decibels
Delisting	removal from the list of Endangered and Threatened Wildlife and Plants
Downlisting	considered for reclassification from endangered to threatened under the ESA
DOS	U.S. Department of State
ESA	Endangered Species Act
Hz	hertz
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
kHz	kilohertz
LFA	low frequency active (for sonar)
m	meters
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
SURTASS	Surveillance Towed Array Sensor System

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EXECUTIVE SUMMARY

Current Species Status: The North Pacific right whale, *Eubalaena japonica*, is among the rarest of all large whale species. The Northern right whale, *Eubalaena glacialis*, was listed under the precursor to the Endangered Species Act (ESA), the Endangered Species Conservation Act of 1969, and remained on the list of threatened and endangered species after the passage of the ESA in 1973 (35 FR 18319, December 2, 1970). In 2008, NMFS reclassified the Northern right whale as two separate endangered species, North Pacific right whale (*E. japonica*) and North Atlantic right whale (*E. glacialis*) (73 FR 12024, March 6, 2008).

Past commercial whaling decimated North Pacific right whale populations, with the species likely numbering fewer than 1,000 individuals. This Recovery Plan identifies two populations of North Pacific right whales. The eastern population is located primarily in the U.S. Exclusive Economic Zone, with an estimated historical seasonal migration range extending from the Bering Sea and Gulf of Alaska in the north down the west coast of the United States to Baja California in the south. The eastern population is estimated to consist of approximately 30 individuals. The western population is located primarily in the Exclusive Economic Zones of Russia, Japan, and China. Its estimated historical seasonal migration range extends from the Okhotsk Sea and northwards to the coasts of China and Vietnam to the south. The western population is estimated to consist of approximately 900 individuals.

Right whale sightings have been very rare (notably in the east) and geographically scattered, leading to persistent uncertainty and data gaps. Small populations and rarity of sightings make it very difficult to estimate current range, habitat use, and population parameters. Therefore, a primary goal of this Recovery Plan is to gain more data needed for effective management.

Habitat Requirements and Limiting Factors: The North Pacific right whale populations have been legally protected from commercial whaling for the past several decades, and this protection continues. Although the main direct threat to North Pacific right whales was addressed by the International Whaling Commission's (IWC) 1982 moratorium on commercial whaling, several potential threats remain. Among the current potential threats are environmental contaminants, the potential for reduced prey abundance or location due to climate change, the potential for increased risk of ship collisions, and exposure to anthropogenic noise corresponding with use of the Arctic for energy development and commercial maritime traffic, which may increase as climate change makes the Arctic more accessible for longer periods of the year. The most significant threat to the eastern population is its extremely small population size, posing a heightened risk for biological extinction if individuals are lost to ship strikes or other threats.

Recovery Strategy: This plan identifies measures to protect, promote, and monitor the recovery of North Pacific right whale populations. Because the most significant historical threat to North Pacific right whales (whaling) is being addressed, and there is a paucity of population data for the species, the primary component of this recovery program is data collection. The collection of additional data will facilitate estimating population size, monitoring trends in abundance, and determining population structure. These data will also provide greater understanding of natural and anthropogenic threats to the species. Key elements of the recovery program for this species are 1) coordinate state, federal, and international actions to maintain whaling prohibitions; 2) estimate population size and monitor trends in abundance; 3) determine North Pacific right whale occurrence, distribution, and range; 4) identify, characterize, protect, and monitor habitat essential to North Pacific right whale recovery; 5) investigate the impact of human-caused threats on North Pacific right whales.

Recovery Goals and Criteria: The goal of this recovery plan is to promote the recovery of North Pacific right whales to the point at which they can be removed from the list of endangered and threatened Wildlife and Plants under the provisions of the ESA. The intermediate goal is to reach a sufficient recovery status to reclassify the species from endangered to threatened.

The recovery criteria presented in this Recovery Plan were based on the *Report of the Workshop on Developing Recovery Criteria for Large Whales Species* (Angliss *et al.* 2002). Workshop objectives were to develop (a) a general framework for the development of recovery criteria that would be applicable to most marine mammal species, large whale species in particular, and (b) specific criteria that can be used to apply the framework to specific populations. A major goal was to use North Pacific and North Atlantic right whales as case studies, and to develop a specific set of recovery criteria which could be used for these populations.

Downlisting Criteria:

North Pacific right whales will be considered for reclassifying from endangered to threatened when both of the following are met:

> 1. Given current and projected threats and environmental conditions, each North Pacific right whale population (eastern and western) satisfies the risk analysis standard for threatened status (has no more than a 1% chance of extinction in 100 years) *and* the global population has at least 1,500 mature, reproductive individuals (consisting of at least 250 mature females and at least 250 mature males in each ocean basin). Mature is defined as the number of individuals known, estimated, or inferred to be capable of reproduction. Any factors or circumstances that substantially contribute to a real risk of extinction but cannot be incorporated into a Population Viability Analysis will be carefully considered before downlisting takes place.
>
> 2. None of the known threats to North Pacific right whales limit the continued growth of populations. Specifically, the factors in section 4(a)(l) of the ESA are being or have been addressed: (A) the present or threatened destruction, modification, or curtailment of a species' habitat or range; (B) overutilization for commercial, recreational, or educational purposes; (D) the inadequacy of existing regulatory mechanisms; and E) other natural or manmade factors (there are no criteria for Factor C, disease or predation).

It is important to emphasize that North Pacific right whales will be considered for downlisting only when all criteria are met globally—minimum abundance level is met, risk analysis standard for threatened status (has no more than a 1% chance of extinction in 100 years) has been satisfied, and all known threats have been addressed.

Delisting Criteria:

North Pacific right whales will be considered for removal from the list of Endangered and Threatened Wildlife and Plants under the provisions of the ESA when both of the following are met:

> 1. Given current and projected threats and environmental conditions, each North Pacific right whale population (eastern and western) satisfies the risk analysis standard for unlisted status (has less than a 10% probability of becoming endangered (as defined above) in 20 years). Any factors or circumstances that are thought to substantially contribute to a real risk of extinction that cannot be incorporated into a Population Viability Analysis will be carefully considered before delisting takes place.
>
> 2. None of the known threats to North Pacific right whales are known to limit the continued growth of populations. Specifically, all the factors in section 4(a)(l) of the ESA have been addressed: (A) the present or threatened destruction, modification or curtailment of a species' habitat or range; (B) overutilization for commercial, recreational or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors.

Anticipated Date of Recovery: The time and cost to recovery is not predictable with the current information on North Pacific right whales. The difficulty in gathering data and the extremely small abundance of eastern North Pacific right whales make it impossible to give a timeframe to recovery for this species. While we estimate costs for some recovery actions, any projections of total costs to accomplish recovery would be imprecise and unrealistic. Therefore, for ongoing actions we have estimated only costs for the next 50 years, as it is expected that recovery would take at least that long. Currently it is impossible to predict when the protections provided by the ESA will no longer be warranted. In the future, as more information is obtained, it should be possible to make better informed projections about the time for recovery and its expense.

Estimated Cost of Recovery Actions (First 50 Fiscal Years): $17.183 Million

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TABLE OF CONTENTS

I. BACKGROUND

A. Brief Overview

The North Pacific right whale, *Eubalaena japonica*, is among the rarest of all large whale species. The Northern right whale, *Eubalaena glacialis*, was listed under the precursor to the Endangered Species Act (ESA), the Endangered Species Conservation Act of 1969, and remained on the list of threatened and endangered species after the passage of the ESA in 1973 (35 FR 18319, December 2, 1970). In 2008, NMFS reclassified the Northern right whale as two separate endangered species, North Pacific right whale (*E. japonica*) and North Atlantic right whale (*E. glacialis*) (73 FR 12024, March 6, 2008).

There is reason for serious concern about the future of the eastern North Pacific right whale population. Because right whales are a long-lived species, extinction may not occur in the near future, but the possibility of biological extinction of the eastern population in this or the next century is very real. Reliable information on the biology and ecology of this population is essential to allow managers to make knowledgeable management decisions. Informed decisions can only be made based on rigorously designed and executed studies. Therefore, one of the most important components of this plan is the identification of data needs and the types of studies required to obtain those data.

B. Species Description, Taxonomy, and Population Structure

Species Description

The North Pacific right whale, *Eubalaena japonica* (Rosenbaum *et al.* 2000), is a large, robust baleen whale. Right whale adults typically are 13–16 m long (Aguilar *et al.* 2002), but may measure up to 17.8 m and weigh up to 100 tons (Cummings 1983), with females growing larger than males. Distinguishing features for right whales include a stocky body, generally black coloration (although some individuals have white patches on their undersides), lack of a dorsal fin, a large head (about 1/4 of the body length), strongly bowed margin of the lower lip, and callosities on the head region. Two rows of long (2 to 3 m), dark baleen plates hang from the upper jaw, with 200 to 270 plates on each side. The tail is broad, deeply notched, and all black with a smooth trailing edge.

Hearing and Vocalizations

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

There is no direct information about the hearing abilities of baleen whales. However, it is generally assumed that most animals hear well in the frequency ranges similar to those used for their vocalizations. Also, estimation of hearing ability based on inner ear morphology has been completed on two mysticete species: humpback whales (*Megaptera novaeangliae*) (700 hertz [Hz] to 10 kHz; Houser *et al.* 2001) and North Atlantic right whales (10 Hz to 22 kHz; Parks *et al.* 2007). Preliminary anatomical data indicate minke whales may be able to hear slightly above 22 kHz (Ketten and Mountain 2009). The anatomy of the baleen whale inner ear seems to be well-adapted for detection of low-frequency sounds (Ketten 1991; 1992; 1994).

Baleen whale calls are also predominantly at low frequencies, mainly below 1 kHz (Richardson *et al.* 1995), and their hearing is presumed to be strong at corresponding frequencies. Southall *et al.* (2007) estimated the hearing range of low-frequency cetaceans extends from approximately 7 Hz to 22 kHz. Additional data support this approximate hearing range for mysticetes. For example, Watkins (1986) reported a variety of mysticete species responding to sounds up to 28 kHz; Au *et al.* (2006) reported humpback whale songs having harmonics that extend beyond 24 kHz; and Frankel (2005) and Lucifredi and Stein (2007) reported gray whales potentially responding to sounds beyond 22 kHz. Thus, the auditory system of baleen whales is almost certainly more sensitive to low-frequency sounds than that of the small- or moderate-sized toothed whales. However, auditory sensitivity in at least some large whale species extends up to higher frequencies than the maximum frequency of the calls, and relative auditory sensitivity at different low-moderate frequencies is unknown.

Taxonomy

The North Pacific and North Atlantic right whales were originally considered a single species, *Eubalaena glacialis* (Muller 1776), while the southern right whale, *Eubalaena australis* (Desmoulins 1822), was considered a separate, but closely related species. Initial classification of *E. glacialis* and *E. australis* was based on a single morphological character in the orbital region of the skull analyzed in limited specimens from each hemisphere (Muller 1776). The Northern and Southern Hemisphere forms were subsequently separated based on skeletal and genetic data (Muller 1776; (Schaeff *et al.* 1997). In 2008, NMFS listed the North Pacific right whale as a separate species under the ESA based on new genetic studies (Rosenbaum *et al.* 2000).

Population Structure

In the United States, North Pacific right whales are managed under three constructs: the Marine Mammal Protection Act (MMPA), the ESA, and the International Convention for the Regulation of Whaling (ICRW), all with different objectives and, therefore, different terminology for population structure. The goal of the MMPA is to protect marine mammal species by maintaining marine mammal population "stocks" as functioning elements of their ecosystem; the

International Whaling Commission (established under the terms of the ICRW) manages whales with a goal of maintaining healthy stocks while authorizing hunts to meet aboriginal needs (and potentially commercial catches), scientific research and related purposes; and the ESA seeks to avoid extinction and recover threatened and endangered species to a point at which they no longer need ESA protections.

During the 1983 IWC right whale workshop (IWC 1986), the Scientific Committee recommended distinguishing eastern and western North Pacific stocks separately, but stated "no conclusion can be reached concerning the identity of biological populations." NMFS has assumed the existence of a single stock in the North Pacific (Angliss *et al.* 2001). However, some authors, such as Brownell *et al.* (2001), have discussed the possibility that North Pacific right whales exist in discrete eastern and western North Pacific stocks; and that the western group may occur in two separate populations. In particular, Brownell *et al.* (2001) pointed to the different catch and recovery histories of the eastern and western populations as support for such a division. This plan adopts the view that there are two separate stocks in the North Pacific, the eastern and western, since this represents the risk-averse approach to management of what is clearly a critically endangered animal.

Past commercial whaling left the small, remnant populations of North Pacific right whales vulnerable to low genetic variability exacerbated by genetic drift and inbreeding. Low diversity potentially affects individual whales by depressing fitness, lowering resistance to disease and parasites, and diminishing the whales' ability to adapt to environmental changes. At the population level, low genetic diversity can lead to slower growth rates, lower resilience, and poorer long-term fitness (Lacy 1997). Marine mammals with an effective population size of a few dozen individuals likely can resist most of the deleterious consequences of inbreeding (Lande 1991). However, it has also been suggested that if the number of reproductive animals is fewer than 50, the potential for impacts associated with inbreeding increases substantially. From a dataset that included historical samples, Rosenbaum *et al.* (2000) found genetic diversity in North Pacific right whales to be relatively high compared to North Atlantic right whales (*E. glacialis*), but their limited dataset suggested lower genetic diversity from their few recent samples.

C. Zoogeography

Right whales have occurred in all the world's oceans from temperate to subpolar latitudes. The pre-exploitation distribution of the North Pacific right whale likely included the temperate and subarctic, coastal, and/or continental shelf waters of the North Pacific Ocean. Although the original listing for right whales did not provide an explanation, it is understood that the main reason for listing is that most populations were severely depleted by commercial whaling.

At least two populations, an eastern and a western, occur in the North Pacific (Brownell *et al.* 2001). Although small, these populations appear large enough to sustain at least some reproduction (Goddard and Rugh 1998; Miyashita and Kato 1998; Leduc 2004). Little is known about the eastern North Pacific right whale population, which was severely depleted by commercial whaling in the 1800s (Brownell *et al.* 2001), further reduced by illegal Soviet whaling in the 1960s (Doreshenko 2000), and which is now estimated to consist of only 30 animals (Wade *et al.* 2011a).

D. Life History

D.1 Distribution and Habitat Use

Due to small population sizes, much remains unknown about how right whales live, breed, and feed in the eastern and western portions of the North Pacific. Information on the historical range, current known distribution, and potential migratory routes and seasonal patterns are discussed below.

Historical Range

Recent studies investigating the potential historical range of North Pacific right whales are largely based on integrating past whaling catch data with recent sightings and oceanographic models using innovative mapping techniques. It has been asserted that right whales historically ranged across the entire North Pacific Ocean from the western coast of North America to the Russian Far East and down to Baja California and the Yellow Sea (Woodhouse and Strickley 1982; Brueggeman *et al.* 1986; Scarff 1986; Goddard and Rugh 1998; Gendron *et al.* 1999; Brownell *et al.* 2001; Clapham *et al.* 2004; Shelden *et al.* 2005). However, Josephson *et al.* (2008a) present modeling data that suggest a pronounced longitudinal bimodal distribution, with fewer whales found in the central North Pacific compared to the eastern and western regions. Additionally, Shelden (2006) suggests that records of right whales in southern California and Hawaii likely represented vagrant individuals.

Clapham *et al.* (2004) integrated 20th century sighting data with 19th century whaling records to reveal an extensive offshore distribution; however, some of these historical data are now known to involve species other than right whales (Josephson *et al.* 2008a). Overall, the species' range has most likely contracted in the North Pacific relative to its spread during the peak period of whaling in the 19th century (Clapham *et al.* 2004). Analysis of Soviet whaling catch records (primarily from 1963–1964) by Ivashchenko and Clapham (2012) shows a broad offshore distribution in the Gulf of Alaska, consistent with 19th century historical whaling data (Townsend 1935).

Current Distribution and Research

The majority of directed research on eastern North Pacific right whales has been conducted by the NMFS National Marine Mammal Lab (NMML) under a program funded by the Bureau of Ocean Energy Management. Recent research using habitat modeling and acoustic monitoring has revealed finer-scale spatial information useful for conservation planning throughout the species range. The western Gulf of Alaska and the southeast Bering Sea are, or were, frequently used areas, with 90 percent of Japanese and Russian encounters (1940s–1960s) occurring between 170°W and 150°W south to 52°N and between 173°W and 161°W south from 58°N (Clapham *et al.* 2006; Ivashchenko and Clapham 2012). Similarly, Zerbini *et al.* (2010) tracked four whales throughout a relatively small area between 56–58°N and 163–167°W primarily in the 50–100 m isobaths for over a month during summer; they found that only one whale moved into the North Aleutian Basin for two days, likely in search of prey. Though whales historically frequented the Gulf of Alaska, Albatross Bank is the only location within the Gulf where this species has been repeatedly identified (and only a few times) for the last four decades (Wade *et al.* 2011b).

With little sighting data available for this species, it is not yet apparent what areas have been abandoned or have not yet been reinhabited by the current stocks (Clapham *et al.* 2006). Based on aerial surveys in 2008 and 2009, Rone *et al.* (2010) suggest that right whales consistently occupy a smaller area than would be predicted based on identified critical habitat in the southeastern Bering Sea. A claim by Tynan *et al.* (2001) that right whales had shifted their distribution within the last 50 years was based on inadequate survey coverage and lack of historical whaling data; it has since been contradicted by the discovery of 17 right whales outside the middle-shelf domain in the southeastern Bering Sea in the summer of 2004 (Wade *et al.* 2006), and again in October 2005 when approximately 12 right whales were observed just north of Unimak Pass (NMML unpublished data).

Overall, while information on distribution has come from NMML surveys of the Bering Sea, there has been very little effort in the Gulf of Alaska, and almost no survey coverage of the offshore waters of the Gulf that functioned as habitat for right whales as recently as the period of Soviet illegal catches in the 1960s.

Seasonal Migration

Little is known about the migratory behavior of either the western or eastern North Pacific right whales and little new information has arisen since the most recent review (NMFS 2006). Historical sighting and catch records provide the only information on possible migration patterns for North Pacific right whales (Omura 1958; Omura *et al.* 1969; Scarff 1986). Due to infrequent sightings and because whalers almost never reported right whales in winter, calving locations in the North Pacific remain unknown (Brownell *et al.* 2001; Scarff 2001; Clapham *et al.* 2004; Shelden *et al.* 2005). However, in an attempt to identify potential calving grounds, Good and Johnston (2010) conducted likelihood modeling of the North Pacific based on habitat preferences of North Atlantic right whales, and identified southern California, the Northwest Hawaiian Islands, the southern coast of China, and the northern coast of Vietnam as potential areas based on depth, sea surface temperature, and surface roughness. These modeling results present only potential locations, as few or no right whales have been seen in recent years in the North Pacific in fall, winter, or spring.

However, there have been some sightings south of high latitudes in those seasons. Since 1950, there have been at least three sightings from Washington, twelve from California, three from Hawaii, and two from Baja California, Mexico (Brownell *et al.* 2001). Since 1950, there have been two catches in the Yellow Sea in China, one catch in Korean waters in the Sea of Japan, two sightings in the Ryuku Islands, Japan (near Okinawa), four sightings in the Bonin Islands (Ogasawara, Japan), and four sightings on the Pacific side of Honshu, the main island of Japan (Brownell *et al.* 2001).

Unlike calving areas, more is known about right whale feeding areas. Based on recorded historical concentrations of whales in the Bering Sea and recent survey sightings, it is likely that feeding areas in the Okhotsk Sea and adjacent waters along the coasts of Kamchatka and the Kuril Islands together with the Gulf of Alaska have been important summer habitats for eastern North Pacific right whales (Scarff 1986; Goddard and Rugh 1998; Brownell *et al.* 2001; IWC 2001; Clapham *et al.* 2004; Shelden *et al.* 2005; Clapham *et al.* 2006). North Pacific right whales observed by Wade *et al.* (2011b) since 1998 in the Gulf of Alaska were all observed in shelf waters adjacent to Kodiak, Alaska. However, it should be noted that sightings in coastal or shelf waters are certainly a function of survey effort, and thus do not perfectly reflect current or historical distribution. In support of this caveat, sighting records also indicate that right whales frequently occur far offshore, with observed movements over abyssal depths (Scarff 1986; Mate *et al.* 1997). Acoustic recorders in the Gulf of Alaska detected right whale calls on only five days out of 70 months of recordings from 5 deepwater stations. The calls were heard at the deepwater station in the Gulf of Alaska ~500 km southwest of Kodiak Island in August and September of 2000, but no calls were detected from four other instruments deployed in deep water farther east during 2000 and 2001 (Mellinger *et al.* 2004). Whether this was a function of instrument detection range or of a generally low abundance of whales is unclear.

Based on acoustic recordings of right whale call patterns from 2000 to 2006, Munger *et al.* (2008) found that whales remain in the southeastern Bering Sea later in the year than was previously thought, and move into mid-shelf waters intermittently throughout the summer. More recent year-round acoustic monitoring has detected right whale vocalizations virtually year-round in the Bering Sea, although calls become far less common in mid-winter (NMML, unpublished). Fall and spring distribution is the most widely dispersed, with whales occurring in mid-ocean waters and extending from the Sea of Japan to the eastern Bering Sea. In winter, right whales have been found in the Ryukyu Islands, the Bonin Islands, the Yellow Sea, the Sea of Japan, Honshu Island Japan, Washington, California, and Baja California, Mexico (Omura *et al.* 1969; Scarff 1986; NMFS 2006). Although this general northward migration for spring and summer feeding is apparent, Clapham *et al.* (2006) cites uncertainty as to whether all or only some of the whales follow this seasonal movement. One individual sighted both in Hawaii and the Bering Sea in 1996 represents the only confirmed evidence of an annual migration (Kennedy *et al.* 2010). How these seasonal distribution patterns may have changed recently based on population structure, habitat availability, and prey resources is unknown.

North Atlantic and southern right whales are observed primarily in low-latitude shallow coastal waters during winter calving and in higher latitude shelf waters during the summer when distribution is most tightly linked to patchily distributed zooplankton prey (Winn *et al.* 1986; Perry *et al.* 1999; Gregr and Coyle 2009). Eastern North Pacific right whales in summer have been found apparently feeding in shelf waters of the eastern Bering Sea and south of Kodiak Island in the Gulf of Alaska (Tynan *et al.* 2001; Wade *et al.* 2011a; Wade *et al.* 2011b). As such, NMFS designated two areas as critical habitat in the Gulf of Alaska and the Bering Sea in 2006 (Allen and Angliss 2012; 73 FR 19000, April 2008). Clapham *et al.* (2006) observed that although the historic distribution of North Pacific right whales is significantly reduced, the waters of the western Gulf of Alaska and the Bering Sea remain critical habitat for this depleted species. This work to characterize and map critical habitat has resulted in improved understanding of how these whales might be utilizing suitable habitat areas in the North Pacific.

Right whales preferentially inhabit areas with high zooplankton abundance and must therefore adapt their behavior based on prevailing basin-scale oscillations and multi-year processes that govern currents, productivity, and food web structure (Kenney 1998; Greene *et al.* 2003; Angell 2005; Klanjscek *et al.* 2007; Gregr and Coyle 2009; Miller *et al.* 2011). Zooplankton abundance and density in the Bering Sea has been shown to be highly variable, and affected by climate, weather, ice extent, and oceanographic processes (Napp and Hunt 2001; Baier and Napp 2003).

Shelden *et al.* (2005) plotted 20th century records and found that seasonal distribution between offshore and shelf waters largely depended on sea surface temperature, surface mixing, and the presence of upwelling canyons. In this case, they suggest that the location and timing of suitable habitat at the regional scale is determined by local oceanographic processes that would differ for the eastern and western populations.

Similarly, Gregr (2011) overlaid whaling catches with ocean climate circulation models to show two non-overlapping areas of suitable habitat that consistently exhibited large water temperature gradients from year to year. Gregr (2010) suggests that eastern and western right whale lineages may have developed different habitat preferences. Several hypotheses exist on how right whales successfully find and use dynamic and shifting habitat areas (Gregr 2010). How these areas and processes will shift in a changing climate remains unknown, but these findings represent key information for present and future critical habitat designations.

D.2 Feeding and Prey Selection

Right whales are thought to feed largely on copepods (IWC 1986) and are skim ("ram") feeders, continuously filtering through their baleen while moving through a patch of zooplankton. This type of feeding strategy requires exceptionally high prey densities (Baumgartner *et al.* 2003; Baumgartner and Mate 2003; Baumgartner *et al.* 2011). Stomach content analysis has revealed that whales feeding in the Gulf of Alaska, Sea of Okhotsk, and the eastern Aleutian Islands consume primarily *Neocalanus plumchrus*, *Metridia sp*., and *N. cristatus*, respectively (Omura 1958) (Omura *et al.* 1969; Omura 1986). The predominant prey species in the southeastern Bering Sea has since been identified as *Calanus marshallae*, followed by *P. newmani* and *A. longiremis* (Tynan 1999; Coyle 2000; Tynan *et al.* 2001).

It is difficult to extrapolate dietary shifts and preferences in the North Pacific based on these limited survey samples (Shelden *et al.* 2005). North Pacific right whales were recently observed in three consecutive late summers apparently feeding on Albatross Bank, south of Kodiak Island in the Gulf of Alaska (Wade *et al.* 2011b). In all three years, the whales were associated with a high-density demersal layer of zooplankton near 175 m depths. The only net tow through this layer in proximity to a right whale found a mix of euphausiids and late-stage calanoid copepods rich in depot lipids, with a copepod assemblage of *Neocalanus cristatus* (26%), *N. flemingeri* (14%), *N. plumchrus* (10%), and *Calanus marshallae* (10%), similar to previous observations of stomach contents. Recent oceanographic sampling in the Critical Habitat in the southeastern Bering Sea will shed additional light on the question of prey preferences (M. Baumgartner, in prep.).

D.3 Competition

Nothing is known about possible competition between North Pacific right whales and sympatric species.

D.4 Reproduction

Due to the logistical challenges of studying small populations, little is known about the reproductive rate, age structure, or sex ratio of North Pacific right whales. Very little new information is available, as there have been very few confirmed sightings of calves in the eastern North Pacific in the last several decades. The reports from the Bering Sea include one possible calf seen in 1996 (Goddard and Rugh 1998; Leduc 2004; Wade *et al.* 2006). The size of a right whale photographed in California was 12.2 m, indicating it was a subadult (Caretta *et al.* 1994). Several of the right whales seen in the past few years also appear to be subadults (Shelden and Clapham 2006; Wade *et al.* 2006; Wade *et al.* 2011b), likely born after the cessation of Soviet whaling in the early 1960s, suggesting some successful reproduction within the population (Wade *et al.* 2006). However, the reproduction rate remains unknown but is likely low due to a persistent male-biased sex ratio, which was also observed in the Soviet catch (Ivashchenko and Clapham 2012). In 2002, the ratio of females to males biopsied in the Bering Sea was 1:9. In 2004, biopsy results indicated a considerably higher ratio of almost 1:2. Most recently, photographic and genotypic survey data collected from 1997 through 2008 suggest a ratio of 2:5 (Wade *et al.* 2011a). Low population estimates combined with the small number of females severely reduce the potential for North Pacific right whales to find viable mates.

Right whales elsewhere in the world are known to calve on average every three to five years (Knowlton *et al.* 1994; Kraus *et al.* 2007). Studies have shown that calving success is tightly linked to maternal energy reserves, which are influenced by oceanographic oscillations that impact the abundance of suitable prey (Kenney 1998; Fujiwara and Caswell 2001; Greene *et al.* 2003; Angell 2005; Miller *et al.* 2011). Most recently, Klanjscek *et al.* (2007) modeled and compared energetic models between southern and North Atlantic right whales and found that calving intervals and time of first parturition depended heavily on energy availability and feeding rate. Furthermore, modeled seasonal oceanographic variability had a significantly larger impact on reproductive success when feeding was presumed to be low, or when females were energy-limited (Klanjscek *et al.* 2007). These principles likely also apply to North Pacific right whales, where prevailing oceanographic conditions impact prey abundance, reducing energy reserves and reproductive output.

D.5 Natural Mortality

Similar to other life history characteristics, small population sizes and limited sampling opportunities have led to little new information on mortality rates for the eastern and western North Pacific populations. However, natural mortality is likely very similar to that in western North Atlantic right whales, which has been calculated as 17 percent and 3 percent in yearling and subadult whales, respectively (Kraus 1990). An overall subadult mortality rate (including anthropogenic sources) of 27 percent (Kraus 1990) is likely an overestimate for the North Pacific, where ship strikes and entanglements almost certainly occur far less frequently.

D.6 Abundance and Trends

The North Pacific right whale remains one of the most endangered whale species in the world, likely numbering fewer than 1,000 individuals between the eastern and western populations. Despite high levels of survey effort in the eastern North Pacific (Miyashita and Kato 1998; Perry *et al.* 1999; Zerbini *et al.* 2006; Ford *et al.* 2010), right whale sightings have been relatively rare (notably in the east) and geographically scattered, leading to persistent uncertainty and data gaps. In the last three decades, right whale sightings have been so rare that single sightings have sometimes resulted in scientific publications (e.g., Herman *et al.* 1980; Rowntree *et al.* 1980;

Rowlett *et al.* 1994; Goddard and Rugh 1998; Gendron *et al.* 1999; Salden and Mickelsen 1999; Waite *et al.* 2003; Carretta *et al.* 2007).

Small populations (likely due to illegal Soviet catches that occurred throughout the 1960s) documented since 1964 (Ivashchenko and Clapham 2012) make population parameters difficult to estimate. The rarity of sightings and small numbers of individuals seen in any year suggests the population in the eastern North Pacific is very small. The largest number of individuals detected in a single year in this population was 17 in 2004 (Wade *et al.* 2006). Aerial surveys in 2008 sighted 13 individuals, 10 of which were matched to previously identified whales (Clapham *et al.* 2009). More recently, Wade *et al.* (2011a) made the first abundance estimates for the eastern North Pacific population using mark-recapture data from the Bering Sea and Aleutian Islands, resulting in abundance estimates of 31 individuals (95% confidence interval 23–54) and 28 individuals (95% confidence interval 24–42) using photographic and genetic identification techniques, respectively. Additionally, Marques *et al.* (2011) used passive acoustic cue counting to derive a similar abundance estimate of 25 individuals (CV 29.1%; 95% confidence interval 13–47). Those abundance estimates refer only to the Bering Sea and Aleutian Islands but there is currently no evidence that the entire eastern North Pacific population is much larger. In recent decades only three individuals have been identified from the Gulf of Alaska and none of these have been seen in the Bering Sea (Wade *et al.* 2011b).

In contrast, right whales have been sighted more regularly in the western North Pacific, notably in the Okhotsk Sea, Kuril Islands, and adjacent areas (Brownell *et al.* 2001). Based on sightings data collected during minke whale surveys that covered a portion of the historic right whale range, the western population has been estimated to contain approximately 900 individuals (confidence limit 404 – 2,108; Miyashita and Kato 1998). However, the precision of this estimate is low.

E. Threats

E.1 Anthropogenic Noise

Humans routinely introduce sound intentionally and unintentionally into the marine environment for underwater communication, navigation, research, and construction. Many marine mammals use sound to communicate, navigate, locate prey, and/or sense their environment. Both anthropogenic and natural sounds may interfere with these functions. The impact of noise exposure on marine mammals can range from little or no effect to severe effects, depending on factors including: noise source level, the type and characteristics of the noise source, distance between the source and the animal, characteristics of the animal (*e.g.*, hearing sensitivity, behavioral context, age, sex, and previous experience with sound source), and time of the day or season (Richardson *et al.* 1995; National Research Council 2003; National Research Council 2005; Southall *et al.* 2007). Noise may be intermittent or continuous, impulsive or non-impulsive (steady), and may be generated by stationary or transient sources.

As one of the potential stressors to marine mammal populations, noise may seriously disrupt marine mammal communication, navigational ability, and social patterns. The effects of anthropogenic noise are often difficult to ascertain, and research on this topic is ongoing. The possible impacts of the various sources of anthropogenic noise, described below, have not been studied on North Pacific right whales, although some conclusions fromstudies on baleen whales could be applied to this species.

Types of Noise: Ambient and Discrete Sources

Ambient or background noise levels are an important consideration in assessing acoustic impacts. Natural (*e.g.*, noise from wind and biological sources) and anthropogenic sources contribute significantly to ambient noise levels as a whole (i.e., composite of all sources together; Wenz 1962). These sound sources can occur locally or accumulate from afar, such as distant shipping activities (Curtis *et al.* 1999; Andrew *et al.* 2002; McDonald *et al.* 2006; McDonald *et al.* 2008). The ambient noise level of an environment can be quite complicated and vary by location (*e.g.*, involving deep versus shallow water), from day to day, within a day, and/or from season to season. For example, the amount of noise from shipping can correspond to the amount of traffic (e.g., major shipping lanes are louder than areas outside shipping lanes; Hatch *et al.* 2008). Furthermore, soniferous fish species have a seasonal or diel pattern to their vocalizations (Sirovic *et al.* 2009). In addition to describing the ambient acoustic environment, sound can be described as discrete sources (*e.g.*, individual seismic vessel, individual tactical sonar, individual ships). More information on sound produced by discrete sources is provided later in this section.

Hearing Damage or Impairment

As mentioned previously, there are no direct measurements of the hearing abilities of most baleen whales. Baleen whale calls are predominantly at low frequencies, mainly below 1 kHz (see section on Hearing and Vocalizations), and it stands to reason that if a species vocalizes in certain frequency ranges, its hearing acuity is strong in at least those same ranges. Direct changes in hearing ability from noise exposure have only been measured in a laboratory on a limited number of species (odontocete and pinniped species only) and for only a handful of individuals within those species (Southall *et al.* 2007).

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

Behavioral Response

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

Most observations of marine mammal behavioral responses to anthropogenic sounds have been limited to short-term behaviors, which included the cessation of feeding, resting, or social interactions. Relationships between specific sound sources, or anthropogenic sound in general, and the responses of marine mammals to those sources are still subject to scientific investigation, but no clear patterns have emerged (Southall *et al.* 2007). Marine mammals may adapt by altering vocalizations, but acute changes or slight modifications of normal vocalizing behavior or other behavior for an extended period could have detrimental consequences (for example, a reduced ability to efficiently locate food sources or potential mates).

Sensitization (increased behavioral or physiological responsiveness over time) to noise could also exacerbate other effects and habituation (decreased behavioral responsiveness over time) to chronic noise could result in animals remaining close to noise sources. Sound transmissions could also displace animals from areas for a short or long time period. Noise may also reduce the availability of prey, or increase vulnerability to other hazards, such as fishing gear, predation, etc. (Richardson *et al.* 1995).

It is important to recognize the difficulty of measuring behavioral responses in free-ranging whales. The cumulative effects of habitat degradation are difficult to define and almost impossible to evaluate. Additionally, there is a lack of information on how short-term behavioral responses to noise translate into long-term or population-level effects (National Research Council 2003; National Research Council 2005). For more specific information on potential impacts of noise associated with military activities, oil and gas exploration, and research, see sections below.

Masking

Masking, or "Auditory Interference," is the obscuring of sounds of interest by interfering sounds and occurs when noise interferes with a marine animal's ability to hear a sound of interest or have its own calls heard. Marine mammals use acoustic signals for a variety of purposes, which differ among species, but include communication between individuals, navigation, foraging, reproduction, and acquisition of information about their environment (Erbe and Farmer 2000; Tyack and Clark 2000). Masking generally occurs when the interfering noise is louder than, and of a similar frequency to, the auditory signal received or produced by the animal. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations.

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

Animals may alter their behavior in response to masking. These behavior changes may include producing more calls, longer calls, or shifting the frequency of the calls. For example, two studies indicate that North Atlantic right whales (Parks *et al.* 2009) and blue whales (Di Iorio and Clark 2010) alter their vocalizations (call parameters or timing of calls) in response to background noise levels. Nonetheless, uncertainties remain regarding how masking affects marine mammals. The potential impacts that masking may have on individual survival, energetic costs, and behavioral changes are poorly understood.

E.1.1 Ship Noise

Sound emitted from large vessels is the principal source of noise in the ocean today, primarily due to the properties of sound from cargo vessels. Ship propulsion and electricity generation engines, engine gearing, compressors, bilge and ballast pumps, as well as hydrodynamic flow surrounding a ship's hull and any hull protrusions and vessel speed contribute to a large vessel's noise emission into the marine environment. Prop-driven vessels also generate noise through cavitations, which account for approximately 85% or more of the noise emitted by a large vessel (Richardson *et al.* 1995). Large vessels tend to generate sounds that are louder and at lower frequencies than small vessels (Polefka 2004).

Surface shipping is the most widespread source of anthropogenic, low frequency (0 to 1,000 Hz) noise in the oceans (Simmonds and Hutchinson 1996). Ross (1976) estimated that between 1950 and 1975, shipping caused a rise in ambient noise levels of 10 decibels (dB) (this scale is logarithmic, so a 6 dB increase is a doubling) worldwide. He predicted that this would increase by another 5 dB by the beginning of the 21st century. The National Research Council (2003) estimated that the background ocean noise level at 100 Hz has been increasing by about 1.5 dB per decade since the advent of propeller-driven ships, while others have estimated that the increase in background ocean noise is as much as 3 dB per decade in the Pacific Ocean (McDonald *et al.* 2006). Clark *et al.* (2009) recently attempted to quantify the effects of masking on mysticetes (i.e., fin, North Atlantic right, and humpback whales) exposed to noise from ships and reported that, among other things, whale call rates diminished in the presence of passing vessels.

While certain species of large whales have shown behavioral changes and adaptations to anthropogenic noise in the marine environment (Geraci and Aubin 1980; Geraci 1990a), there have been few studies on how it might affect right whales. However, existing data suggest that the level of sensitivity to noise disturbance and vessel activity appears related to the behaviors in which they are engaged at the time (Watkins 1986; NMFS 2006). In particular, feeding or courting right whales may be relatively unresponsive to loud sounds and, therefore, slow to react to approaching vessels. Malme *et al.* (1983) speculated on the potential detrimental impacts of the noise created during oil and gas production, but the impact of noise from shipping and industrial activities on the communication, behavior, and distribution of right whales remains unknown (Southall *et al.* 2007).

At this time, the severity of the threat of ship noise to North Pacific right whales is unknown and uncertainty of the threat is high. Therefore, the relative impact to recovery is ranked as **unknown** (Table 1).

E.1.2 Oil and Gas Exploration and Development

A number of activities associated with oil and gas exploration and development result in the introduction of sound into the underwater environment. Loud sound sources from seismic surveys to locate undersea oil reserves may adversely affect marine mammals. Oil and gas exploration, including seismic surveys (airguns), typically operate with marine mammal observers as part of required mitigation measures detailed in incidental take permits issued for the activity. Baleen whales are known to detect the low-frequency sound pulses emitted by airguns and have been observed, in some cases, reacting to seismic vessels (Stone 2003). All these systems require a vessel platform (or several vessels), which themselves may impact whales. In addition, a variety of devices and technologies are used that 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. There have been no reported seismic-related or industry ship-related mortalities or injuries to North Pacific right whales and other large whale species in areas where marine mammal observers and oil and gas exploration and development operations are present; however, these activities are currently conducted largely outside the known range of this species.

During various exploration-related activities, underwater noise is introduced 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 aircraft's altitude, aspect, and strength of the noise coming from the aircraft. Generally, the greater the altitude of the aircraft, the lower the sound level received underwater (Richardson *et al.* 1995).

Drilling for oil and gas generally produces low-frequency sounds with strong tonal components—these sounds occur in frequency ranges in which large baleen whales communicate. There is little information on the noise produced by 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 undetectable alongside the platform at Beaufort scale sea states of three or above. The strongest tones were at low frequencies, near 5 Hz (Richardson *et al.* 1995).

Past offshore oil and gas leasing has occurred in the Gulf of Alaska and Bering Sea in the northern areas of known right whale habitat. The Bureau of Ocean Energy Management (BOEM) proposed an Outer Continental Shelf leasing plan for 2007–2012 that prioritized lease sales for the North Aleutian Basin in 2010 and 2012 (Aplin and Elliott 2007), but was withdrawn by Presidential Executive Order. The development of oil fields off the Sakhalin Islands is occurring within habitat of the western North Pacific population of right whales (NMFS 2006). However, no oil exploration or production is currently underway in offshore areas of the Bering Sea or Gulf of Alaska and no lease sales are scheduled to occur in the 2012–2017 proposed program (Andrew *et al.* 2008). The possibility remains that there will be lease sales in these areas in the future even though no discoveries have yet been announced and most leases have not contained commercially viable deposits (NMFS 2006). Oil exploration is occurring in the Beaufort sea and is scheduled begin in the Chukchi in the near future, which will include an increased level of associated vessel traffic through the Bering Sea en route to and from the Arctic.

For the aforementioned reasons, the severity of this threat is unknown but potentially low for the eastern population and unknown but potentially high for the western populations and the uncertainty of this threat is medium. Therefore, because of uncertainties associated with the extent and severity of the effects of these activities, the relative impact to recovery is ranked as **unknown** (Table 1).

E.1.3 Military Sonar and Explosives

No evidence is available to assess whether military activities in the North Pacific Ocean have had an impact on North Pacific right whale populations. However, the large scale and diverse nature of military activities in this ocean basin suggest there is potential for disturbing, injuring, or killing these and other whales.

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

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

The effect of active sonar on North Pacific right whales has not been studied and remains uncertain; however, active sonar associated with naval training activities might adversely affect North Pacific right whales in several ways. First, low-frequency sonar transmissions that overlap with the frequency ranges of North Pacific right whale vocalizations might mask communication between whales which could affect the social interactions of North Pacific right whale groups. Second, overlap between North Pacific right whale hearing and low- and mid-frequency sonar transmissions might result in noise-induced losses of hearing sensitivity or behavioral disturbance as North Pacific right whales avoid or evade sonar transmissions. Studies of the effects of SURTASS LFA sonar on mysticetes, specifically foraging blue and fin whales in California, migrating gray whales off California, and singing humpback whales in Hawaii, did not detect biologically significant responses (*e.g.*, detected effects were primarily short-term, with variance between individuals and with context) (U.S. Department of the Navy 2007).

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

Various measures have been developed to prevent North Pacific right whales from being exposed to active sonar transmissions or underwater detonations during testing or exercises, although these measures would not necessarily be employed during combat use. For example, the SURTASS LFA sonar system employs a high-frequency active sonar that allows the U.S. Navy to detect large and most small cetaceans and, if marine mammals are detected, the U.S. Navy is required to shut down sonar transmissions until whales have moved away from the sonar source. As another example, the suite of monitoring protocols the U.S. Navy developed during the ship shock trial on the U.S.S. Winston Churchill off the coast of Florida were effective at preventing North Atlantic right whales, other cetaceans, and sea turtles from being exposed to the shock wave associated with those detonations (Clarke and Norman 2005). Other measures are being developed and tested to reduce the probability of exposing North Pacific right whales and other cetaceans to active sonar transmissions and shock waves of underwater detonations.

The relatively large spatial scale, frequency, duration, and diverse nature of these training activities in areas in which North Pacific right whales occur suggest that these activities have the potential to adversely affect North Pacific right whales. However, the severity of the effect of military sonar and detonations on North Pacific right whales and the effectiveness of mitigation measures remain largely unknown and the uncertainty of our knowledge is high. Therefore, the relative impact to recovery of North Pacific right whales due to this threat is ranked as **unknown** (Table 1).

E.2 Vessel Interactions

The role that vessel interactions may play in the mortality rates of stocks in the North Pacific is not known. However, the proximity of some known right whale habitats to shipping channels (*e.g.*, Bristol Bay) suggests that collisions with vessels represent a potential threat to right whales.

Although the available evidence suggests that impacts of ships (principally noise and collision) on North Pacific right whales are currently low because of the volume of vessel traffic involved in known right whale habitats, two points should be noted. First, the level of observer effort in virtually all of the right whale's range in the North Pacific is low to none; this means that any mortalities or sub-lethal effects would likely pass undetected. More importantly, the increasing loss of sea ice in the Arctic makes it all but certain that trans-arctic shipping routes will soon be predictably available for vessels traveling from Europe to the North Pacific. The opening of the Northwest Passage and Northern Sea Route will bring an unprecedented increase in the volume of vessel traffic through polar waters, all of which would funnel through the Bering Strait and into the Bering Sea. When this occurs, the potential for negative impacts on North Pacific right whales and other cetaceans will increase.

E.2.1 Ship Strikes

The possible impacts of ship strikes on the recovery of North Pacific right whale populations are not well understood. Ship strikes are a well-documented threat to North Atlantic right whales, and thus a potential for increased ship traffic could constitute a threat to North Pacific right whales. Because many ship strikes go unreported or undetected for various reasons and the offshore distribution of right whales may make collisions with them less detectable than with other species, any estimates of serious injury or mortality should be considered minimum estimates, thus there is a high level of uncertainty associated with the information presented above. The severity of this threat is unknown but potentially high for the eastern population given the possibility for increased ship traffic in the region due to melting sea ice in the Arctic and unknown but potentially low for the western population. The uncertainty of this threat is high for both populations and the relative impact to recovery is ranked as **unknown but potentially high for the eastern population and unknown but potentially low for the western population** (Table 1).

E.2.2 Disturbance from Whale Watching and Other Vessels

There are no recreational or educational uses of North Pacific right whales. However, if a right whale is seen in a highly accessible area, such as near the coast of California, there is always the potential for an enthusiastic response from whale watching operations.

In consideration of studies of all large whale species, several investigators reported behavioral responses to close approaches by vessels suggesting that individual whales might experience a stress response (Watkins 1981; Baker *et al.* 1983; Bauer 1986; Bauer and Herman 1986; Baker and Herman 1987; Richardson *et al.* 1995; Jahoda *et al.* 2003). Others suggest that there is mounting evidence that wild animals respond to human disturbance in the same way that they respond to predators (Harrington and Veitch 1992; Lima 1998; Gill *et al.* 2001; Frid and Dill 2002; Beale and Monaghan 2004; Romero 2004). These responses have been associated with the abandonment of sites (Bartholomew 1949; Allen 1991; Sutherland and Crockford 1993), reduced reproductive success (Müllner *et al.* 2004), and the death of individual animals (from expending energy and thus compromising their survival) (Daan *et al.* 1996). However, there is no evidence indicating that these effects are detrimental at the population level.

The potential for injury or disturbance to cetaceans from close proximity of military ships is also a potential threat. To the extent North Pacific right whales might be exposed to vessel activity associated with these and other military activities, they, too may be adversely affected. Based on this information, the threat occurs at a low severity and there is a low level of uncertainty. Thus, the relative impact to recovery is ranked as **low** (Table 1).

E.3 Contaminants and Pollutants

The manner in which pollutants negatively impact animals is complex and difficult to study, particularly in animals for which many of the key variables and physiological pathways are unknown (Aguilar 1987; O'Shea and Brownell Jr. 1994). Organic chemical contaminants have been regarded as being less of a threat to mysticetes than odontocetes (Reijinders *et al.* 1999) and are not considered primary factors in slowing the recovery of any stocks of large whale species (O'Shea and Brownell Jr. 1994). O'Shea and Brownell (1994) indicated that concentrations of organochlorine and metal contaminants in tissues of baleen whales were low, and lower than other marine mammal species. They further stated that there was no firm evidence that levels of organochlorines, organotins, or heavy metals in baleen whales generally were high enough to cause toxic or other damaging effects. However, individuals with higher contaminant levels in tissues show increased susceptibility to infections, lesions, impairments and even reproductive failure (De Guise *et al.* 1995; Moore *et al.* 1998; Aguilar *et al.* 2002; Jenssen *et al.* 2003).

In a review of organochlorine and metal pollutants in southern Pacific marine mammals (Franciscana dolphins, *Pontoporia blainvillei*, from Argentina and pantropical spotted dolphins, *Stenella attenuata*, from the eastern tropical Pacific), Borrell and Aguilar (1999) noted that organochlorine levels suggested low exposure compared to other regions of the world. Although information is extremely scarce, concentrations of organochlorines in the tropical and equatorial fringe of the Northern Hemisphere and throughout the Southern Hemisphere appear to be low in marine mammals.

Organochlorine concentrations in marine mammals off South America, South Africa and Australia were invariably low (Aguilar *et al.* 2002). The lowest organochlorine concentrations in cetaceans were found in the polar regions of both hemispheres. However, due to the systematic long-term transfer of airborne pollutants toward higher latitudes, it is expected that the Arctic and, to a lesser extent, the Antarctic will become major sinks for organochlorines in the future, warranting long-term monitoring of polar regions (Aguilar *et al.* 2002). In a study of organochlorine exposure and bioaccumulation in the North Atlantic right whale, Weisbrod *et al.* (2000) noted that biopsy concentrations of organochlorines were an order of magnitude lower than concentrations in the blubber of seals and odontocetes. They concluded that there was no evidence to indicate that right whales bioaccumulate hazardous concentrations of organochlorines, and further noted that this was consistent with similar studies of baleen whales (Weisbrod *et al.* 2000).

The transgenerational accumulation of contaminants (Colborn and Smolen 1996) is a source for concern and has been modeled in right whales by Klanjscek *et al.* (2007), who found that calves can assimilate as much as 30 percent of maternal toxicant load through nursing. Additionally, these metabolic models predict that the concentration of toxicants increases when energy reserves (i.e., blubber) are low and are further released into tissues during periods of fasting or starvation brought on by environmental variability (Klanjscek *et al.* 2007). This study suggests that the combination of seasonal nutritional stress and pollutant exposure may be negatively impacting reproductive success and limiting right whale recovery in the North Atlantic by increasing calving intervals and decreasing fertility. Weisbrod *et al.* (2000) found that the accumulation of PCBs and pesticides in North Atlantic right whales did not reach significant levels but varied depending on where along the coast copepod prey was consumed. Additionally, Wise *et al.* (2008) studied accumulated chromium levels in North Atlantic right whale tissues and concluded that this toxin occurs in concentrations that could prove harmful.

The impacts of chemical contamination on cetaceans and habitat are a growing concern in the North Pacific Ocean. While high latitude oceans receive less exposure to anthropogenic chemicals, global circulation brings these contaminants into polar regions where they are taken up into Arctic food webs (Tanabe 2002). In the North Pacific, PCB and DDT contamination more than doubled in the last decade, evidenced by rising concentrations in albatrosses (Finkelstein *et al.* 2006). Elliott and Scheuhammer (1997) found that concentrations of cadmium and lead were higher in seabirds living in the North Pacific compared with similar species on the east coast. Levels of PCBs and newly identified DDT-like microcontaminants in the blubber of some North Pacific cetaceans (including right whales) was greater than those in tropical locations, with levels exceeding those known to suppress immune function in harbor seals (Minh *et al.* 2000a; Minh *et al.* 2000b). However, contaminant levels were lower in humpback whales from Alaska than they were in whales from California and Washington, where there have been more known point sources of contaminants (Elfes *et al.* 2010). It is unknown whether and how these effects would be manifested at a population level relevant to recovery and management decisions.

However, assessment of contaminant body burden ignores toxic non-halogenated aromatic hydrocarbons and polynuclear aromatic hydrocarbons (PAH), from crude oil and combusted fossil fuels that do not bioaccumulate. Such compounds are metabolized and may cause some effects to individuals, but then are mostly excreted. Contaminant impact is therefore insufficiently assayed by blubber burden analysis of parent compound alone.

Oil Spills

Oil spills that occur while North Pacific right 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 1990b). Actual impacts would depend on the extent and duration of contact and the characteristics (*e.g.*, the age) of the oil. Most likely, the effects of oil would include irritation to the respiratory membranes and absorption of hydrocarbons into the bloodstream (Geraci 1990b). If a marine mammal was present in an area polluted with fresh oil, it is possible that it could inhale enough vapors to affect its health. Inhalation of petroleum vapors can cause pneumonia in humans and animals, due to large amounts of foreign material (vapors) entering the lungs (Lipscomb *et al.* 1994). Long-term ingestion of pollutants, including oil residues, could affect reproductive success, but data are lacking to determine how oil may fit into this scheme for North Pacific right whales.

If a North Pacific right whale encountered spilled oil, baleen hairs might be fouled, which would reduce a whale’s filtration efficiency during feeding. Lambertsen *et al.* (2005) concluded that because previous “experimental assessment of the effects of baleen function... thus far has considered exclusively the role of hydraulic pressure in powering baleen function” but “our present results indicate that more subtle hydrodynamic pressure may play a critical role in the function of the baleen in the [balaenids]... the current state of knowledge of how oil would affect the function of the mouth of right whales and bowhead whales can be considered poor, despite considerable past research on the effects of oil on cetaceans.”

Lambertsen *et al.* (Lambertsen *et al.* 2005) contended that oil could be efficiently ingested if globules of oil behave like prey inside the mouth. They point out that if oil is of low viscosity and does not behave like prey, only small amounts would be ingested. Lambertsen *et al.* (2005) characterize these two conditions as being of "questionable validity" and note that if, on the other hand, the resistance of the baleen is significantly increased by oil fouling, as experimental evidence on the baleen of other mysticetes indicates it may be, the most likely adverse effect "would be a substantial reduction in capture of larger, more actively mobile species, that is euphausiids, with possible reductions in capture of copepods and other prey" (Lambertsen *et al.* 2005). They concluded that their results highlight the uncertainty about how rapidly oil would depurate at the near zero temperatures of arctic waters and whether baleen function would be restored after oiling.

Relatively few spills have occurred in the northern North Pacific to date, but the extent to which these activities may impact right whales is unknown. In general, the threat from contaminants and pollutants occurs at an unknown severity and there is a high level of uncertainty regarding the likelihood of a spill occurring and North Pacific right whales being exposed to spilled oil. Thus, the relative impact to recovery of North Pacific right whales due to contaminants and pollution is ranked as **unknown** (Table 1). However, this ranking may need to be elevated if future data indicate that reproductive rates are negatively impacted by exposure to contaminants or pollution.

E.4 Disease

Data do not currently exist to quantify the impact of disease on the survivability of the North Pacific right whale and there is no record of epizootics occurring in baleen whales. It has been suggested that the frequency of naturally-occurring red tide events that can lead to the ingestion of deleterious toxins may become more common with the rise of coastal development and anthropogenic activities (NMFS 2006). While these natural toxins have led to mass mortalities of many pinnipeds and cetaceans, there is currently no evidence linking red tide toxins to deaths or chronic health problems in North Pacific right whales. It is not known whether right whales suffer from stress-induced bacterial infections similar to those observed in captive cetaceans (Buck *et al.* 1987). The occurrence of skin lesions on North Atlantic right whales has been documented in recent years, but their origin and significance are unknown (Marx *et al.* 1999; Pettis *et al.* 2004). The system developed by Pettis *et al.* (2004) to assess health and bodily condition of North Atlantic right whales is currently being applied by NMML to photographs of North Pacific right whales.

Disease presumably plays a role in natural mortality of North Pacific right whales, but there are no studies indicating diseases would be expected to threaten this species. There are no data on, or reports of, diseases in North Pacific right whales. The severity of disease among the North Pacific right whale population is considered to be unknown and the uncertainty is high. Thus, the relative impact to recovery of North Pacific right whales due to disease is considered **unknown**.

E.5 Injury from Marine Debris, Including Gear Entanglement

Harmful marine debris consists of plastic garbage and other materials washed or blown from land into the sea, fishing gear lost or abandoned by recreational and commercial fishers, and solid non-biodegradable floating materials (such as plastics) disposed of by ships at sea. Examples of plastic and other materials posing potential risks are: bags, bottles, strapping bands, sheeting, synthetic ropes, synthetic fishing nets, floats, fiberglass, piping, insulation, paints, and adhesives. Plastics and other debris may be consumed incidental to normal feeding, and some marine species may actually confuse plastic bags, rubber, or balloons with prey and ingest them. The debris may cause a physical blockage in the digestive system, leading to internal injuries or other types of significant complications.

Observational studies cannot fully evaluate the potential for entanglement in ghost gear because entangled whales may die at sea and thus not be seen or reported. The eastern Bering Sea supports fisheries throughout the year, but the impact of these activities on North Pacific right whales remains unknown. Fishing intensity in the Bering Sea is low relative to that occurring off the eastern coast of North America where North Atlantic right whales suffer high entanglement and mortality rates (Kraus 1990); consequently, the potential for entanglement in the Bering Sea, while certainly not zero, is probably relatively low.

One case of entanglement without mortality is known from the western North Pacific (Kornev 1994; Perry *et al.* 1999; Brownell *et al.* 2001), though this number probably does not reflect the potential rate of interactions. Several cases of bowhead entanglements have been recorded during the Alaska Native subsistence hunt (Philo *et al.* 1992). Aerial photographs in at least two cases have shown ropes trailing from the mouths of bowheads (NMFS, NMML, unpublished data). A similar review of photographs of North Pacific right whales has shown a low apparent rate of interaction with fishing gear, but given the remoteness of the habitats concerned, any mortalities would almost certainly go unrecorded.

Two right whale mortalities from entanglement were reported in association with the Russian gillnet fishery: one in 1983, and the other in October 1989. The 1989 incident involved a right whale stranded in Kamchatka with a salmon gillnet around its tail (Kornev 1994). As noted by Brownell *et al.* (2001), entanglements in fishing gear may represent a significant problem for the western North Pacific population of right whales, particularly given the operation of Japanese driftnet fisheries within the Russian Exclusive Economic Zone (EEZ), inside the Okhotsk Sea, and around Kamchatka since 1991. This concern is highlighted by an observation of a right whale entangled in fishing gear in the Okhotsk Sea in 1992. Fishery-related mortalities in the Bering Sea have not been reported, however, the eastern Bering Sea supports multiple fisheries and therefore fishery interactions with right whales are possible.

Entanglement-related stress may decrease an individual's reproductive success or reduce its life span, which may in turn depress population growth. Additionally, injuries and entanglements that are not initially lethal may result in a gradual weakening of entangled individuals, making them more vulnerable to other causes of mortality (Kenney and Kraus 1993). Kraus (1990) estimated that 57 percent of right whales in the western North Atlantic bear scars and injuries indicating fishing gear entanglement. This figure was revised to 61.6 percent in more recent analysis (Hamilton *et al.* 2007). Monitoring of scarring rates among North Pacific right whales is difficult due to the extreme rarity of this species, but this would provide significant insight into the extent of this problem in the region.

There has been no documentation of stomach obstruction caused by marine debris in North Pacific right whales, but there are documented cases of ingestion of marine debris in both odontocete and other mysticete species including, but not limited to, sperm, pygmy sperm (*Kogia breviceps*), and minke whales (*Balaenoptera acutorostrata*) (Viale *et al.* 1991; Tarpley and Marwitz 1993). However, it is not believed to be a major threat to North Pacific right whales.

In the eastern North Pacific, the severity of entanglement and ingestion of marine debris on right whales is unknown but potentially low, the uncertainty in this determination is considered to be medium, and the relative impact to recovery is **unknown but potentially low**. In the western North Pacific, the severity of entanglement and ingestion of marine debris on right whales is unknown but potentially high, the uncertainty in this determination is considered to be high, and the relative impact to recovery is **unknown but potentially medium** (Table 1).

E.6 Research

Scientific research marks the continued efforts to learn more about this species and can involve close interactions with whales to obtain photographs, genetic samples, or tagging information. All of these activities are permitted and closely monitored in the U.S. and Canada, a process that ensures any potential negative impacts are minimized. The potential for disturbance or harassment through observing or approaching whales for behavioral studies, photography, satellite tagging, and data collection (including samples collected for health and genetic analysis) is likely minimal and is far outweighed by the benefits of gaining information that could prove critical in helping manage and recover the species.

The effects of research activities that do not involve the direct study of North Pacific right whales are addressed in other subsections of the threats section of this Recovery Plan, such as vessel interactions, anthropogenic noise, contaminants and pollutants, oil and gas exploration, and military sonar and explosives.

The threat occurs at a low severity and a low level of uncertainty, as a small potential exists for unobserved mortality to occur following the completion, or in the course, of research activities. Thus, the relative impact to recovery of North Pacific right whales due to this threat is ranked as **low** (Table 1).

E.7 Predation and Natural Mortality

Data do not currently exist to quantify the impact of predation on the survivability of the North Pacific right whale. There is currently no evidence that North Pacific right whales experience predatory attacks from killer whales or large sharks. The current North Pacific right whale catalogue contains no images of the rake marks that are typical of killer whale attacks. If these interactions do occur, they would likely have a larger impact on calf and subadult age classes. Thus, the relative impact to recovery from predation and natural mortality is ranked as **low**, based on low severity and medium uncertainty (Table 1).

E.8 Directed Hunting

Direct hunts, although rare today, were the main cause of initial depletion of North Pacific right whales and other large whales. Commercial whalers hunted North Pacific right whales heavily during the 19^{th} and 20^{th} centuries. The IWC estimates that 15,451 right whales were taken in the North Pacific in the 19^{th} century with 741 additional catches recorded in the early 20^{th} century (411 in the eastern and 330 in the western) (Brownell 1986; Best 1987; Brownell *et al.* 2001; Josephson *et al.* 2008b). Scarff (2001) adjusted that previous analysis to account for whales that were struck and lost and estimated that between 26,500 and 37,000 right whales were killed between 1839 and 1909. In the western North Pacific, numerous right whale catches were made in Japanese and adjacent waters in the first half of the twentieth century (Omura 1986). Also during this time, additional catches for scientific purposes were made in various parts of the North Pacific by Japan and the Soviet Union (Omura *et al.* 1969). These catches presumably occurred primarily during summer. The impact of these catches on the recovery of this remnant population is no doubt significant.

Ivashchenko and Clapham (2012) reported that large illegal catches of right whale were made by the USSR in 1962–68 in the eastern North Pacific and in 1959–72 in the Okhotsk Sea. The best estimate of total right whale catches is 681, including 529 catches in the eastern North Pacific (compared to a previously published figure of 373 by Doroshenko 2000) and 132 catches in the Okhotsk Sea. Catches were distributed in the Bering Sea (115), eastern Aleutian Islands (28), Gulf of Alaska (366), Okhotsk Sea (132) and other areas (40).[1] Detailed information on catches of 112 right whales taken in May/June 1963 shows a broad distribution in offshore waters of the Gulf of Alaska, consistent with 19^{th} century historical whaling records compiled by Townsend (Townsend 1935). Other major areas in which right whales were caught include south of Kodiak Island, western Bristol Bay (southeastern Bering Sea), and the central Okhotsk Sea off eastern Sakhalin Island. These illegal catches—which in many cases involved the taking of large, mature whales—must have drastically reduced the recovery potential for the species, notably in the eastern North Pacific. The most recent known North Pacific right whale catch was a single animal taken by a Chinese operation in the Yellow Sea in December 1977.

The IWC's 1982 moratorium on the commercial hunting of whales has almost certainly had a positive effect on the species' recovery. There is currently no commercial whaling for North Pacific right whales by IWC member nations that are party to the moratorium. In the eastern North Pacific, the severity of directed hunting on right whales is low, the uncertainty in this determination is considered to be low, and the relative impact to recovery is **low**. In the western North Pacific, the severity of directed hunting on right whales is unknown but potentially low, the uncertainty in this determination is considered to be high, and the relative impact to recovery is **unknown** (Table 1).

[1] Ivashchenko and Clapham (2012) originally identified catches in only 20 "other areas," but they have found an additional 20 unassigned area catches since publication and the best estimate of total illegal catches has been updated accordingly here.

E.9 Competition for Resources

There is limited information on competition with other sympatric whales, but there is also no evidence that competition with other sympatric whales is a threat for any large whale species. Thus, the relative impact to recovery from predation and natural mortality is ranked as **low**, based on low severity and low uncertainty (Table 1).

E.10 Loss of Prey Base Due to Climate and Ecosystem Change

Climate change has received considerable attention in recent years, with growing concerns about warming ocean temperatures and the recognition of natural climatic oscillations, such as the Pacific Decadal Oscillation or El Niño and La Niña conditions. Evidence suggests that productivity in the North Pacific (Mackas *et al.* 1989; Quinn and Niebauer 1995) and other ocean areas could be affected by changes in the environment. Increases in global temperatures are expected to have profound impacts on arctic and subarctic ecosystems, and these impacts are projected to accelerate during this century (Aguilar *et al.* 2002). Climate and oceanographic change will likely affect habitat and food availability of North Pacific right whales. Whale migration, feeding, and breeding locations may be influenced by factors such as ocean currents and water temperature. For example, decadal scale climatic regime shifts have been related to changes in zooplankton in the North Pacific (Brodeur and Ware 1992; Francis *et al.* 1998).

Long-term trends of warming sea surface temperatures in the California Current Ecosystem have been linked to major changes in zooplankton abundance (Roemmich and McGowan 1995) that could also affect right whales. Any changes in these factors could render currently used habitat areas unsuitable, and new use of previously unutilized or previously nonexistent habitats may be a necessity for displaced individuals. Changes to climate and oceanographic processes may also lead to decreased productivity in different patterns of prey distribution and availability. Such changes could affect North Pacific right whales that are dependent on those affected prey. Copepod distribution has shown signs of shifting in the North Atlantic due to climate change (Hays *et al.* 2005). The effects of climate-induced shifts in productivity, biomass, and species composition of zooplankton on the foraging success of right whales has received little attention and more research is needed to understand possible impacts.

Also, as discussed in section E.2, the increasing loss of sea ice in the Arctic due to climate change makes it all but certain that trans-arctic shipping routes will soon be predictably available for vessels traveling from Europe to the North Pacific. When this occurs, the potential for negative impacts on North Pacific right whales and other cetaceans will increase dramatically.

The threat severity posed by environmental variability to North Pacific right whale recovery was ranked as unknown due to the oceanographic and atmospheric conditions that have changed over the last several decades and the uncertainty was ranked as unknown, due to the unknown potential impacts of climate and ecosystem change on North Pacific right whale recovery and regime shifts on whale prey; thus the relative impact to recovery was ranked as **unknown** (Table 1).

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

Table 1. Threats analysis table.

Reference	Threat	Source	Population	Severity	Uncertainty	Relative Impact to Recovery
				(Unknown, Unknown but Potentially High, Unknown but Potentially Low, Low, Med, High)		
E.1	Anthropogenic Noise					
E.1.1	Ship Noise	Ships	Both	Unknown but potentially high	High	Unknown
E.1.2	Oil and Gas Activities	Seismic surveys, noise from operation of oil exploration	East	Unknown but potentially low	Medium	Unknown
			West	Unknown but potentially high		
E.1.3	Military Sonar and Explosives	ship shock trials, low and mid-frequency sonar	Both	Unknown	High	Unknown
E.2	Vessel interactions					
E.2.1	Ship strikes	Areas of high vessel traffic and/or high speed vessel traffic	East	Unknown but potentially high	High	Unknown but potentially high
			West	Unknown but potentially low	High	Unknown but potentially low

Reference	Threat	Source	Population	Severity	Uncertainty	Relative Impact to Recovery
				(Unknown, Unknown but Potentially High, Unknown but Potentially Low, Low, Med, High)		
E.2.2	Disturbance from Vessels	recreational	Both	Low	Low	Low
E.3	Contaminants and Pollutants	Organochlorines, organotins, heavy metals, *e.g.*	Both	Unknown	High	Unknown
E.4	Disease	Parasites, other vectors	Both	Unknown	High	Unknown
E.5	Injury or mortality from marine debris, including gear entanglement	Plastic garbage from land, lost/abandoned fishing gear Drift gillnet fishery, *e.g.*	East	Unknown but potentially low	Medium	Unknown but potentially low
			West	Unknown but potentially high	High	Unknown but potentially medium
E.6	Disturbance due to Research	Genetic, photographic and acoustic studies, *e.g.*	Both	Low	Low	Low
E.7	Predation and Natural Mortality	Killer whales, sharks	Both	Low	Medium	Low
E.8	Directed Hunts	whaling	East	Low	Low	Low
			West	Unknown but potentially low	High	Unknown
E.9	Competition for Resources	Competition with biological competitors	Both	Low	Low	Low
E.10	Loss of Prey Base due to Climate and Ecosystem Change or Shifts in habitat	Climate and Ecosystem Change	Both	Unknown	Unknown	Unknown

F. Conservation Measures

The North Pacific right whale is protected in the U.S. under both the ESA and the MMPA. It is listed as endangered by the Union for the Conservation of Nature (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 (CITES). The CITES classification is intended to ensure that no commercial trade in the products of North Pacific right whales occurs across international borders.

Right whales have been protected from commercial whaling by the IWC and its implementing convention since 1949, although illegal whaling has occurred more recently. The species was protected by international agreement in 1935, but since neither Japan nor the Soviet Union signed this earlier agreement (Japan signed the Second Convention in 1938), these countries were free to kill right whales until passage of the 1949 International Convention for the Regulation of Whaling. In U.S. waters, right whales were listed as endangered under the Endangered Species Conservation Act in June 1970 (35 FR 18319), the precursor to the ESA. The species was subsequently listed as endangered under the ESA in 1973, and automatically designated as depleted under the MMPA in the same year. The ESA delegates authority to the Secretary of Commerce for protecting most endangered marine species, including right whales. NMFS has lead responsibility for developing and implementing a recovery program for this species.

Recently released information (Yablokov 1994; Doreshenko 2000; Brownell *et al.* 2001) indicates that Soviet whalers made substantial unreported catches of right whales, primarily in the 1960s; these catches almost certainly greatly reduced the recovery prospects of this remnant population. The Soviet catches (681 whales in total) were made primarily in the Bering Sea, Gulf of Alaska, and Okhotsk Sea.

II. RECOVERY STRATEGY

Because the current status of North Pacific right whales is unknown, the primary purpose of this Recovery Plan is to provide a research strategy to obtain data necessary to estimate population abundance, trends, and structure, and to identify factors that may be limiting North Pacific right whale recovery. Once the population and its threats are more fully understood, this plan may be updated to include actions to minimize potential threats.

A. Key Facts

When the ESA was enacted in 1973, Northern right whales were included in the List of Endangered and Threatened Wildlife and Plants as endangered because of the threat of commercial whaling. North Pacific right whales were reduced considerably by extensive commercial whaling in the 1950s through the early 1970s. This original direct threat to North Pacific right whales was addressed by the IWC's 1982 commercial whaling moratorium, and an important element in the strategy to protect North Pacific right whale populations is to continue the effective international regulation of whaling. The relative impact to recovery of hunting is currently considered "low" for the eastern population and "unknown" for the western population.

Because of the cessation of legal commercial whaling for North Pacific right whales, there are now no known "high" level threats to North Pacific right whales. The following threats to North Pacific right whale populations are considered to have low relative impact to recovery: disturbance from vessels, research activities, predation and natural mortality, and competition for resources. Other potential threats, whose relative impact to recovery is unknown, include disturbance from anthropogenic noise, collisions with vessels, disease, contaminants and pollutants, marine debris, and loss of prey base due to climate change (see Table 1). More research is needed to ascertain whether these potential threats are impeding North Pacific right whale recovery.

B. Recovery Approach

Because the greatest known threat to North Pacific right whales (*i.e.*, commercial whaling) has been addressed and there is a paucity of population data for the species, the primary component of this recovery program is data collection. The collection of additional data will facilitate estimating population size, monitoring trends in abundance, and determining population structure. These data will also provide greater understanding of natural and anthropogenic threats to the species.

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III. RECOVERY GOALS, OBJECTIVES, AND CRITERIA

A. Goals

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

B. Objectives and Criteria

The two main objectives for North Pacific right whales are to 1) achieve sufficient and viable populations in all ocean basins, and 2) ensure significant threats are addressed. A prerequisite to achieving these objectives is obtaining sufficient data to determine whether they have been met. Likewise, recovery criteria take two forms: 1) those that reflect the status of the species itself and 2) those that indicate effective management or elimination of threats. The former criterion may explicitly state a certain risk of extinction as a threshold for downlisting or delisting and uses models based on at least abundance and trends in abundance to assess whether this threshold has been reached. These criteria would apply to the species throughout its range.

Guidance on appropriate levels of risk for down-listing and de-listing decisions was developed in a workshop for large cetaceans (Angliss *et al.* 2002). This guidance was employed in the North Atlantic Right Whale Recovery Plan criteria (National Marine Fisheries Service 2005) and is also appropriate here since the North Pacific right whale was used as a case study in the workshop. The following framework was suggested:

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

B.1 Downlisting Objectives and Criteria

North Pacific right whales will be considered for reclassifying from endangered to threatened when all of the following are met (Table 2).

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

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

The International Union for the Conservation of Nature and Natural Resources (IUCN) maintains a "Redlist" to classify species and populations worldwide according to their extinction risk. The IUCN system was designed to provide an objective method for classifying a wide variety of species with varying amounts and kinds of data available. The IUCN Redlist criteria are used to classify species into four different risk categories: Critically Endangered, Endangered, Vulnerable, and Least Concern. The IUCN Redlist uses five criteria: A. magnitude of population reduction, B. geographic range, C. abundance and trends in abundance, D. abundance alone (population size numbers fewer than 50 mature individuals), and E. quantitative estimate of the probability of extinction. For criteria D, the IUCN Redlist uses a tiered approach, expressing increasing levels of risk. These levels are <1,000 mature individuals for Vulnerable, <250 mature individuals for Endangered, and <50 mature individuals for Critically Endangered.

The IUCN categories do not equate directly to the ESA categories of Endangered and Threatened. However, the three IUCN population levels are based on standards in the conservation literature that can be used to provide a relative measure of risk. Relative to the IUCN criteria, in each ocean basin the downlisting criteria for abundance alone contained in this plan are more protective, in that they are higher, than the IUCN "Endangered" threshold (<250 mature to be Endangered), but less protective than the IUCN "Vulnerable" threshold (<1,000 mature). However, at a global scale, this is more protective than the IUCN "Vulnerable" category, as <1,000 mature is less than the total of 1,500 mature across 3 ocean basins.

Objective 2: Ensure significant threats are addressed

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

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

- Effects of anthropogenic noise continue to be investigated and actions taken to minimize potential effects, as appropriate.

- Effects of contaminants and pollutants are determined to not affect the potential for continued growth or maintenance of North Pacific right whale populations.

- Effects of marine debris, including gear entanglement, continue to be investigated and actions taken to minimize potential effects, as appropriate.

- Effects of reduced prey abundance due to climate change continue to be investigated and action is being taken to address the issue, as appropriate.

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

- Where possible within legal authority, management measures restrict any hunting that may overutilize the species (whether for commercial, subsistence, or scientific purposes).

Factor C: Disease or Predation.

- Effects of disease do not limit the potential for continued growth or maintenance of North Pacific right whale populations.

Factor D: The inadequacy of existing regulatory mechanisms.

- Hunting is addressed under Factor B.

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

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

- Entanglement with fishing gear continues to be investigated and actions taken to minimize potential effects, as appropriate.

B.2 Delisting Objectives and Criteria

Objective 1: Achieve sufficient and viable populations in all ocean basins.

Criterion: Given current and projected threats and environmental conditions, each North Pacific right whale population (eastern and western) satisfies the risk analysis standard for unlisted status (has less than a 10% probability of becoming endangered in 20 years).

Any factors or circumstances that substantially contribute to a real risk of extinction but cannot be incorporated into a Population Viability Analysis will be carefully considered before delisting takes place.

Objective 2: Ensure significant threats are addressed.

Criteria: Factors that may limit population growth (those that are identified in the threats analysis as high or medium or unknown) have been identified and are being or have been addressed to the extent that they allow for continued growth of populations. Specifically, the factors in section 4(a)(l) of the ESA are being or have been addressed as follows:

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

- Effects of anthropogenic noise have been investigated and any actions taken to address the issue are effective or this is no longer believed to be a threat.

- Effects of contaminants and pollutants are not known to affect the potential for continued growth or maintenance of North Pacific right whale populations and actions taken or having been taken to minimize potential effects have been proven effective.

- Effects of marine debris have been investigated and any actions taken to address the issue are effective or this is no longer believed to be a threat.

- Effects of reduced prey abundance due to climate change have been investigated and any actions taken to address the issue are effective or this is no longer believed to be a threat.

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

- Where possible within legal authority, management measures have been promoted that oppose any hunting that may overuse the species (whether for commercial, subsistence, or scientific purposes).

Factor C: Disease or Predation.

- Effects of disease are not known to affect the potential for continued growth or maintenance of North Pacific right whale populations and actions taken or having been taken to minimize potential effects have been proven effective.

Factor D: The inadequacy of existing regulatory mechanisms.

- Hunting is addressed under Factor B.

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

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

- Entanglement with fishing gear has been investigated and actions taken to address the issue are effective or this is no longer believed to be a threat.

Table 2. Criteria for considering reclassification (from endangered to threatened or from threatened to not listed) for North Pacific right whales.

	Minimum population		**PVA**		**Threats**
Downlisted	$\geq$1,500 mature, reproducing individuals, including 250 females and 250 males in ***each*** population	***AND***	<1% Probability of extinction in 100 years	***AND***	Are being or have been addressed
Delisted	(Not specified, but implicitly must be $\geq$1,500 mature, reproducing individuals)	***AND***	<10% Probability of becoming endangered in 20 years	***AND***	Have been addressed (i.e., the threat does not have a medium, high, or unknown relative impact to recovery)

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IV. RECOVERY PROGRAM

A. Recovery Action Outline

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

1.0 Coordinate State, Federal, and International Actions to Maintain International Regulation of Whaling for North Pacific Right Whales.

2.0 Estimate Population Size and Monitor Trends in Abundance.

2.1 *Conduct surveys to assess current distribution of North Pacific right whales, and to estimate abundance and monitor population trends.*

2.1.1 Assess current distribution and estimate abundance and monitor trends in eastern population.

2.1.2 Establish collaborative agreements with relevant national governmental bodies and scientific institutions in Russia to develop plan for assessing current distribution, estimating abundance and monitoring trends in the western population.

3.0 Determine Right Whale Occurrence, Distribution, and Range.

3.1 *Use passive acoustic monitoring to assess right whale occurrence and distribution.*

3.2 *Conduct studies of historical data to determine the extent of the right whale's potential range, and identify unknown potential habitats.*

4.0 Identify, Characterize, Protect, and Monitor Habitat Important to North Pacific Right Whale Populations in U.S. Waters and Elsewhere.

4.1 *Better characterize North Pacific right whale habitat.*

4.2 *Monitor important habitat features and North Pacific right whale use patterns to assess potentially detrimental shifts in habitat features that might reflect disturbance or degradation of habitat.*

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

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

4.5 *Use satellite tagging to assess feeding ground movements and identify wintering areas.*

5.0 Investigate Human-Caused Threats and, Should They Be Determined to Be Medium or High, Reduce Frequency and Severity.

5.1 *Investigate and, if medium or high ranked threat, reduce injury and mortality caused by anthropogenic noise.*

5.1.1 Conduct studies to determine whether anthropogenic noise is adversely affecting the distribution and behavior of North Pacific right whales.

5.1.2 Take steps to minimize anthropogenic noises that are found to be potentially detrimental to North Pacific right whales.

5.2 *Investigate and, if medium or high ranked threat, reduce mortality and serious injury from vessel collisions.*

5.2.1 Identify areas where the historical occurrence of North Pacific right whales will coincide with significant levels of increasing maritime traffic resulting from decreases in annual Arctic ice and subsequent opening of trans-arctic shipping routes.

5.2.2 Maintain a record of any ship strikes.

5.2.3 Work with mariners, the shipping industry, and appropriate state, federal, and international agencies to develop and implement measures to reduce the threat of ship strikes.

5.3 *Investigate the impacts of contaminants and pollutants on North Pacific right whales and seek strategies to reduce any impacts found to be detrimental to North Pacific right whales and their habitat.*

5.4 *Investigate the impacts of marine debris, including fishing gear entanglement, on North Pacific right whales.*

5.4.1 Determine if areas exist in which right whale habitat and significant deposits of marine debris coincide.

5.4.2 If substantial overlap are detected and they appear to pose a significant threat to right whales, seek ways to reduce or eliminate sources of marine debris.

5.4.3 Review data on North Pacific right whale interactions with fishing operations.

5.4.4 Review photographic databases for evidence of injuries to North Pacific right whales caused by encounters with fishing gear to better characterize and understand fishing gear interactions.

5.5 *Promote and adopt, if possible within legal authority, management measures that oppose any hunting (whether for commercial, subsistence, or scientific purposes).*

B. Recovery Action Narrative

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

1.0 Coordinate State, Federal, and International Actions to Maintain International Regulation of Whaling for North Pacific Right Whales.

Cooperate with the IWC (and other relevant international bodies or agreements) to ensure that any whaling of North Pacific right whales is conducted on a sustainable basis and that all whaling activity is conducted within the purview of the IWC. The international regulation of whaling is vital to the recovery of whale populations.

2.0 Estimate Population Size and Monitor Trends in Abundance.

2.1 *Conduct surveys to assess current distribution of North Pacific right whales, and to estimate abundance and monitor population trends.*

Recovery of North Pacific right whales can only be assessed if reliable estimates of abundance are available and if trends in abundance can be determined, although trend analysis for the eastern population will not be possible until the population has grown. Because of the relatively long generation times of North Pacific right whales and the time scales on which environmental factors affecting their distribution may operate, programs to monitor trends in their populations must involve long-term commitments and extended periods of ship-based surveys on large research vessels. Potential cost savings include combining this objective with other large ship-based research projects in the same area and other objectives listed in this Recovery Plan.

2.1.1 Assess current distribution and estimate abundance and monitor trends in eastern population.

While new information on distribution has come from NMML surveys of the Bering Sea (Townsend 1935), there has been very little effort in the Gulf of Alaska, and almost no survey coverage of the offshore waters of the Gulf that were habitat for right whales as recently as the period of Soviet illegal catches in the 1960s.

2.1.2 Establish collaborative agreements with relevant national governmental bodies and scientific institutions in Russia to develop plan for assessing current distribution, estimating abundance and monitoring trends in the western population.

For meaningful estimates, it will be necessary for U.S. scientists to promote and participate in cooperative surveys with scientists from other countries for the western population. A primary goal should be to foster an international collaboration and cooperation in the study and protection of North Pacific right whales.

3.0 Determine Right Whale Occurrence, Distribution, and Range.

3.1 *Use passive acoustic monitoring to assess right whale occurrence and distribution.*

3.2 *Conduct studies of historical data to determine the extent of the right whale's potential range, and identify unknown potential habitats.*

It has been generally assumed that North Pacific right whales do not occur in the northern Bering Sea, Bering Strait, or Chukchi Sea; however, historical data and recent acoustic detections suggest that this is not the case. A study should be conducted to examine whaling logbooks to investigate the historical occurrence of right whales in the Bering Sea, Bering Strait, and Chukchi Sea and better define the species' range.

4.0 Identify, Characterize, Protect, and Monitor Habitat Important to North Pacific Right Whale Populations in U.S. Waters and Elsewhere.

4.1 *Better characterize North Pacific right whale habitat.*

This is among the highest priority actions in this plan because it would improve understanding and management of the species. Areas where North Pacific right whales have been seen are assumed to be important to their survival. Compile or collect relevant physical, chemical, biological, meteorological, fishery, and other data to better characterize features of important habitats and potential sources of human-caused destruction and degradation of what are determined to be important areas for North Pacific right whales. Habitat characterization also involves, among other things, descriptions of prey types, densities, and abundances, and of associated oceanographic and hydrographic features. Inter-annual variability in habitat characteristics, and in North Pacific right whale habitat use, is an important component of habitat characterization. More research is needed to define rigorously and specifically, the environmental features that make an area important to North Pacific right whales. Only with information on the ecological needs of the species will managers be able to provide necessary protections.

4.2 *Monitor important habitat features and North Pacific right whale use patterns to assess potentially detrimental shifts in habitat features that might reflect disturbance or degradation of habitat.*

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

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

Support efforts to collect and compile data on habitat use patterns for the eastern North Pacific right whale population. Validate those areas where North Pacific right whales are thought to occur and determine if those habitat areas warrant additional protection.

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

Collaborative efforts should be made with Russia, and possibly Korea, Japan, and China to protect North Pacific right whale habitat within their EEZs, and to join multi-national efforts on behalf of marine habitat protection. International efforts to collect and compile data on habitat use patterns for the North Pacific right whale population should be supported. Actions that have impacts on North Pacific right whales should be mitigated, and the U.S. should support and endorse such efforts. Validation of those areas where North Pacific right whales are thought to occur and support the protection of those habitat areas where warranted.

4.5 *Use satellite tagging to assess feeding ground movements and identify wintering areas.*

The location of wintering grounds for North Pacific right whales is entirely unknown; thus, the only practical way of assessing the winter distribution of this species is to deploy satellite-monitored radio tags on right whales in the feeding grounds in the hope that such tags will continue to transmit during the animals' winter migration. Such tags would also potentially provide information on habitat use and movements, as well as possibly identifying other (currently unknown) feeding grounds. Tags should be deployed in Bering Sea and, if practicable, in the Gulf of Alaska and Okhotsk Sea.

5.0 Investigate Human-Caused Threats, and, Should they be Determined to be Medium or High, Reduce Frequency and Severity.

5.1 *Investigate and, if medium or high ranked threat, reduce injury and mortality caused by anthropogenic noise.*

5.1.1 Conduct studies to determine whether anthropogenic noise is adversely affecting the distribution and behavior of North Pacific right whales.

5.1.2 Take steps to minimize anthropogenic noises that are found to be potentially detrimental to North Pacific right whales.

5.2 *Investigate and, if medium or high ranked threat, reduce mortality and serious injury from vessel collisions.*

5.2.1 Identify areas where the historical occurrence of North Pacific right whales will coincide with significant levels of increasing maritime traffic resulting from decreases in annual Arctic ice and subsequent opening of trans-arctic shipping routes.

Studies are needed to identify areas where ship traffic densities will increase as the annual Arctic ice extent decreases and allows for the opening of trans-arctic shipping routes. This data should be compared to the historical range of right whales to assess the overlap.

5.2.2 Maintain a record of any ship strikes.

The possible impacts of ship strikes on recovery of North Pacific right whale populations are not well understood. Many ship strikes go unreported or undetected and the offshore distribution of North Pacific right whales make ship strikes less detectable than for other species. Also, the small number of animals in the eastern population means that even a single ship strike would impact recovery.

5.2.3 Work with mariners, the shipping industry, and appropriate state, federal, and international agencies to develop and implement measures to reduce the threat of ship strikes.

5.3 *Investigate the impacts of contaminants and pollutants on North Pacific right whales and seek strategies to reduce any impacts found to be detrimental to North Pacific right whales and their habitat.*

When possible (i.e., when carcasses or biopsies are available), investigate contaminant loads in right whales.

5.4 *Investigate the impacts of marine debris, including fishing gear entanglement, on North Pacific right whales.*

5.4.1 Determine if areas exist in which right whale habitat and significant deposits of marine debris coincide.

5.4.2 If substantial overlap are detected and they appear to pose a significant threat to right whales, seek ways to reduce or eliminate sources of marine debris.

5.4.3 Review data on North Pacific right whale interactions with fishing operations.

Continue to examine potential overlaps in distribution between fishing operations and right whales to make a preliminary evaluation of what types of fisheries and fishing gear pose the greatest risk to North pacific right whales.

5.4.4 Review photographic databases for evidence of injuries to North Pacific right whales caused by encounters with fishing gear to better characterize and understand fishing gear interactions.

Continue to review photographic databases to better characterize and understand fishing gear interactions.

5.5 *Promote and adopt, if possible within legal authority, management measures that oppose any hunting (whether for commercial, subsistence, or scientific purposes).*

V. IMPLEMENTATION SCHEDULE

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

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

> Priority 1 **–** An action that must be taken to prevent extinction or to identify those actions necessary to prevent extinction.
>
> Priority 2 **–** An action that must be taken to prevent a significant decline in population numbers or habitat quality, or to prevent other significant negative trends short of extinction.
>
> Priority 3 **–** All other actions necessary to provide for full recovery of the species.

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

Funding is estimated in accordance with the number of years necessary to complete the task once implementation has begun. The provision of cost estimates does not mean to imply that appropriate levels of funding will necessarily be available for all North Pacific right whale recovery tasks. For each, sub-totals are given as a whole in ***bold italics***. Some costs are listed as discrete (*e.g.*, 5 years) and some are listed for 50 years. The time and cost to recovery is not predictable with the current information on North Pacific right whales. The difficulty in gathering data, as well as the extremely small abundance of eastern North Pacific right whales makes it impossible to give a timeframe to recovery for this species. While we are comfortable estimating costs for some recovery actions, any projections of total costs to recovery are likely to be imprecise and unrealistic. Therefore, for ongoing actions we have only given costs for the next 50 years, as it is expected that recovery would take at least that long. Currently it is impossible to predict when the protections provided by the ESA are no longer warranted, or even determine whether the species has recovered enough to be downlisted or delisted. In the future, as more information is obtained it should be possible to make more informative projections about the time to recovery, and its expense.

DISCLAIMER

The Implementation Schedule that follows outlines actions and estimated costs for the next 50 years of the recovery program for the North Pacific right whale, as set forth in this Recovery Plan. It is a guide for meeting the recovery goals outlined in this Recovery Plan. This schedule indicates action numbers, action descriptions, action priorities, duration of actions, the parties responsible for actions (either funding or carrying out), and estimated costs. Parties with authority, responsibility, or expressed interest to implement a specific recovery action are identified in the Implementation Schedule. The listing of a party in the Implementation Schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s).

Table 3. Implementation Schedule by Fiscal Year

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Potentially Involved	Cost Estimates by FY (thousands of dollars)					
					FY14	FY15	FY16	FY17	FY18	Total/yr. x 50 years
1.0	***Coordinate State, Federal, and International Actions to Maintain International Regulation of Whaling for North Pacific Right Whales.***	2	Ongoing	NMFS, IWC, Department of State (DOS), Alaska Native Groups	50	50	50	50	50	2,500
TOTAL 1										***2,500***
2.0	***Estimate Population Size and Monitor Trends in Abundance Conduct surveys to assess current distribution of North Pacific right whales, and to estimate abundance and monitor population trends.***									
2.1.1	Assess current distribution and estimate abundance and monitor trends in eastern population.	2	5+	NMFS, International Partners			2,000	2,000	2,000	10,000
2.1.2	Establish collaborative agreements with relevant national governmental bodies and scientific institutions in Russia to develop plan for assessing current distribution, estimating abundance and monitoring trends in the western population.	2	2	NMFS, DOS, International Partners	50	50				100
TOTAL 2										***10,100***
3.0	***Determine Right Whale Occurrence, Distribution, and Range.***	2								
3.1	Use passive acoustic monitoring to assess right whale occurrence and distribution.	2		NMFS	500	500	500	500	500	2,500

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Potentially Involved	Cost Estimates by FY (thousands of dollars)					
					FY14	FY15	FY16	FY17	FY18	Total/yr. x 50 years
3.2	Conduct studies of historical data to determine the extent of the right whale's potential range, and identify unknown potential habitats.	2	1	NMFS	60					60
TOTAL 3										***2,560***
4.0	***Identify, Characterize, Protect, and Monitor Habitat Important to North Pacific Right Whale Populations in U.S. Waters and Elsewhere.***									
4.1	Better characterize North Pacific right whale habitat.	2	2-3	NMFS, International Partners	500	500	500			1,500
4.2	Monitor important habitat features and North Pacific right whale use patterns to assess potentially detrimental shifts in habitat features that might reflect disturbance or degradation of habitat.	2	Ongoing	NMFS, International Partners	TBD	TBD	TBD	TBD	TBD	TBD
4.3	Promote actions to protect important habitat in U.S. waters.	3	Ongoing	NMFS	*	*	*	*	*	*
4.4	Promote actions to define, identify, and protect important habitat in foreign or international waters.	3	Ongoing	NMFS, International Partners	*	*	*	*	*	*
4.5	Use satellite tagging to assess feeding ground movements and identify wintering areas.	2	5	NMFS	100	100	100	100	100	500
TOTAL 4										***2,000***

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Potentially Involved	Cost Estimates by FY (thousands of dollars)					
					FY14	FY15	FY16	FY17	FY18	Total/yr. x 50 years
5.0	***Investigate Human-Caused Threats, and, Should they be Determined to be Medium or High, Reduce Frequency and Severity.***									
5.1	Investigate and, if medium or high ranked threat, reduce injury and mortality caused by anthropogenic noise.	2	10	NMFS, U.S. Navy, Bureau of Ocean Energy Management (BOEM), Int'l Partners	TBD	TBD	TBD	TBD	TBD	TBD
5.1.1	Conduct studies to determine whether anthropogenic noise is adversely affecting the distribution and behavior of North Pacific right whales.	2	10	NMFS, U.S. Navy, BOEM, Int'l Partners	TBD	TBD	TBD	TBD	TBD	TBD
5.1.2	Take steps to minimize anthropogenic noises that are found to be potentially detrimental to North Pacific right whales.	3	TBD	NMFS, U.S. Navy, BOEM	TBD	TBD	TBD	TBD	TBD	TBD
5.2	Investigate and, if medium or high ranked threat, reduce mortality and serious injury from vessel collisions.	2	10	NMFS, USCG	TBD	TBD	TBD	TBD	TBD	TBD
5.2.1	Identify areas where the historical occurrence of North Pacific right whales will coincide with significant levels of increasing maritime traffic resulting from decreases in annual Arctic ice and subsequent opening of trans-arctic shipping routes.	2	1+	NMFS, USCG	20					20
5.2.2	Maintain a record of any ship strikes.	3	Ongoing	NMFS	*	*	*	*	*	*

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Potentially Involved	Cost Estimates by FY (thousands of dollars)					
					FY14	FY15	FY16	FY17	FY18	Total/yr. x 50 years
5.2.3	Work with mariners, the shipping industry, and appropriate state, federal, and international agencies to develop and implement measures to reduce the threat of ship strikes.	2	Ongoing	NMFS, USCG	*	*	*	*	*	*
5.3	Investigate the impacts of contaminants and pollutants on North Pacific right whales.	3	Ongoing	NMFS, International Partners	TBD	TBD	TBD	TBD	TBD	TBD
5.4	Investigate the impacts of marine debris, including fishing gear entanglement, on North Pacific right whales.	2	10	NMFS, International Partners	TBD	TBD	TBD	TBD	TBD	TBD
5.4.1	Determine if areas exist in which right whale habitat and significant deposits of marine debris coincide.	3	5	NMFS, National Ocean Service (NOS), International Partners	*	*	*	*	*	*
5.4.2	If substantial overlaps are detected and they appear to pose a significant threat to right whales, seek ways to reduce or eliminate sources of marine debris.	2	10	NMFS, NOS, International Partners	*	*	*	*	*	*
5.4.3	Review data on North Pacific right whale interactions with fishing operations.	2	1	NMFS	3					3
5.4.4	Review photographic databases for evidence of injuries to North Pacific right whales caused by encounters with fishing gear to better characterize and understand fishing gear interactions.	3	Ongoing	NMFS	*	*	*	*	*	*

Action Number	Action Description	Priority	Task Duration (years)	Agencies/ Organizations Potentially Involved	Cost Estimates by FY (thousands of dollars)					
					FY14	FY15	FY16	FY17	FY18	Total/yr. x 50 years
5.5	Promote and adopt, if possible within legal authority, management measures that oppose any hunting (whether for commercial, subsistence, or scientific purposes).	2	Ongoing	NMFS, Alaska Native Groups	*	*	*	*	*	*
TOTAL 5										**23**
TOTAL										**17,183**

*No cost associated, NMFS staff time.

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