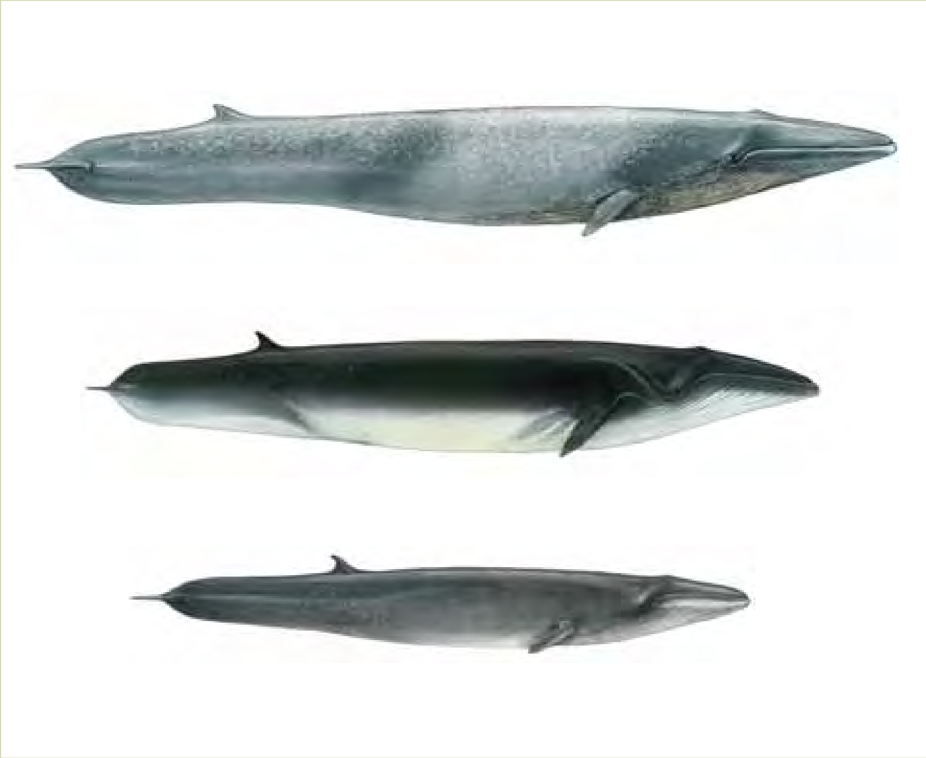
PROPOSED

Species at Risk Act

Recovery Strategy Series

Recovery Strategy for Blue, Fin, and Sei Whales *(Balaenoptera musculus, B. physalus, and B. borealis)* in Pacific Canadian Waters

Blue, Fin, and Sei Whales



January 2006

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

About the Species at Risk Act Recovery Strategy Series

What is the *Species at Risk Act* (SARA)?

SARA is the Act developed by the federal government as a key contribution to the common national effort to protect and conserve species at risk in Canada. SARA came into force in 2003 and one of its purposes is *"to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity."*

What is recovery?

In the context of species at risk conservation, **recovery** is the process by which the decline of an endangered, threatened or extirpated species is arrested or reversed, and threats are removed or reduced to improve the likelihood of the species' persistence in the wild. A species will be considered **recovered** when its long-term persistence in the wild has been secured.

What is a recovery strategy?

A recovery strategy is a planning document that identifies what needs to be done to arrest or reverse the decline of a species. It sets goals and objectives and identifies the main areas of activities to be undertaken. Detailed planning is done at the action plan stage.

Recovery strategy development is a commitment of all provinces and territories and of three federal agencies — Environment Canada, Parks Canada Agency and Fisheries and Oceans Canada — under the Accord for the Protection of Species at Risk. Sections 37–46 of SARA (http://www.sararegistry.gc.ca/the_act/default_e.cfm) spell out both the required content and the process for developing recovery strategies published in this series.

Depending on the status of the species and when it was assessed, a recovery strategy has to be developed within one to two years after the species is added to the List of Wildlife Species at Risk. Three to four years is allowed for those species that were automatically listed when SARA came into force.

What's next?

In most cases, one or more action plans will be developed to define and guide implementation of the recovery strategy. Nevertheless, directions set in the recovery strategy are sufficient to begin involving communities, land users, and conservationists in recovery implementation. Cost-effective measures to prevent the reduction or loss of the species should not be postponed for lack of full scientific certainty.

The series

This series presents the recovery strategies prepared or adopted by the federal government under SARA. New documents will be added regularly as species get listed and as strategies are updated.

To learn more

To learn more about the Species at Risk Act and recovery initiatives, please consult the SARA Public Registry (http://www.sararegistry.gc.ca/) and the web site of the Recovery Secretariat (http://www.speciesatrisk.gc.ca/recovery/default_e.cfm).

Recovery Strategy for Blue, Fin and Sei Whales (*Balaenoptera musculus, B. physalus*, and *B. borealis*) in Pacific Canadian waters [Proposed]

January 2006

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Additional copies:

You can download additional copies from the Species At Risk Public Registry (http://www.sararegistry.gc.ca/)

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DECLARATION

This proposed Recovery Strategy for blue, fin, and sei whales in Pacific Canadian waters has been prepared in cooperation with jurisdictions responsible for the species, as described in Appendix I. Fisheries and Oceans Canada has reviewed and accepts this document as its Recovery Strategy for these species as required by the *Species at Risk Act*.

Success in the recovery of these whales depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Fisheries & Oceans Canada or any other jurisdiction alone. In the spirit of the National Accord for the Protection of Species at Risk, the Minister of Fisheries & Oceans invites all Canadians to join Fisheries & Oceans Canada in supporting and implementing this strategy for the benefit of blue, fin, and sei whales and Canadian society as a whole. Fisheries & Oceans Canada will support implementation of this strategy to the extent possible, given available resources and its overall responsibility for species at risk conservation. The Minister will report on progress within five years.

This strategy will be complemented by one or more action plans that will provide details on specific recovery measures to be taken to support conservation of these species. The Minister will take steps to ensure that, to the extent possible, Canadians interested in or affected by these measures will be consulted.

RESPONSIBLE JURISDICTIONS

The responsible jurisdiction for blue, fin and sei whales in Pacific Canadian waters is Fisheries and Oceans Canada. The Pacific populations of blue, fin and sei whales occur off the coast of the Province of British Columbia and the proposed National Marine Conservation Area off Gwaii Haanas National Park Reserve. The Province of BC and Parks Canada also cooperated in the development of this recovery strategy.

AUTHORS

This document was prepared by E.J. Gregr, J. Calambokidis, L. Convey, J.K.B. Ford, R.I. Perry, L. Spaven, and M. Zacharias on behalf of Fisheries and Oceans Canada.

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EXECUTIVE SUMMARY

Blue (*Balaenoptera musculus)*, fin (*B. physalus)*, and sei (*B. borealis*) whales are collectively referred to in this Recovery Strategy as balaenopterids (order Cetacea, family Balaenopteridae). The species are considered collectively because the similar geographic distribution and shared threats warrant the development of an integrated, multi-species recovery strategy.

As the first target of the modern (i.e., steamship) whaling industry, blue whale populations were severely reduced in all the world's oceans during the early 1900s. Protected in the North Pacific in 1966, the Eastern North Pacific population currently numbers about 2000 animals and is one of the few blue whale populations known to be stable or recovering. The presumed summer range of this population extends from California to British Columbia and Alaska.

Fin whales were hunted concurrently with blue whales in the North Pacific. The largest catches were in the 1950s and 1960s, and resulted in significant population declines prior to their protection in 1976. The population structure in the eastern North Pacific is unclear. A putative California/Washington/Oregon population is comprised of over 3000 animals, and is believed to be distinct from the population in Alaska. Fin whales frequent Pacific Canadian waters year-round, with highest numbers seen in the summer months. However, it is not known to which population they belong.

Sei whales were hunted by modern whalers primarily after the preferred larger (or more easily taken) baleen whale species had been seriously depleted. Most populations of sei whales were reduced by whaling in the 1950s through the early 1970s. North Pacific sei whales were not protected from whaling until 1976. The sei whale is the least studied of the large whales, and the current status of most populations is not known. The existence of an Eastern North Pacific population is assumed, but its range is unknown.

Whaling remains the greatest potential threat to large whales. However, since commercial whaling is unlikely to resume in the near future and there is no aboriginal interest in hunting these species, whaling is not seen as a current threat. The escalation of scientific whaling would become a concern should it start to target blue, fin and/or sei whales. More imminent threats to these three species in Pacific Canadian waters include collisions with vessels, noise from industrial and military activities, pollution, and habitat displacement resulting from shifts in the physical and biological structure of the ocean.

Blue and sei whales are listed as endangered under the *Species at Risk Act* (*SARA*). Fin whales are designated as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and are under consideration for listing under the *SARA*. While the degree of information on the

individual species is variable, recovery is believed to be feasible for all three species.

Balaenopterid whales are long-lived species with life spans between 50 and 100 years. Recovery goals must span several generations, and therefore have a horizon of 150-300 years. The goals of this Recovery Strategy are to attain long-term viable populations of the blue, fin, and sei whales that use Pacific Canadian waters. In order to determine whether progress is being made towards reaching these goals, the Recovery Strategy objectives over the next five to 10 years are: to determine the populations to which the blue and fin whales that occur in Pacific Canadian waters belong; to see that the relative proportion of blue and fin whales using these waters is maintained or increased; to confirm the presence of sei whales and, once confirmed, to see that the relative proportion of sei whales using these waters is maintained or increased; and to see that threats do not significantly reduce potential habitat or the species' distribution.

Critical habitat for balaenopterid whales has not been identified, and represents one of the most significant knowledge gaps, along with basic information on the size and distribution of the populations. Threats to the species and their critical habitat can be better addressed once this basic information has been collected. Thus, the strategies outlined in this Recovery Strategy to address threats and effect recovery are: Critical Habitat Identification, Species Abundance and Distribution, and Threat Mitigation.

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1 Introduction

Blue (*Balaenoptera musculus)*, fin (*B. physalus)*, and sei (*B. borealis*) whales are collectively referred to herein as balaenopterid whales (order Cetacea, suborder Mysticeti, family Balaenopteridae). Balaenopterids, together with the families Balaenidae and Eschrichtiidae comprise the baleen whales. Baleen whales are characterised by a unique method of feeding, where mouthfuls of water containing prey are strained through large baleen plates. This distinctive feeding behaviour allows these species to take advantage of concentrations of zooplankton or schooling fish.

The balaenopterid whales are considered collectively because of a similar geographic distribution and shared threats. These similarities have warranted the development of an integrated, multi-species Recovery Strategy.

This Recovery Strategy provides the scientific basis to recover the populations of blue, fin and sei whales that occur in Pacific Canadian waters off the coast of British Columbia. Knowledge about these whales is poor in Pacific Canadian waters. Therefore the collection of basic data on abundance and distribution, critical habitat, and threats is the first priority for their recovery. As information is gathered, the Recovery Strategy may be amended to incorporate new findings (a copy of the amendment must be included in the public registry www.sararegistry.gc.ca).

2 Blue whale background

2.1 Current status

Common name:	Blue whale
Scientific name:	*Balaenoptera musculus*
Legal listing (*SARA*):	January 2005 (Endangered)
COSEWIC status:	Endangered
Assessment summary:	May 2002
Reason for designation:	Blue whales off the coast of British Columbia are likely part of a population based in the northeastern Pacific. The population was reduced by whaling. The rarity of sightings (visual and acoustic) suggests their numbers are very low (significantly less than 250 mature individuals). Threats for blue whales along the coast of British Columbia are unknown but may include ship strikes, pollution, entanglement in fishing gear, and long-term changes in climate (which could affect the abundance of their zooplankton prey). (www.cosewic.gc.ca)
Occurrence in Canada:	North Pacific, North Atlantic
Status history:	Entire Canadian range was designated as Special Concern in April 1983. Split into two populations in May 2002. The Pacific population was up-listed to Endangered in May 2002, based on an updated status report.

2.2 Species description

Blue whales are the largest animals on the planet and are found in most oceans of the world. Blue whales range from the pack ice of both hemispheres to temperate and tropical waters, with distinct populations found in the North Atlantic, North Pacific, Southern Hemisphere, and the northern Indian Ocean (Mizroch *et al.* 1984, Rice 1998). These populations are further separated into six “stocks” (i.e., populations) by the International Whaling Commission (IWC) despite a poorly understood stock structure (Donovan 1991).

The longest blue whale ever recorded (33.6 m; 110 ft) was caught in the Antarctic. In the North Pacific, the longest animal caught was 27.1 m (89 ft) (Sears and Calambokidis 2002). Body weights range from 80-150 tons (73,000-136,000 kg) with one report of a 190 ton (173,000 kg) female killed off South Georgia in 1947 (Tomilin 1967). Females are generally larger and longer than males and animals are larger on average in the southern hemisphere than in the northern hemisphere.

Blue whales have a light to slate-grey appearance above water with a characteristic mottled pigmentation. The pigmentation can range from a sparse mottling pattern to highly mottled individuals with splotches along the flanks, back and ventral surface.

Chevrons often curve down and back on both sides of the rostrum behind the blowholes. This highly variable pigmentation and mottling patterns are distinctive and stable throughout life allowing individuals to be tracked using photo-identification (Sears and Calambokidis 2002).

The blue whale has a large, broad U-shaped head that comprises nearly 25% of its body length. The top of the head has a prominent rostral ridge that runs from the upper jaw and mandibles to the splash-guard in front of two blowholes. The dorsal fin is relatively small compared to other balaenopterids and is highly variable in shape. The flippers are approximately 4m in length (15% of body length) with blunt tips. The flukes are broad and triangular with a straight or slightly curved trailing edge, grey in colour, possibly with variable white patches on the underside.

Females give birth every 2-3 years in winter following a 10-12 month long gestation period. The calf weighs 2-3 tonnes and measures 6-7 m at birth. Blue whales nurse until 6-7 months of age and are likely weaned during the summer when on feeding grounds. Blue whales are thought to reach sexual maturity between 5-15 years for both sexes, and live 70-80 years (Sears and Calambokidis 2002). Calving rates are not well known, however, observations of calves from the Sea of Cortez (R. Sears, personal communication. Mingan Island Cetacean Study, 285 rue Green, St. Lambert, Québec, J4P 1T3), and California (J. Calambokidis, personal communication. Cascadia Research, 218 1/2 W 4th Ave., Olympia, WA 98501) indicate that reproduction is taking place.

2.3 Population size, trends, and distribution

Blue whales undertake extensive, seasonal north-south migrations each year from wintering grounds in the low latitudes to summer feeding grounds in productive mid to high latitude waters. Their historic distribution is better described at higher latitudes due to the extensive whaling that took place on these feeding grounds.

The extensive range and dispersion of blue whales coupled with low sampling effort and depleted populations makes reliable estimates of population size difficult. Global population estimates range from 5000-12,000, though the accuracy of these estimates is questionable (Carretta *et al.* 2003). Historically, Southern Ocean populations were the largest with an estimated 300,000 animals pre-exploitation. Recent estimates of 710-1265 have been calculated for summer feeding grounds in Antarctic waters (IWC 1990, Butterworth *et al.* 1993, IWC 1996).

Historically, blue whales ranged throughout the coastal and pelagic waters of the North Pacific. Data on population structure come primarily from historic whaling records, sightings, and acoustic recordings of vocalizations. Based on whaling records, Gambell (1979) suggested that there were three blue whale populations in the North Pacific, while Reeves *et al.* (1998) concluded that as many as five sub-populations, including ones in the eastern Gulf of Alaska and California/Mexico, inhabited the North Pacific with an uncertain level of mixing between them. The lack of recent sighting data in much of the species' former range suggests that some sub-populations may have been extirpated by commercial whaling.

Analysis of blue whale calls has revealed two distinct call types; one prevalent in the western and central North Pacific and the other in the eastern North Pacific (Stafford *et al.* 2001), suggesting at least two populations of blue whales in the North Pacific.

The U.S. National Marine Fisheries Service (NMFS) manages blue whales as two populations, an eastern North Pacific stock and a Hawaiian stock. The eastern North Pacific population ranges as far south as Mexico and Central America during the winter and spring. It is regularly sighted feeding off California during the summer and fall. Migration occurs in spring north from the Gulf of California, Mexico, and the offshore waters of Central America and moves along the west coast of North America to concentrations off California, peaking in July to September.

Due to a continued rarity of sightings at higher latitudes, the northern range of this population is unclear. Blue whale calls have been detected off Vancouver Island and further north in the Gulf of Alaska. The call intensity (defined as dB above ambient) off Vancouver Island from September to February (Burtenshaw *et al.* 2004) suggests that the animals off California may disperse northward and possibly offshore after September, before, presumably, returning to southern latitudes for the winter. A blue whale identified in the Gulf of Alaska, south of Prince William Sound, in 2004 had been identified frequently off California in previous years (J. Calambokidis and J. Barlow, unpublished data). In light of this information, it is presumed that the animals using Pacific Canadian waters belong to the putative eastern North Pacific population as defined by NMFS.

The size of the eastern North Pacific population has been estimated using both line transect and mark-recapture (photo-identification) techniques. The population has been increasing since the moratorium on commercial whaling (Barlow 1994) and is currently reliably estimated at 2000 animals (Calambokidis and Barlow 2004). However, the rate of increase is too great to be attributed to population growth alone (Barlow 1994) and may reflect a shift in distribution. Sparse sighting data throughout the northern Gulf of Alaska from Canada to the Aleutian Islands indicates that this increase does not apply to all regions of the eastern North Pacific (Sears and Calambokidis 2002). The relative contributions of population growth, distributional shifts, and habitat contraction to the increasing trends observed off California is unclear. Nevertheless, given available population estimates, the eastern North Pacific population represents a large proportion of the known blue whales in the world.

2.3.1 <u>Canadian Pacific</u>

Sighting data from Japanese scouting surveys (1965 – 1978) throughout the North Pacific include blue whale sightings in Pacific Canadian waters. While these data are difficult to translate into densities or abundances, they do show a relatively higher sighting rate for waters off British Columbia compared to most other areas surveyed (Sears and Calambokidis 2002).

“Discovery” tags, used to examine the movements of commercially hunted whales, showed a blue whale tagged on 4 May 1963 off Vancouver Island later killed on 21 June 1964 south of Kodiak Island (Ivashin and Rovnin 1967). This was the longest distance recorded from this tagging program and provides evidence of exchange between Pacific Canadian and Alaskan waters. Historic records show an on-shelf to deep water distribution off British Columbia (Figure 1a), and a seasonal peak in abundance in July to September (Figure 2).

More recently, two blue whales photo-identified off the Queen Charlotte Islands in northern British Columbia both matched to animals seen off California (Calambokidis *et al.* 2004a). A whale identified on 12 June 1997 was re-sighted in the Santa Barbara Channel on 10 July 1997. It had therefore travelled at least 2500 km in 28 days representing a minimum swimming speed of 3.7 km/h (Sears and Calambokidis 2002). This individual represents the first confirmed movement between Californian waters and higher latitude feeding areas. Two blue whales were sighted near the shelf-break off Queen Charlotte Sound in the spring of 2002, during the first of two bi-annual cruises now conducted annually by the Cetacean Research Program - Fisheries and Oceans Canada (CRP-DFO) (Figure 3a). A blue whale photo-identified south of Cape St James on a joint DFO/Cascadia Research cruise in August 2003 (Figure 3b) also matched to the California catalogue. A blue whale seen in 2004 in the Gulf of Alaska matched to the California catalogue, though in a different year (J. Calambokidis and J. Barlow, unpublished data). In summer 2004, a blue whale tagged off California travelled as far north as Estevan Point, west coast Vancouver Island (B. Mate, personal communication. Hatfield Marine Science Center, 2030 SE Marine Science Drive, Newport, Oregon 97365).

The British Columbia Cetacean Sightings Network (BCCSN) database (courtesy of D. Sandilands, Cetacean Research Lab, Vancouver Aquarium Marine Science Centre, 845 Avison Way, Vancouver, BC, V6G 3E2) contains whale sightings from 1972 – 2004, with the majority collected since 1999 and virtually all of them provided by recreational boaters. Such opportunistically collected data provide an indication of the distribution and relative abundance between species; however they are not corrected for effort, and observers have variable species identification skills. Consequently these data cannot be used to estimate population abundance or trends. The database contains 3 high confidence sightings of blue whales.

While visual sightings have been rare in recent years off British Columbia, Washington, and southeast Alaska, calls presumed to be from the eastern North Pacific population of blue whales have been consistently detected by bottom-mounted hydrophones from California to British Columbia and Alaska (Sears and Calambokidis 2002). Burtenshaw *et al.* (2004) showed a significant, almost constant intensity of blue whale calls off

British Columbia from October to February. Thus, Pacific Canadian waters appear to represent an important feeding ground for a large portion of the world's blue whales.

2.4 Biological needs, ecological role and limiting factors

Blue whales are low trophic level foragers requiring several tonnes of prey per day per individual. Thus, the viability and recovery of the blue whale population could be constrained by factors that limit availability of food. Given the large quantities of zooplankton required to maintain a blue whale population, their presence in, or absence from, an ecosystem is likely significant (Sears and Calambokidis 2002).

Changes in ocean climate (See Section 5.2.4) could affect both the total available prey for, and the foraging effectiveness of, blue whales. Such lower trophic foraging specialists may be more immediately affected by large-scale oceanographic shifts than other species with more diverse diets (Benson and Trites 2002).

Killer whale predation may be a source of mortality for blue whales, however, the prevalence in Pacific Canadian waters is unclear and few data on scarring are available from this region. Scars associated with killer whale (*Orcinus orca*) attacks are present on 25% of the blue whales sighted in the Sea of Cortez, however these scars are rare on blue whales in the St. Lawrence (Sears and Calambokidis 2002). One report describes an attack by a group of killer whales on a blue whale off Baja California (Tarpy 1979). While the rate of predation is unknown, increasing whale populations could lead to increased predation by killer whales. Killer whale predation may be more prevalent off California and Mexico than elsewhere based on the scarring rate of humpback whales (*Megaptera novaeangliae*) (G. Steiger, personal communication. Cascadia Research, 218 1/2 W 4th Ave., Olympia, WA 98501). Nevertheless, mortality rates are not known (Reeves *et al.* in press).

2.5 Habitat needs

Higher-latitude habitat is likely best defined by its suitability as a foraging ground. Blue whales feed along productive shelf-break upwellings in temperate to polar waters from spring to early winter. They feed primarily on euphausiids (*Euphausia pacifica, Thysanoessa spinifera, T. inermis, T. longpipes, T. raschii*, and *Nematoscelis megalops*), though calanoid copepods (*Calanus* spp.) and pelagic red crab (*Pleuroncodes planipes*) also occur in the diet. They exploit dense concentrations of these prey species by engulfing prey with their large mouths and expanding throat pleats.

Reproductive activity occurs in the winter season in tropical and sub-tropical waters, but no specific breeding grounds have yet been identified for eastern North Pacific blue whales (Sears and Calambokidis 2002) or any other blue whale population.

3 FIN WHALE BACKGROUND

3.1 Current status

Common name:	Fin whale
Scientific name:	*Balaenoptera physalus*
Legal listing (*SARA*):	under consideration
Assessment summary:	May 2005
COSEWIC status:	Threatened
Reason for designation:	Currently sighted only infrequently on former whaling grounds off British Columbia. Coastal whaling took at least 7,600 animals from the population between 1905 and 1967, and thousands of additional animals were taken by pelagic whalers through the 1970s. Catch rates from coastal whaling stations declined precipitously off British Columbia in the 1960s. Based on the severe depletion and lack of sufficient time for recovery, it is inferred that present population is below 50% of its level 60-90 years ago. Individuals continue to be at risk from ship strikes and entanglement in fishing gear. (www.cosewic.gc.ca)
Occurrence in Canada:	North Atlantic and North Pacific
Status history:	The species was considered a single unit and designated Special Concern in April 1987. Split into two populations (Atlantic and Pacific) in May 2005. The Pacific population was designated Threatened in May 2005.

3.2 Species description

The fin whale is the second largest member of the family Balaenopteridae, after the blue whale. It has been characterized as the “greyhound of the sea” due to its fast swimming speed and streamlined body (Reeves *et al.* 2002). Fin whales are widely distributed in all the oceans of the world, in both coastal and offshore waters. Although considered a single stock in the North Pacific by the IWC, there is more likely at least an eastern and a western population (COSEWIC 2004).

Fin whales can reach 27 m (88 ft) in length, with adult females 5-10% longer than males. Adult fin whales in the southern hemisphere are up to 4 m longer than their northern hemisphere counterparts, and have longer, narrower flippers. The body is generally dark grey or brownish-grey dorsally, shading to white ventrally. Some individuals have a V-shaped chevron on the dorsal side, behind the head. Asymmetrical colouring of the lower jaw, dark on the left and light on the right, continues about a third of the distance through the baleen plates, the remainder of which are a dark blue-grey. This colouration pattern is diagnostic for the species. The ventral surfaces of the flippers and flukes are also white. Some adults show scarring indicative of lamprey or remora attachment or nicks and scars on the fins or body that may stem from interactions with fishing gear or other animals. Individual animals can be identified by means of scarring, pigmentation patterns, dorsal fin shapes and nicks (COSEWIC 2004).

The head of the fin whale is narrow, measuring about 20-25% of total body length, with the rostrum particularly pointed, prominent splash guards around the double nares (i.e., nostrils) and a single median head ridge. The eyes lie just above the corners of the mouth. The lower jaw is laterally convex and juts 10-20 cm beyond the tip of the rostrum when the mouth is shut. The dorsal fin is set about three quarters of the way back along the dorsal surface, is falcate or pointed, and can be 60 cm high. Behind the dorsal fin, the caudal peduncle has a sharp, prominent ridge (COSEWIC 2004).

Fin whales can be confused with blue, sei and Bryde's (*B. brydei*) whales, and with the recently described *B. omurai*. However, based on the distribution of these species, confusion in Pacific Canadian waters is likely limited to blue and sei whales. The fin whale head is more pointed than that of the blue whale, with a larger dorsal fin, which is set further back and has a shallower rise than that of the sei whale. On surfacing, a fin whale's blowholes are seen first followed by the dorsal fin. In sei whales, the blowholes and dorsal fin usually appear almost simultaneously. The blue whale is the only member of the genus *Balaenoptera* to regularly "fluke up" (i.e., lift its flukes above the surface when starting a deep dive) (COSEWIC 2004).

Reproduction is similar to blue whales, with females calving every 2-3 years following an 11-12 month gestation period. Calves are born at about 6 m in length, and are weaned at an average length of about 11.5 m, at 6-7 months of age. Age at sexual maturity is estimated at 5 to 15 years for both sexes, at an average length in the northern hemisphere of 17.2 m (COSEWIC 2004). Similar to blue whales, the life span of fin whales is assumed to be around 80 years.

3.3 Population size, trends, and distribution

Fin whales have a cosmopolitan distribution, though they are more abundant in temperate and polar latitudes. In the North Pacific, the known summer range extends northward to 50°N in the Sea of Okhotsk, 60°N in the Bering Sea and 58°N in the Gulf of Alaska, and southward to 40°N in the Sea of Japan and 32°N off the coast of California. The known winter range extends from Korea to Taiwan, the Hawaiian Islands and to the Baja California peninsula, although this distribution is believed to be primarily offshore (Leatherwood *et al.* 1988).

Fin whales summer at various locations along the eastern North Pacific coast, and are known to occupy some regions (at least the Gulf of California and south/central California) on a year-round basis. Summer aggregations have been documented off Oregon, and summer-fall groups have been observed in the Shelikof Strait/Gulf of Alaska region (Carretta *et al.* 2003). Acoustic detection occurs year-round off northern

California, Oregon and Washington, with a concentration of activity between September and February (Moore *et al.* 1998).

NMFS recognizes three stocks in U.S. waters of the North Pacific: the Northeast Pacific stock, the Hawaiian stock, and the California/Oregon/Washington stock (Carretta *et al.* 2003). Fujino (1960) concluded that the North Pacific contains an eastern and a western population based on histological and marking data. The marking data further suggest that the fin whales off British Columbia may have been isolated to some degree.

Oshumi and Wada (1974) estimated pre-exploitation abundance in the North Pacific at 40,000 – 45,000. Whaling reduced the numbers to an estimated 13,000 – 19,000 by 1973, of which 8500 – 11,000 were assumed to be from the eastern North Pacific (Oshumi and Wada 1974). The most recent estimate of the size of the California/Oregon/Washington stock based on ship surveys is 3279 (Coefficient of Variation (CV) = 0.31) (Barlow and Taylor 2001 cited in Carretta *et al.* 2003). Vessel surveys in July-August 1999 produced an estimate of 4951 (CV=0.29) fin whales in the Bering Sea, though these numbers did not provide an indication of the size of any of the putative stocks (Angliss and Lodge 2003). To date, the available data are not sufficient for estimating population trends.

The population structure in Pacific Canadian waters is equivocal. There is no way to presently determine whether animals sighted in Pacific Canadian waters are from either of the two stocks defined by NMFS. Indeed, there is currently no evidence to determine whether these two putative stocks are truly distinct populations or whether they represent a single, eastern North Pacific population.

3.3.1 Canadian Pacific

Pike and MacAskie (1969) regarded the fin whale as the most abundant baleen whale in Pacific Canadian waters, and suggested that the waters off Vancouver Island contained a summer feeding aggregation. Historically, fin whales were frequently observed in exposed coastal seas (Hecate Strait and Queen Charlotte Sound) and occasionally in the more protected waters of Queen Charlotte Strait and the Strait of Georgia (Pike and MacAskie 1969). Only 17% of the catch for which positions were recorded by British Columbia coastal whalers was on the continental shelf (Figure 1 and Gregr 2004).

Based on a comparison of whaling records from coastal stations around the Gulf of Alaska, Gregr *et al.* (2000) concluded that the species did not appear restricted latitudinally. An analysis of whaling records from British Columbia whaling stations identified fin whale habitat along the continental shelf, in the exposed inland waters of Dixon Entrance and Hecate Strait, and in a region offshore of northern Vancouver Island (Figure 1, from Gregr and Trites 2001).

Contemporary sightings of fin whales in Pacific Canadian waters are predominantly from the west coast of Vancouver Island, Hecate Strait and Queen Charlotte Sound, and occur in summer and winter. Recent annual spring research cruises (CRP-DFO) have recorded 75 fin whale sightings between 2002 and 2004 in off-shelf waters, near the shelf break boundary of Queen Charlotte Sound, in Hecate Strait, and in Dixon Entrance (Figure 3a). Summer cruises in 2002 and 2003 sighted 12 fin whales in Queen Charlotte Sound (Figure 3b). Recent summer sightings have also been made off southern Vancouver Island (COSEWIC 2004). An opportunistic winter cruise in February 2004 resulted in sightings off the north end of Vancouver Island and in Hecate Strait (CRP-DFO, unpublished data). The BCCSN database contains 48 high confidence fin whale sightings.

In contrast to the relatively frequent sightings off British Columbia, NMFS conducted 2-week summer surveys in the northern offshore waters of Washington State each year from 1995 to 2002 and did not sight a single fin whale (Calambokidis *et al.* 2004b). Similarly, aerial surveys off the west coast of Washington in the early 1990s also did not spot any fin whales (Green *et al.* 1992 cited in Calambokidis *et al.* 2004b).

It may be that this pattern of sightings represents the re-occupation of the historic fin whale feeding grounds in Pacific Canadian waters. Alternatively, it may also be a reflection of increased observational effort, or some other demographic shift in the local population(s).

3.4 Biological needs, ecological role and limiting factors

Fin whales forage on a variety of species. Generally in the northern hemisphere they eat small invertebrates, schooling fishes and squids. Consequently, it has been suggested that fin whale diet is as much a function of availability as preference (Gambell 1985b).

In the North Pacific, the diet is dominated by euphausiids (70%) followed by copepods (25%) with some fish and squid (Kawamura 1980). Flinn *et al.* (2002) examined records of stomach contents for fin whales taken in British Columbia and found similar results.

Due to the global overlap in range and diet with other baleen whales, inter-specific competition is likely (Aguilar and Lockyer 1987). Mixed groups of fin and blue whales are common and hybrids occur with surprising frequency in the North Atlantic (Bérubé and Aguilar 1998), although hybrids have not been identified in the St. Lawrence with 40% of fin and blue whales analysed (R. Sears pers. comm.). The degree to which hybridization may occur in the North Pacific is unknown.

Consequent to their depletion by whaling, large baleen whales may have been ‘replaced’ in the ecosystem to some extent by ecologically-equivalent finfish stocks (Payne *et al.* 1990). Trites *et al.* (1999) suggested that some species of fish are significant competitors of whales in the Bering Sea. Another possible consequence of whaling is that the remaining populations may be too small to recover. However, while there is insufficient population data for an unequivocal assessment, this is not believed to be a limiting factor for fin whales.

Some predation of fin whales is possible by killer whales and sharks, though the degree of predation is unknown (Reeves *et al.* in press). Increased abundance could lead to increased predation.

3.5 Habitat needs

The summer habitat of fin whales tends to consist of areas with dense prey concentrations (Kawamura 1980, Gaskin 1982). Woodley and Gaskin (1996) found that in the Bay of Fundy, fin whales occurred primarily in shallow areas with high topographic relief, and their occurrence was correlated with herring and euphausiid concentrations.

Fin whale distribution is associated with low surface temperatures off the northeastern U.S. and in the Bay of Fundy during summer months (Woodley and Gaskin 1996). Hain *et al.* (1992) documented an association with oceanic fronts, areas known for high biological productivity (Herman *et al.* 1981).

Conception and calving are believed to occur in low latitudes during winter, but no specific breeding grounds have yet been identified (e.g., Mizroch *et al.* 1984). Payne (2004) suggested that the long-distance communication abilities of the species may allow mating to occur without the need for aggregating on breeding grounds.

4 SEI WHALE BACKGROUND

4.1 Current status

Common name:	Sei whale
Scientific name:	*Balaenoptera borealis*
Legal listing (*SARA*):	January 2005 (Endangered)
Assessment summary:	May 2003
COSEWIC status:	Endangered
Reason for designation:	This was one of the most abundant species sought by whalers off the British Columbia coast (with over 4000 individuals killed) and was also commonly taken in other areas of the eastern North Pacific. Sei whales have not been reported in British Columbia since whaling ended and may now be gone. There are a few, if any, mature individuals remaining in British Columbia waters, and there is clear evidence of a dramatic decline caused by whaling and no sign of recovery. (www.cosewic.gc.ca)
Occurrence in Canada:	North Atlantic and North Pacific
Status history:	Designated Endangered in May 2003.

4.2 Species description

The sei whale is the third largest member of the Balaenopteridae, after the blue and fin whales. Sei whales are cosmopolitan in their distribution, though they appear somewhat restricted to temperate waters, occurring within a more restricted range of latitudes than all other rorquals except Bryde’s whales (COSEWIC 2003). There is evidence for three stocks of sei whales (western, central and eastern) in the Pacific (Masaki 1977).

An average adult sei whale is 15 m long and weighs 19 tonnes (Horwood 1987). Females are larger than males. Animals in the northern hemisphere appear to be smaller than those in the southern hemisphere (Tomilin 1967). The maximum reported lengths for a female were 18.6 m in the northern hemisphere and 20 m in the south (Gambell 1985a).

Sei whales are dark to bluish grey dorsally and white to cream coloured ventrally. The ventral grooves commonly have a white or light-coloured area extending from the chin to the umbilicus, although colouration is extremely variable. Oval-shaped scars from cookie-cutter shark bites and lampreys, and infestations of ectoparasitic copepods often occur on the lateral and ventral sides. The curved, slender dorsal fin is prominent measuring 0.25-0.75 m, and is set further forward on the body compared to blue and fin whales. The pectoral flippers are relatively short measuring only 9-10 per cent of the body length, dark grey ventrally, and pointed at the tips. The dark grey flukes are rarely raised to “fluke-up” before dives (COSEWIC 2003).

In the eastern North Pacific, fin and sei whales overlap morphologically in body size, colouration, and dorsal fin shape making the two easily confused. However, sei whales lack the asymmetric white colouration of the right jaw and ventral side that is diagnostic for fin whales. Confusion with fin whales, and to a lesser degree with Bryde's and minke (*B.acutorostrata*) whales, implies that sei whale population size and range could easily be underestimated (COSEWIC 2003).

Sei whales migrate from low-latitude wintering areas to high-latitude, summer feeding grounds. Catch records indicate that migrations are segregated according to length (i.e., age), sex, and reproductive status, with pregnant females leading the migration to the feeding grounds. The youngest animals arrive last and leave first, and travel to lower latitudes than adults. The wintering grounds of sei whales are largely unknown, though they are thought to occur far offshore (COSEWIC 2003).

Males and females reach sexual maturity between 5 and 15 years of age and live to approximately 60 years of age. In both hemispheres, the age of sexual maturity declined from 10-11 years to 8 years between the 1930s and the 1960s, likely in response to exploitation. Mating, followed by a gestation period of 10.5 to 12 months, and calving occur in winter. Calves nurse for about 6 months and are weaned on the feeding grounds. The calving interval is 2-3 years (COSEWIC 2003).

4.3 Population size, trends, and distribution

Historically the most abundant of the baleen whales, sei whales are now considered rare in U.S. and Pacific Canadian waters. They were once described as abundant off the west coast of Vancouver Island, British Columbia, in June through August (Pike and MacAskie 1969). The pre-whaling North Pacific population, estimated at between 58,000 and 62,000 individuals, was reduced to between 7,260 and 12,620 animals by 1974 (COSEWIC 2003). Although whaling from British Columbia coastal stations stopped after 1967, international whaling in the North Pacific continued to target this species until 1975. Almost 40% of the total (62,550) reported North Pacific sei whale catch was taken after 1967 (IWC database, J. Breiwick, NMML, AFSC, NMFS, 7600 Sand Pt Way NE, Seattle, WA 98115-0070). Since the total catch exceeds the estimated pre-exploitation population size, it is clear this species was severely depleted.

The IWC recognizes a single stock of sei whales in the North Pacific (Donovan 1991). However, evidence does exist for multiple populations, at least historically. A review of marking studies, catch distributions, sighting and baleen morphology revealed three North Pacific stocks separated by 175°W and 155°W longitude (Masaki 1977). Fujino (1964) suggested a difference between sei whales caught in the inner Gulf of Alaska and off Vancouver Island based on examination of blood type. Different forms of parasites observed at opposite sides of the Pacific imply the existence of at least an eastern and western population (Rice 1974).

NMFS recognizes an eastern and a western stock in the North Pacific, divided by 180°W (Carretta *et al.* 2002). The stock boundary is arbitrary due to a lack of information on population structure. An abundance estimate of 56 animals (CV = 0.61) was recently calculated by Barlow (2003 cited in Carretta *et al.* 2003) for the Eastern North Pacific stock, to a distance of 300 nm (560 km) from shore. No population trend data are available. It is presumed that sei whales in Canadian Pacific waters are part of the eastern North Pacific population.

4.3.1 Canadian Pacific

Historic records clearly demonstrate that Pacific Canadian waters were once extensively used by sei whales (Figure 1), with a sharp peak in seasonal abundance during July (Figure 2). In recent years, cetacean surveys off the British Columbia coast and shelf-break region have not resulted in a single confirmed sei whale sighting (CRP-DFO, unpublished data). The BCCSN database contains 3 high confidence sei whale sightings.

Two confirmed sei whale sightings and 5 possible sightings (recorded as sei or Bryde's whales) were made off California, Oregon, and Washington during ship and aerial surveys between 1991 and 2001 (Carretta et al. 2003). These few sightings are the basis for the recent abundance estimate in that region.

Based on sighting data, the number of sei whales currently occurring in Pacific Canadian waters appears quite small and has shown no measurable signs of recovery since the species received protection from commercial whaling in 1976. No reliable information is available to estimate population trends.

4.4 Biological needs, ecological role and limiting factors

Sei whales are low trophic level foragers that feed primarily on calanoid copepods. However, their diet also contains euphausiids, amphipods, and schooling fish and squid, particularly in the North Pacific (Nemoto and Kawamura 1977, Flinn *et al.* 2002). Stomach content analyses have revealed substantial regional differences in diet. In the Antarctic, euphausiids represented 54% of the sei whale diet, whereas calanoid copepods represented 83% of the diet in the North Pacific (Nemoto and Kawamura 1977, Kawamura 1982).

Sei whales may forage more opportunistically in coastal waters, taking advantage of a more diverse prey base than is available in pelagic waters (Kawamura 1982). Stomach contents from British Columbia whaling stations reveal that copepods were the most common in 3 of 5 years, whereas fish and euphausiids each dominated in one of the other years (Flinn *et al.* 2002).

Differences in stomach contents between the North Pacific and the Antarctic may be due to the different trophic structures and prey availability in the two regions. In the Antarctic, the majority of biomass is in the form of zooplankton. In the North Pacific on the other hand, there is a greater abundance of zooplankton consumers, increasing the prey abundance at higher trophic levels (Nemoto and Kawamura 1977). Seasonal trends in stomach contents may also indicate a seasonal shift from a spring diet dominated by fish to one dominated by euphausiids or copepods later in the summer (Rice 1977, Flinn *et al.* 2002).

The ecological role of sei whales therefore seems to be that of a generalist, low-trophic level feeder. Whether this ability to generalize diet is a characteristic of all individuals, or if different individuals tend to specialize on different prey types, is unknown.

The likelihood of trophic displacement by finfish stocks, as has been suggested for other large whales (Payne *et al.* 1990), may be lower for sei whales, whose diet diversity may enable them to adapt to fluctuations in prey quality and abundance. The species does appear to alter its distribution in response to fluctuations in prey availability. However, given the limited sightings in the eastern North Pacific, there is a possibility that the remnant sei whale population may be too small to recover.

Sei whales are reported to carry both endo- and ectoparasites, and appear to be more susceptible to heavy infestations of parasitic helminthes (i.e., flatworms) than other baleen species. Although these parasites are typically not pathogenic, a sufficiently large infestation of the liver or kidneys can be fatal. The degree to which parasitic infections currently affect sei whales is unknown. Seven percent of sei whales killed in California between 1959 and 1970 were infected with a disease that caused the shedding of baleen plates. Apart from the missing baleen, these whales had fish in their stomachs and were in good condition (COSEWIC 2003).

Some predation of sei whales is possible by killer whales and sharks, though the degree of predation is unknown (Reeves *et al.* in press). Increased abundance could lead to increased predation.

4.5 Habitat needs

Sei whales use both “skimming” and “engulfing” (or gulping) feeding strategies (Nemoto and Kawamura 1977) and feed primarily on calanoid copepods. They are typically found in relatively deep waters, primarily associated with offshore, pelagic habitats. In the northwest Atlantic, sei whales are associated with the continental shelf-break (Hain *et al.* 1985). In British Columbia, less than 0.5% of the historical coastal whaling catch for which positions were recorded were on the continental shelf (Gregr 2002).

Examinations of baleen whale distributions in relation to oceanographic conditions suggest a close association with oceanic fronts. Sei whales are reportedly observed along major mixing zones and eddies that had broken away from fronts and the animals may follow these fronts seasonally (Nasu 1966). These fronts can be somewhat permanent, near predictable oceanic features such as major upwelling areas, or they can be associated with more dynamic features such as eddies or jets formed near topographical features shearing off major currents (COSEWIC 2003).

Sei whales are often observed on the same foraging ground for many years and then disappear for prolonged periods of time. Whalers spoke of “sei whale years” in the Antarctic (Gambell 1985a). In Norwegian waters, these dramatic influxes of sei whales were called “invasion years” and were correlated with high abundances of pollock (likely *Theragra finnmarchica*) (Jonsgård and Darling 1977). Unpredictable arrivals of sei whales to the North Pacific feeding grounds are also evident in the British Columbia whaling record (Gregr 2002).

5 THREATS

Blue, fin, and sei whales share both historic and current threats. These species are currently threatened by a variety of anthropogenic sources, including ship strikes, acute and chronic noise, possible pollution effects, and fishing gear interactions. The influence of some or all of these threats may result in reduced use of available habitat and/or reduced reproduction. Habitat may also be altered by medium and long-term shifts in ocean climate.

5.1 Whaling

Commercial whaling devastated the populations of blue, fin, and sei whales in every ocean of the world in less than 80 years. Whaling continues in a variety of forms including subsistence hunts and scientific research (Clapham et al. 1999). Recent genetic analysis of midden contents in the Pacific Northwest indicate that aboriginal whaling in Pacific Canadian waters did not target balaenopterid species (A. D. McMillan, personal communication. Department of Anthropology, Douglas College, P.O. Box 2503, New Westminster, BC, V3L 5B2). Scientific whaling (i.e., by Japan) is likely to remain directed at more abundant species (i.e., minke, Bryde's and sperm whales (*Physeter macrocephalus*)). Therefore whaling is not presently considered a threat to blue, fin or sei whales in the eastern North Pacific.

Blue whales were the first target of modern commercial whaling and their populations were severely depleted in all oceans of the world. The species was protected worldwide in 1966 by the IWC. An estimated 325,000-360,000 blue whales were killed in the Antarctic during the first half of the 20th century, nearly extirpating the Southern Hemisphere population. In the North Pacific, blue whales were hunted by both coastal, shore-based whalers and pelagic whaling fleets, taking an estimated 9500 animals. Almost half of these were killed off the west coast of North America (Sears and Calambokidis 2002).

There is clear evidence that whaling depleted the populations of blue whales off British Columbia. Shore-based stations operating in British Columbia from the early 1900's through 1967 killed at least 650 blue whales, though the annual catch declined rapidly as the population was depleted (Figure 2). From 1948 to 1965, mean lengths of blue whales killed from British Columbia shore stations declined significantly along with pregnancy rates (Gregr *et al.* 2000).

Fin whale populations off the coast of British Columbia were reduced by whaling in parallel with blue whales, following the introduction of modern whaling. Local populations suffered further loss when the coastal fleet was upgraded in the 1950s (Figure 2). At least 7605 fin whales were taken by British Columbia coastal stations between 1908 and 1967 (Gregr *et al.* 2000). Fin whales were most heavily exploited through the 1950s and 1960s, when the annual catch from the North Pacific ranged from 1000 to 1500 animals. Until 1955, most whaling off the west coast of North America was off British Columbia, after which catches began to increase off California. Fin whales in the North Pacific were protected by the IWC in 1976 (Mizroch et al. 1984).

Although not a primary target for whalers until blue and fin whale populations were severely depleted, sei whales were heavily exploited during the last decades of commercial whaling. Following the depletion of blue and fin whales, over 110,000 sei whales were killed in the Antarctic between 1960 and 1970. In the North Pacific, catches peaked at over 25,000 animals per year in the late 1960s. The last year of sanctioned whaling for sei whales in the North Pacific was 1975. On the Pacific coast, at least 4002 sei whales were taken by coastal stations in British Columbia between 1908 and 1967, with the majority taken after 1955 (Gregr *et al.* 2000). The total sei whale catch from the North Pacific was almost twice the fin whale catch, and close to 20 times the blue whale catch between 1925 and 1985 (IWC Database, J. Breiwick, pers. comm.).

5.2 Current threats

Ship strikes, chronic noise from shipping, and acute noise from low frequency active sonar and seismic exploration are potentially the greatest current threats to balaenopterid whales. Commercial shipping, oil and gas extraction, and seismic surveys, have the potential to reduce potential habitat for these species by making areas uninhabitable due to increased background noise levels, at least for short periods of time. Entanglement in fishing gear and marine debris may also pose threats to individuals. As populations increase, fin whales in particular may become more at risk to interactions with human activities because of their more coastal distribution. Pollution is an increasing concern in the oceans, though there is currently little evidence to suggest a significant impact on balaenopterids. However, synergistic effects of seemingly unrelated stressors have recently been identified in other mammal species and cannot be ruled out for cetaceans (Sih *et al.* 2004 cited in Payne 2004).

While threats are difficult to prioritize given the lack of information, ship strikes should currently be considered the most important threat to individual balaenopterids in Pacific Canadian waters, particularly fin whales because of their more coastal distribution. The possibility that habitat degradation (or loss of use), through increased background noise levels, may limit the recovery of these species near shipping lanes and other areas of high noise production should also be considered a leading threat.

5.2.1 <u>Ship strikes</u>

Blue and fin whales often occupy shelf-break locations that frequently coincide with shipping lanes, which concentrate large vessel traffic. In a review of 292 records of ship strikes, Jensen and Silber (2004) reported that fin whales were the most commonly struck species, while blue and sei whales were two of the least likely to be struck. However, strikes of offshore species are more likely to go undetected. The mortality rate associated with ship strikes is 70-80% (Jensen and Silber 2004). In the St. Lawrence, 16% of observed blue whales have marks associated with large propellers or hulls (Sears and Calambokidis 2002). Between 1980 and 1993, at least four blue whales were struck and killed off California. An additional four injuries and two mortalities of large whales were attributed to ship strikes during 1997-2001 in North Pacific waters (Carretta *et al.* 2003). At least six fin whales were reported struck and killed in or near Pacific Canadian waters between 1999 and 2004 (COSEWIC 2004), and a single dead sei whale came into the Strait of Juan de Fuca on the bow of a ship in 2003. It appears that large vessels travelling more than 14 knots (26 km/h), particularly high-speed container ships, present the greatest risk of ship strike mortality to whales (Laist *et al.* 2001). Container and cruise ship traffic through British Columbia ports has increased by 200% since the 1980s (Canada 2005), and growth can be expected to continue.

More data on the distribution of blue, fin, and sei whales and the identification of how their critical habitat overlaps with shipping lanes will help determine the degree to which ship strikes threaten balaenopterid whales.

5.2.2 Noise

Baleen whales rely on sound primarily for social communication. Whales may also use sound for predator detection, orientation, navigation, and possibly prey detection. Underwater noise has the potential to disrupt these behaviours. Potential effects depend on the nature of the noise. Chronic noise may result in population level changes in both short and long-term behaviour, while acute sounds may result in hearing damage leading to drastically reduced fitness or death. Noise is therefore a potential threat to individuals, the population, and the habitat of these species (COSEWIC 2003).

While few data are available to assess physiological responses of marine mammals to anthropogenic noise, observed effects include both temporary and permanent hearing threshold shifts, the production of stress hormones, and tissue damage, likely due to air bubble formation or as a result of resonance phenomena (Ketten *et al.* 1993, Crum and Mao 1996, Evans and England 2001, Finneran 2003, Jepson *et al.* 2003).

The ‘loudness’ of a sound is described in terms of pressure. How quickly a sound attenuates depends on the physical and oceanographic features of the local marine environment, and on its frequency – higher frequencies attenuate more quickly than lower frequencies. Some sounds are continuous, whereas others are pulses generated at specific intervals. Frequency ranges are also variable, ranging from broadband seismic surveys, to narrowband military sonar. The impact on marine mammals is thus a function of the length of exposure, loudness, frequency, and nature of the sound.

There has been a rapidly growing awareness that noise may be a significant threat to animals that degrades habitat and adversely affects marine life. It is estimated that background underwater noise levels have increased an average of 15 dB in the past 50 years throughout the world’s oceans (NRC 2003). One result is that in certain parts of

Northern Hemisphere oceans, the area over which a fin whale can hear a conspecific has decreased by four orders of magnitude (Payne 2004). Thus any activities, including research, that make use of acoustics have the potential for incidental harm.

Functional models indicate that hearing in larger marine mammals extends to 20 Hz, and may extend to frequencies as low as 10-15 Hz in several species, including blue, fin and bowhead (*Balaena mysticetus*) whales. The upper range of mysticetes is predicted to extend to 20-30 kHz (Ketten 2004). Thus, anthropogenic noises produced primarily in these frequencies are of concern for balaenopterids. These include air guns and drilling used for oil and gas exploration and extraction, active sonar and explosives used for military operations, and commercial shipping traffic.

Commercial shipping has increased dramatically in recent years, and is largely responsible for the increased noise levels in the marine environment over the last 100 years. In the northern hemisphere, shipping noise is the dominant source of background noise between 10 to 200 Hz (NRC 2003). This chronic noise likely reduces the ability of large whales to maintain contact with conspecifics, potentially reducing mating and foraging opportunities (Payne 2004). The noise from these vessels is at a frequency capable of masking blue whale calls (Richardson *et al.* 1995). The degree to which such acoustic pollution may, or already has, degraded habitat located near commercial shipping lanes has not been determined. However, background noise levels will continue to increase with vessel traffic, such as with the planned port expansion near Vancouver to accommodate the largest ‘super’ tankers (VPA 2004).

Active military sonars transmit pulses of tones at frequencies within the acoustic range of balanenopterid whales, and at source levels that may be heard underwater for tens to hundreds of km, depending on the frequency (Evans and England 2001). There is growing evidence that these noises may pose a significant threat to cetaceans. Active military sonars have been associated with increased strandings of beaked whales (*Ziphiidae spp.*) and humpback whales, and with the displacement of western North Pacific grey whales (*Eschrichtius robustus*) from their feeding grounds (see studies cited in IWC 2004). Active sonar must be considered a threat to northeast Pacific balaenopterids, as the U.S. and Canadian Navies conduct joint operations in Canadian waters. However, information on the use of active military sonar is limited for security reasons.

Low Frequency Active (LFA) sonars send out ‘pings’ to detect submarines, and operate at frequencies between 0.75 and 3 kHz. Their range can extend tens to hundreds of km (Tomaszeski 2004). As an acute source, LFA could disrupt food sources or abruptly displace or injure foraging whales. The U.S. Navy is now forbidden from deploying these units except in one area in the western Pacific Ocean and during periods of war (Malakoff 2003), however this ruling is under appeal. A Canadian LFA sonar was recently tested off the Atlantic coast (Bottomley and Theriault 2003), however there are no plans for procurement at this time (D. Smith, personal communication. Environment

Office, CFB Esquimalt, Maritime Forces Pacific, Department of National Defence, Building 199 Dockyard Room 302 PO Box 1700 Station Forces Victoria, BC V9A 7N2).

Mid-frequency (MF) sonars operating between 3-30 kHz are used to detect mines and submarines, and have been associated with mass stranding events in the Bahamas, Canary Islands, and Greece (IWC 2004). MF sonars are suspended into the water by helicopters, and are hull-mounted on some classes of Canadian military vessels (Wainwright *et al.* 1998). The current policy is to avoid transmission of sonar any time a marine mammal is observed (D. Smith, pers. comm.), although the adequacy of this policy has not been evaluated. In addition, crews are trained to identify marine mammals, and sightings are reported to local sightings programs. The Canadian Navy is also developing maps that will identify sensitive marine areas, allowing bridge personnel to incorporate this information into project planning and general navigation (D. Smith, pers. comm.).

Commercial sonar systems are generally standard equipment on any vessel over 5 m. While units operating below 100 kHz may be of concern to balaenopterid whales, the majority of these units are operated in near-shore, shelf areas less likely to be used by blue or sei whales. Fin whale distributions tend to overlap with areas of increased commercial sonar use. However, the predictable nature of this sound should provide an opportunity for avoidance, potentially mitigating any acute effects.

The potential for oil and gas exploration and extraction may be an acoustic concern for balaenopertid species in some areas such as Queen Charlotte Sound and Hecate Strait. As recommended by the Royal Society panel (RSC 2004), a rigorous regulatory regime should be implemented, and numerous data gaps (including the collection of baseline data and the definition of critical habitat for endangered species) should be addressed prior to the commencement of any exploratory activities.

Seismic surveys generate high intensity sounds with most of their energy concentrated at frequencies (5-300 Hz) relevant to balaenopterids. Current survey methods involve towing airgun arrays at approximately 2.6 m/s (5 knots), and firing the guns every 10-12 seconds. Airgun arrays have been detected over 3000 km from their source (Nieukirk *et al.* 2004).

Systematic observations in the eastern North Atlantic found that cetaceans were generally seen further away from the survey vessel during periods when airgun arrays were firing (Stone 2003). Grey and bowhead whales appear to avoid seismic surveys (Malme and Miles 1987, Ljungblad *et al.* 1988, Myrberg 1990), although in some cases male sperm whales and feeding humpback whales did not (Malme *et al.* 1985, Madsen *et al.* 2002). Mortality has been associated with the use of seismic surveys in the Gulf of Mexico (IWC 2004). It could be that the degree of tolerance exhibited by cetaceans to noise is related to the behavioural state of the animals.

No experimental studies of the physical effects of seismic surveys on cetaceans have been conducted. However, mammalian ears share certain structural similarities with other vertebrates (Fay and Popper 2000), and a small (20 cu in) airgun has been shown to cause permanent hearing loss in caged fish (McCauley *et al.* 2003). It is thus reasonable to assume that airguns are capable of damaging cetacean ears if the whales cannot avoid the sound source.

Mitigation strategies exist, to some extent, for the acute effects of military sonar and seismic surveys. In the U.S., military sonar use is to be discontinued if marine mammals are observed. Various mitigation strategies to reduce potential disturbance from seismic surveys have been used on Canada's east coast and elsewhere. Based on the summary of available information on impacts of seismic sound on marine animals (DFO 2004), possible mitigation strategies have been identified (DFO 2005). These strategies typically include 'soft starts' (the ramping up of noise levels at the start of surveys), discontinued use if marine mammals are observed, and scheduling to avoid seasons when the majority of animals are believed to be present. As the disturbance of marine mammals is prohibited under the *Fisheries Act*, DFO Pacific Region currently restricts impacts from geophysical surveys by reviewing each application and providing project specific advice on mitigation.

Seismic surveys are localized to shelf regions. The potential acute effects associated with these surveys are thus likely of limited concern for sei and blue whales because of their primarily offshore distribution. However, fin whales' use of shelf habitat may be impacted.

Habitat loss (actual and/or loss of use) due to chronic background noise from a variety of sources may ultimately prove to be a greater concern. As with acute noise, chronic noise would likely be more severe for fin whales, however it is also a concern for blue and sei whales because of the potential for sound propagation in water. However, these chronic effects remain uninvestigated.

5.2.3 <u>Pollution</u>

Large whales may be exposed to pollution in a number of ways, including the ingestion of marine debris or contaminated prey items, or through contact with oil spills. O'Shea and Brownell (1994) concluded that there was no evidence of toxic effects from metal or organochlorine contamination in baleen species (see also Sanpera *et al.* 1996), largely because they feed at relatively low trophic levels. No effects of oil contamination were detected for humback whales after the Exxon Valdez oil spill in Prince William Sound (von Ziegesar *et al.* 1994). However other, primarily piscivorous, marine mammals are thought to be at risk from immunotoxic chemicals (Ross 2002). Pollution effects that have been observed in marine mammals include depression of the immune system, reproductive impairment, lesions and cancers (Aguilar *et al.* 2002).

Concentrations of organochlorines sufficient to warrant concern were found in fin whale samples taken in the Gulf of St. Lawrence in 1991-92 (Gauthier *et al.* 1997). However, a retrospective analysis comparing these samples to earlier ones collected in 1971-72 off

Newfoundland and Nova Scotia found that the St. Lawrence concentrations were significantly lower (Hobbs *et al.* 2001). Fin whales feed at a similar trophic level to sei whales, thus, the risk from chemical bioaccumulation in sei whales is likely to be similar, and possibly even lower for blue whales. Decreasing trends have been found for other marine mammals (principally pinnipeds) in eastern Canada (Hobbs *et al.* 2001). However, Muir *et al.* (1999) found that organochlorine contaminants in cetaceans show both increasing and decreasing trends, depending on species and geographic location.

Marine debris is a recognized threat to smaller marine mammals but poses less risk to larger species. It is possible for balaenopterids to ingest marine debris during feeding. However, the frequency and consequences have not been quantified and no associated mortality has been reported.

5.2.4 <u>Habitat displacement</u>

Balaenopterid habitat can be displaced by changes in ocean climate, or by changes in trophic structure. The Pacific Ocean climate responds to interannual (e.g., El Niño) and decadal scale (e.g., Pacific Decadal Oscillation) variability. These natural cycles can combine to cause regime shifts – significant changes in the physical and biological structure of the ocean. Ocean climate may also be affected over the long-term due to anthropogenic causes (e.g., global warming), however the effect of human-induced changes will be difficult to distinguish from natural variability.

Regime shifts cause major changes in ecological relationships in marine systems over large-scale oceanographic areas (Francis and Hare 1994), and are manifested earlier at lower trophic levels (Benson and Trites 2002). Significant declines in zooplankton abundance have taken place off California since the 1970s and have been linked to increases in sea surface temperature (Roemmich and McGowan 1995).

The displacement of balaenopterid foraging habitat by regime shifts may occur because the timing and spatial distribution of zooplankton abundance can be directly related to physical conditions. How large whales locate suitable foraging habitats is unknown. However, matrilineal fidelity to feeding grounds has been observed in other baleen species (humpback, right, and grey whales). Such fidelity implies a limited ability to locate new feeding grounds when changing oceanographic conditions lead to a significant shift in prey distribution.

Trophic structure can also be affected by overfishing. For example, the massive reduction in whale biomass due to large-scale commercial whaling in the Antarctic is thought to have released as much as 150 million tonnes of krill annually, resulting in an increase in smaller predators such as seals, small cetaceans, and seabirds. The loss of krill consumers in the Bering Sea due to commercial whaling may also have influenced the dominant fish species observed in the Bering Sea during the 1970s and 1980s (Trites *et al.* 1999), although this change has also been related to regime shifts.

The krill fishery in Pacific Canada is restricted to a few mainland inlets and the Strait of Georgia, and because there is an existing moratorium on the expansion of this fishery, blue whales are currently not at risk from direct competition with this fishery. Commercial harvesting of herring, sardines, or other forage fish is more wide-spread, and thus has the potential to alter the coastal distribution of fin whales, and, to a lesser degree reduce the frequency with which sei whales venture into coastal waters to feed. However, given the complexity of trophic interactions, it is possible that feeding habitat of balaenopterid whales could be enhanced through the removal of competing fish stocks.

Blue whales feed exclusively on zooplankton, primarily euphausiids. In Pacific Canada, fin whales eat euphausiids and schooling fish, whereas sei whales have a more diverse diet that includes copepods and forage fish (which prey on zooplankton). All three species require high density prey aggregations for successful feeding. Such concentrations depend on physical oceanographic factors such as current flows, temperature, and phytoplankton growth. Given the narrower range of prey types, the blue whale may be relatively more sensitive to declines in zooplankton production than either the fin or sei whale. However, the true impacts of changes to ocean climate on the abundance and distribution of zooplankton are unknown. A local increase in zooplankton off the British Columbia coast as a result of changing ocean conditions resulting from climate change cannot be ruled out.

5.2.5 Other threats

While gear entanglements do result in some mortality of large whales on the east coast, there has been little evidence of gear-related injury or mortality for balaenopterid whales in the eastern North Pacific. The NMFS Pacific Take Reduction Plan, implemented in 1997 to reduce by-catch from fisheries, has not documented any blue or sei whale kills from 1997-2001 (Barlow and Cameron 2003). A review of stranding reports from 1990 to 1996 for Canada’s Pacific coast reported several incidents of entangled, unidentified large whales, and a fin whale was observed entangled in what appeared to be a crab-pot line during a 2004 survey (COSEWIC 2004). As the species begin to recover, the potential for gear interactions may increase, particularly for fin whales using more nearshore waters where such interactions are more likely to take place.

Whale watching tours targeting blue whales in the North Pacific are based primarily off California and in the Sea of Cortez, Mexico. Whale watching industries in British Columbia primarily target killer whales, grey, and humpback whales. However given their size, blue and fin whale watching would very likely increase should such trips become economically feasible for commercial operators. Potential impacts on blue and fin whales from whale watching would include injury from propellers and vessel strikes, and increased acoustic disturbance (see above). Sei whales are unlikely targets for any whale watching operation in Pacific Canadian waters because of their primarily offshore distribution.

6 CRITICAL HABITAT

The *SARA* defines critical habitat as the "habitat necessary for the survival and recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species." Critical habitat for balaenopterid whales is likely to include spaces important for feeding, socializing, migration, and possibly other activities.

Marine habitat for baleen whales in temperate waters is most often defined as foraging habitat or feeding areas. This is because baleen whales are generally believed to frequent temperate waters during summer to take advantage of increased seasonal productivity. Additionally, behavioural data on these species is relatively difficult to collect, and feeding is the most observable behaviour. Feeding habitat is also the most straightforward to define, given the available oceanographic and biological data. While research efforts will initially focus on identifying feeding areas, the determination of other habitats necessary for essential life processes should not be ignored.

The distribution of blue, fin, and sei whales is believed to be somewhat sympatric. However, the lack of contemporary sei and blue whale sightings in Pacific Canadian waters makes critical habitat designation difficult at this stage of the recovery planning process.

Gregr and Trites (2001) proposed that oceanographic conditions off the north end of Vancouver Island create suitable conditions for the entrainment of phytoplankton and zooplankton. These conditions include the transport of primary production from areas of upwelling further south, the wash-out of zooplankton from the continental shelf, and the confluence of major currents creating entrainment features such as fronts and eddies. They proposed that the region (Figures 1 and 4) represented a 'multi-species critical habitat' area for a suite of large whale species. The importance of the region has yet to be investigated, and does not represent critical habitat in the *SARA* context. Nevertheless, critical habitat for these species may be largely ephemeral (e.g., fronts and eddies), structured by oceanographic conditions and their interactions with each other, and with permanent physical features (e.g., shelf-breaks and canyons).

6.1 Schedule of studies to identify critical habitat

Further research is needed before critical habitat in Pacific Canadian waters for balaenopterid whales can be identified. *SARA* allows for a schedule of studies to be developed to identify critical habitat where available information is inadequate (See Section 9.4.1).

6.2 Activities likely to result in destruction of critical habitat

Critical habitat for these species in Pacific Canadian waters is believed to consist primarily of ephemeral foraging areas structured largely by oceanographic processes.

These foraging areas likely occur over a wide area, and are therefore less vulnerable than terrestrial landscapes to destruction by localized human activities. In this context, activities that are likely to result in the destruction of critical habitat will include activities that degrade critical habitat to the point where it is unlikely to be occupied by balaenopterids. Once critical habitat is defined (i.e, in the action plan or as an amendment to the Recovery Strategy), potentially destructive activities will be more easily assessed.

7 ACTIONS COMPLETED OR UNDERWAY

7.1 International legal status and protection

Internationally, blue whales have been protected from whaling by the IWC since 1966 while North Pacific fin and sei whales have been protected by the IWC since 1976. All three species are listed as “Protected,” an IWC designation for stocks smaller than 40% of their maximum sustainable yield levels.

The three species are also listed as “Endangered” by the IUCN (World Conservation Union) based on whaling exploitation. The Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) lists blue, fin and sei whales under Appendix 1 (species threatened with extinction, in which international trade is prohibited).

In the U.S., blue, fin, and sei whales are listed as “Endangered” under the *Endangered Species Conservation Act* and are protected under the *Endangered Species Act* and the *Marine Mammal Protection Act*. NMFS and the United States Fish and Wildlife Service share responsibility for the administration of these Acts.

7.2 Canadian legal status and protection

In Canada, the Pacific populations of blue and sei whales were legally listed and protected as “Endangered” under the *SARA* in January 2005. The Pacific fin whale population was designated by COSEWIC as “Threatened” in May 2005, and listing under the *SARA* is anticipated. The *SARA* prohibits harm (killing, harassing, capture or take) to listed species, includes provisions to protect critical habitat, and requires the development of a recovery strategy for each listed species.

Marine Mammal Regulations pursuant to the federal *Fisheries Act* prohibit the taking or disturbance of marine mammals, unless specifically authorized under the authority of a harvest licence (i.e., commercial whaling), scientific licence, or aboriginal authority to hunt for food, social or ceremonial purposes. No licenses for the taking of cetaceans have been issued for Pacific Canadian waters since 1967. Any application for a Scientific Licence for invasive or disturbance-based sampling would require a rigorous assessment based on Section 73 of the *SARA*. There is no historic evidence of, or expressed current interest in, an aboriginal hunt for these species.

While the potential opportunities for ecotourism or private-based whale watching are limited for these species, whale watching guidelines have been developed as a general code of conduct to limit disturbance. Monitoring and enforcement of these guidelines, as they relate to the disturbance prohibition of the Marine Mammal Regulations, is conducted as required. Amendments to the Marine Mammal Regulations that would provide more explicit prohibitions aimed at preventing disturbance situations are under consideration.

7.3 Habitat protection (Canada)

There are currently no marine areas designated to specifically protect the habitat of blue, fin, or sei whales. However, the Pacific North Coast Integrated Management Area (PNCIMA) ocean planning initiative will incorporate mitigation strategies to address threats to species at risk and to protect critical habitat(s) on the North Coast of British Columbia from Brooks Peninsula on the west coast of Vancouver Island, and Campbell River on the east coast of Vancouver Island, north to the Alaska border, focusing on the Queen Charlotte Basin (Queen Charlotte Sound to Hecate Strait). The marine area extends to the bottom of the shelf slope and therefore includes a significant portion of on-shelf whale habitat in Pacific Canadian waters.

Under the *Canada National Marine Conservation Areas Act*, Parks Canada is responsible for the creation of National Marine Conservation Areas (NMCAs) which will be managed for sustainable use, and protected from industrial activities such as marine dumping, mining, and oil and gas exploration and development. A proposed NMCA in the southern Queen Charlotte Islands will extend 10 km offshore from Gwaii Haanas National Park Reserve, and thus will include some nearshore habitat occasionally used by fin whales. Consultations on the proposed NMCA are on hold pending negotiations with the Council of the Haida Nation.

Environment Canada is currently assessing the marine area around the Scott Islands archipelago, an internationally recognized Important Bird Area as a possible candidate for designation as a Marine Wildlife Area (MWA) under the *Canada Wildlife Act*. Marine Wildlife areas can be established for the purposes of conservation, research and interpretation. The marine portion of this area may serve to protect a portion of nearshore fin whale habitat.

The *Fisheries Act* has provisions to protect marine mammal habitat. Marine Protected Areas may also be established under the *Oceans Act*. Once critical habitat is identified, approaches for its protection under the provisions of the *SARA* will be more easily determined. Further consultation may be warranted once specific measures required to protect critical habitat can be identified. Measures may also include recommendations from industries and efforts at an international level.

7.4 Research

In the U.S., NMFS finalized the recovery plan for blue whales in 1998 (Reeves *et al.* 1998). The recovery plan for fin and sei whales remains in draft form, awaiting legal clearance (Waring *et al.* 2001). NMFS researchers undertake extensive dedicated surveys of the U.S. west coast and Bering Sea for marine mammals every year. Extensive marine mammal habitat studies are underway off California for species including blue whales, and acoustic detection has been used to study their distribution in the eastern North Pacific.

In Pacific Canada, marine mammal surveys conducted by CRP-DFO along primarily the north coast off British Columbia have resulted in two blue whale sightings in 2002, one in 2003, and none in 2004 (Figure 3). No sighted animals have been identified as sei whales, while individual and groups (3-10) of fin whales are often sighted. Given the difficulty in positively distinguishing between fin and sei whales at sea (the right mandible must be observed for positive identification), the lack of sei whale sightings cannot be considered definitive. Whenever possible, individual whales sighted during these surveys are photographed for identification and comparison with catalogues of whales sighted in U.S. waters.

CRP-DFO is also developing predictions of balaenopterid habitat (e.g., Figure 4) to focus survey effort and work towards identifying potential habitat, the initial step to the identification of critical habitat (Section 9.4.1). Acoustic monitoring efforts using submersible passive acoustic recording devices are also being undertaken. Opportunistic sightings collected by the BCCSN since 1972 will help to determine distribution as well as relative abundance of whales.

8 KNOWLEDGE GAPS

Lack of information on population trends and human caused mortality are the basis of continued listing of large whale species in the U.S. (Waring *et al.* 2001). No current abundance estimates or population trends exist for eastern North Pacific blue, fin, or sei whales in Canadian waters. There is an urgent need for information on their abundance and distribution, their habitat, and the threats they face.

8.1 Abundance and distribution

Uncertainties about population structure, distribution and abundance will make mitigation of threats more difficult. A clear understanding of the populations that use Pacific Canadian waters, and how these populations are distributed in other jurisdictions within the species' range (Alaska, California/Washington/Oregon, Mexico) is needed in order to address threats to recovery and to monitor whether recovery objectives are being met.

8.2 Critical habitat

Critical habitat(s) have not been definitively identified for any baleen whale species in Pacific Canadian waters. This lack of delineation makes habitat protection and potential threat assessment difficult. Basic abundance and distribution data is required in order to identify critical habitat.

8.3 Threats

How human activities affect the mortality, foraging, reproductive success, and critical habitat of blue, fin and sei whales requires investigation in order to be effectively mitigated.

The intensity and distribution of acoustic disturbances needs to be characterized in relation to foraging areas and critical habitat. An improved understanding of the species' sensitivity and resilience to anthropogenic sounds needs to be assessed in order to determine whether noise is, or will become, a significant hindrance to recovery. The frequency of ship strikes and fishing gear interactions needs to be quantified to ensure that these potential sources of mortality are not responsible for the lack of recovery. Understanding how ocean climate contributes to the formation of critical habitat will facilitate the development of hypotheses describing how a changing climate may reduce or displace balaenopterid habitats. While the effect of chemical pollution on balaenopterid whales is thought to be minimal, because of their trophic position, this has not been determined definitively. The effects of oils spills, both chronic and acute, and other forms of marine pollution (i.e., plastics and other forms of floating jetsam) are also poorly understood and should be investigated to the extent possible.

9 RECOVERY

The blue, fin, and sei whales that occur in Pacific Canadian waters are presumed to belong to populations that range over the entire eastern North Pacific. These populations move seasonally between international, Canadian, U.S., and possibly Mexican territorial waters. Thus the recovery of these populations is unlikely to be accomplished by Canadian efforts alone. The need for multi-lateral and international cooperation is therefore considered essential to the successful recovery of these species.

The Recovery Strategy must consider the long time scales associated with the longevity of these species and the relatively slow response of their associated life history parameters. However, it must also address imminent threats and immediate conservation issues impacting the species.

It must also recognize that marine habitats are dynamic, at both short and long time scales, and that the physical oceanographic processes that contribute to the creation of habitat are largely beyond human control. The Recovery Strategy should therefore focus on human actions and activities that can be directly managed.

9.1 Recovery Feasibility

Recovery of the blue and fin whale populations that use Pacific Canadian waters is considered feasible. The precautionary approach requires the presumption that recovery of sei whales that use Pacific Canadian waters is also feasible, until it is shown otherwise.

Given their apparently low abundance and considerable longevity, none of these whale populations can be expected to recover to historic levels in the near future. For example, while the eastern North Pacific blue whale population now appears stable and may be increasing (Carretta *et al.* 2003), this has taken over 30 years since the cessation of commercial whaling. Expectations for recovery should therefore reflect these long time scales.

Despite being depleted by commercial whaling, blue whales continue to make use of Canadian waters, and fin whales are regularly sighted in both shelf-break and on-shelf habitats. Thus, available evidence clearly implies that these species have the opportunity to recover in Pacific Canadian waters.

While apparently less abundant now in the eastern North Pacific than fin or blue whales, sei whales likely continue to use Canada’s offshore Pacific waters. The recovery of the species in the eastern North Pacific should be facilitated by its more diverse diet.

Fin and blue whales in the eastern North Pacific are sufficiently abundant (see Sections 2.3 and 3.3 Population size) to have the reproductive potential needed for increased population growth rates. This may also be the case for sei whales, despite recent estimates of just 56 animals for this region (Section 4.3). Sei whale populations are known to be highly mobile, preferring offshore habitats and rarely frequenting coastal areas. A longer time series of observations is therefore required before recovery feasibility is disproved.

The physical processes responsible for concentrating prey species have changed little over time. Thus, sufficient potential habitat for these species, defined as the availability of prey concentrations, is likely available in Pacific Canadian waters.

The threats identified to both individuals and populations could be mitigated through management actions, and a number of techniques have been demonstrated as effective. For example, in the western Atlantic, shipping lanes on the continental shelf have been moved and an early warning system has been implemented to reduce the likelihood of ship strikes on right whales; and gear modifications on both Atlantic and Pacific coasts have been effective at reducing entanglements of humpback whales and smaller cetaceans. Mitigation strategies have also been developed in a number of jurisdictions to reduce the impact of seismic surveys and military-related sonar use.

9.2 Recovery Goals

Blue, fin and sei whales are long-lived species with life spans between 50 and 100 years. Long-term goals must span several generations, and therefore have a horizon of 150-300 years. The recovery goals for these species are:

1. To attain a long-term viable population of blue whales that use Pacific Canadian waters.
2. To attain a long-term viable population of fin whales that use Pacific Canadian waters.
3. To attain a long-term viable population of sei whales that occasionally use Pacific Canadian waters.

9.3 Recovery Objectives

Blue, fin, and sei whales that occur in Pacific Canadian waters are presumed to belong to eastern North Pacific populations. These populations move seasonally between Canadian, U.S., international, and possibly Mexican territorial waters. These objectives refer only to the portion of these populations that occur in Canadian waters and provide a short-term measure of progress towards reaching the recovery goals.

1. By 2011, determine the identity of the population of blue and fin whales that occur in Pacific Canadian waters.
2. Maintain or increase the relative proportions of blue and fin whales in Pacific Canadian waters compared to the whole population through to 2016.

3. By 2011, confirm the presence of sei whale(s) in Pacific Canadian waters. If confirmed, maintain or increase the relative proportion of sei whales that occur in Pacific Canadian waters compared to the whole population through to 2016.
4. See that the threats as they are identified do not significantly reduce the potential habitat or distribution in Pacific Canadian waters for blue, fin, and sei whales through to 2016 (by comparison to when identified as a threat).

9.4 Strategies to address threats & effect recovery

As sightings of balaenopterids are rare (particularly of blue and sei whales), recovery efforts will need to follow an adaptive approach. The development of mitigation strategies, for example, will have to be tailored to the understanding of threats to individuals and the identification of critical habitat.

In the immediate future, recovery objectives will be predominantly research-focused until basic information on habitat, abundance, and distribution is gathered. The collection of this basic information is led by CRP-DFO (see Section 7 for Actions Completed or Underway) and is needed to assist in the identification of critical habitat and to provide the baseline information necessary to monitor threats and measure progress towards recovery.

Once critical habitat is identified and the abundance and distribution of these species is better understood, further action to address threats to their survival may be required. A number of mitigation measures to address threats to large whales have been demonstrated as effective in other jurisdictions (see examples in Section 9.1) and may be adapted in consultation with industry and possibly other jurisdictions to protect balaenopterids in Pacific Canadian waters. Specific activities to address threats will be further prioritized in the action plan.

9.4.1 <u>Schedule of studies to identify critical habitat</u>

Priority: High

Threats addressed: All

Objective addressed: 2, 3, and 4

The following schedule (Table 1) identifies the activities required over the next 5 years (2006-2011) to identify, to the extent possible, critical habitat for blue, fin, and sei whales. The activities identified in this schedule are recommendations that are subject to priorities and budgetary constraints of the participating jurisdictions and organizations.

The study of balaenopterid critical habitat has been divided into studies of potential and realized habitat. From an ecological perspective, potential habitat represents areas where suitable habitat exists, while realized habitat describes where species actually occur. In theory, realized habitat should be a small portion of the potential habitat, particularly for severely depleted species. The distinction makes it possible to distinguish between unsuitable habitat and suitable habitat that is merely unoccupied. Additionally, given the lack of baseline data on species distributions, identification of potential habitat helps prioritize scarce survey effort.

The potential habitat studies outlined in Table 1 focus on identifying oceanographic regions that could provide appropriate prey at suitable densities for blue, fin, and sei whales. The realized habitat studies focus on how balaenopterids occupy the potential habitats. Critical habitat can then be defined as the realized and potential habitats needed for survival and recovery.

Table 1: Recommended studies and associated timelines for the identification of critical habitat for blue, fin and sei whales by 2011.

Schedule of Studies to Identify Critical Habitat	Date
Identify potential habitat	
Relate historic distributions of balaenopterids to long-term oceanographic conditions to predict potential habitats	2006-2008
Develop and test methods to predict the distribution of prey species	2006-2008
Identify realized habitat	
Determine relative seasonal distribution of eastern North Pacific balaenopterids in Pacific Canadian waters	2006-2010
Identify factors (e.g., prey, ocean currents, upwellings) contributing to species' distributions	2006-2010
Relate the identified factors to the seasonal distributions and predict how species may occupy potential habitats (not all potential habitats will be occupied)	2006-2010
Define critical habitat	
Establish collaborations with researchers in other jurisdictions to identify frequently used habitat and prioritize areas for critical habitat selection	2006-2010
Define critical habitat for blue, fin, and sei whales based on the amount of potential habitat needed for survival and recovery	2008-2011

9.4.2 Species abundance and distribution

Priority: High

Threats addressed: All

Objective addressed: All

a) Estimate number of blue and fin whales using Pacific Canadian waters;

b) Establish presence of sei whales in Pacific Canadian waters;

c) Determine the extent of migrations and identify the populations to which blue, fin and sei whales using Pacific Canadian waters belong;

d) Determine relative seasonal distribution in Pacific Canadian waters of blue, fin and sei whales through surveys, photo-identification, and/or acoustic detection;

e) Establish collaborations and data sharing with researchers in other jurisdictions to develop estimates of abundance and range-wide distribution and habitat use.

9.4.3 Threat mitigation

Priority: High

Threats addressed: All

Objectives addressed: 2, 3, 4

a) Determine the spatial distribution of commercial shipping traffic and relate to the critical habitat of blue, fin and sei whales;

b) Determine likely locations and timing of seismic surveys and low frequency sonar use and relate to critical habitat of blue, fin and sei whales;

c) Determine source locations and background noise levels from industrial activities and other anthropogenic sources and relate to critical habitat of blue, fin and sei whales;

d) With the information gathered in (a) through (c), develop options to protect critical habitat and implement as necessary;

e) Investigate methods to obtain information on the frequency of ship strikes and fishing gear entanglements and, if necessary, develop options to reduce their occurrence;

f) Include the presence of balaenopterids in oil spill response plan(s) to prevent individuals from being oiled in the event of an oil spill;

g) Confirm that there is little threat to balaenopterids in Pacific Canadian waters from chronic and acute sources of pollution;

h) Confirm that seismic mitigation strategies and low frequency sonar use policies protect individuals from injury or mortality and, if necessary develop options to improve protection;

i) Promote marine mammal viewing guidelines and enforce compliance with regulations against disturbance.

10 EVALUATION

The success of the recovery actions will be reviewed annually, while the goals, objectives and broad strategies outlined herein will be reviewed within five years of the Recovery Strategy’s acceptance by the Minister. The following performance measures will be used to assess the effectiveness of the objectives and strategies, and to determine whether recovery remains feasible. Detailed performance measures will be identified more fully during the development of the action plan.

Objective-based evaluation criteria include:

1. Were the population identities of blue and fin whales that occur in Pacific Canadian waters determined?
2. Was the relative proportion of blue whales in Pacific Canadian waters compared to the whole population maintained, or increased?
3. Was the presence of sei whale(s) confirmed in Pacific Canadian waters? If so, has the relative proportion of sei whales that occur in Pacific Canadian waters compared to the whole population been maintained, or increased?
4. Did the identified threat(s) significantly reduce the potential habitat or distribution in Pacific Canadian waters for blue, fin, and sei whales?

Approach-based evaluation criteria include:

1. Were studies undertaken to identify critical habitat for these large whales?
2. Was research conducted and/or surveys carried out to better define the species' abundance and distribution?
3. Were threats better identified? Were threats reduced or mitigated?

11 STATEMENT OF WHEN THE ACTION PLAN WILL BE COMPLETED

An action plan will be developed within two years of approval of the Recovery Strategy. A single multi-species action plan for Pacific blue, fin, sei, and right whales is recommended as these large whales likely occupy similar habitat and face similar threats, and the activities required for their recovery (e.g., determine abundance and distribution) are common to all four species. The integration of what are predominantly research activities will ensure more efficient use of effort.

An action plan provides the specific details for recovery implementation, including measures to monitor and implement recovery, address threats and achieve recovery objectives, and when these measures are to take place. The action plan also includes an identification of critical habitat(s), to the extent possible, and examples of activities that are likely to result in its destruction. It also recommends measures to protect critical habitat(s) and identifies any portions of critical habitat(s) that have not been protected. An evaluation of the socio-economic costs of the action plan and benefits to be derived from its implementation is also included.

12 REFERENCES CITED

Aguilar, A., and C. Lockyer. 1987. Growth, physical maturity and mortality of fin whales *Balaenoptera physalus* inhabiting the temperate waters of the northeast Atlantic. Canadian Journal of Zoology **65(2)**:253-264.

Aguilar, A., A. Borrell, and P. J. H. Reijnders. 2002. Geographical and temporal variation in levels of organochlorine contaminants in marine mammals. Marine Environmental Research **53**:425-452.

Angliss, R. P., and K. L. Lodge. 2003. Alaska Marine Mammal Stock Assessments, 2002. U.S. Department of Commerce, Seattle, WA. 225

Barlow, J. 1994. Abundance of large whales in California coastal waters: A comparison of ship surveys in 1979/80 and in 1991. Report of the International Whaling Commission **44**:399-406.

Barlow, J., and G. A. Cameron. 2003. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Marine Mammal Science **19(2)**:265-283.

Benson, A. J., and A. W. Trites. 2002. Ecological effects of regime shifts in the Bering Sea and eastern North Pacific Ocean. Fish and Fisheries **3**:95-113.

Bérubé, M., and A. Aguilar. 1998. A new hybrid between a blue whale, *Balaenoptera musculus*, and a fin whale, *B. physalus*: Frequency and implications of hybridization. Marine Mammal Science **14(1)**:82-98.

Bottomley, J. A., and J. Theriault. 2003. DRDC Atlantic Q-273 Sea Trial Marine Mammal Impact Mitigation Plan. DRDC Atlantic TM 2003-044, Defense Research and Development Canada – Atlantic. *Accessed* February 14, 2005 *at* http://cradpdf.drdc-rddc.gc.ca/PDFS/unc31/p522682.pdf.

Burtenshaw, J. C., E. M. Oleson, J. A. Hildebrand, M. A. McDonald, R. K. Andrew, B. M. Howe, and J. A. Mercer. 2004. Acoustic and satellite remote sensing of blue whale seasonality and habitat in the Northeast Pacific. Deep-Sea Research II **51**:967-986.

Butterworth, D. S., Borchers, D.L., and S. Chalis. 1993. Updates of abundance estimates for Southern Hemisphere blue, fin, sei, and humpback whales incorporating data from the second circumpolar set of IDCR cruises. Reports of the International Whaling Commission **43**:530.

Calambokidis, J., and J. Barlow. 2004. Abundance of blue and humpback whales in the eastern North Pacific estimated by capture-recapture and line-transect methods. Marine Mammal Science **20(1)**:63-85.

Calambokidis, J., T. Chandler, E. Falcone, and A. Douglas. 2004a. Research on large whales off California, Oregon and Washington in 2003. Contract report by Cascadia Research to Southwest Fisheries Science Center, La Jolla, California.

Calambokidis, J., G. H. Steiger, D. K. Ellifrit, B. L. Troutman, and C. E. Bowlby. 2004b. Distribution and abundance of humpback whales and other marine mammals off the northern Washington coast. Fisheries Bulletin **102**:563-580.

Canada, T. 2005. Statistic from T-FACTS. *Accessed* October 26, 2005 *at* http://www.tc.gc.ca/pol/en/T-Facts3/Statmenu_e.asp?file=marine&Lang=.

Carretta, J. V., M. M. Muto, J. Barlow, J. Baker, K. A. Forney, and M. Lowry. 2002. U.S. Pacific Marine Mammal Stock Assessments - 2002. NOAA Technical Memorandum **NOAA-TM-NMFS-SWFSC-346**:286p.

Carretta, J. V., K. A. Forney, M. M. Muto, J. Barlow, J. Baker, and M. Lowry. 2003. Draft U.S. Pacific Marine Mammal Stock Assessments - 2003. NOAA Technical Memorandum **NOAA-TM-NMFS-SWFSC-358**:280p.

Clapham, P. J., S. B. Young, and R. L. J. Brownell. 1999. Baleen whales: conservation issues and the status of the most endangered populations. Mammal Review **29**:35-60.

COSEWIC. 2003. COSEWIC assessment and status report on the sei whale *Balaenoptera borealis* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. vii + 27 pp.

COSEWIC. 2004. COSEWIC assessment and status report on the fin whale *Balaenoptera physalus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. ii + 35 pp.

Crum, L. A., and Y. Mao. 1996. Acoustically enhanced bubble growth at low frequencies and its implications for human diver and marine mammal safety. Journal of the Acoustical Society of America **99**:2898-2907.

DFO. 2004. Review of scientific information on impacts of seismic sound on fish, invertebrates, marine turtles, and marine mammals. Fisheries and Oceans Canada, Ottawa. 16

DFO. 2005. Statement of Canadian practice on the mitigation of seismic noise in the marine environment. *Accessed* February 21, 2005 *at* http://www.dfo-mpo.gc.ca/canwaters-eauxcan/infocentre/media/seismic-sismique/intro_e.asp.

Donovan, G. P. 1991. A review of IWC stock boundaries. Report of the International Whaling Commission **Special Issue 13**:39-68.

Evans, D. L., and G. R. England. 2001. Joint interim report Bahamas marine mammal stranding event of 15-16 March 2000. NOAA, US Dept. of Commerce and Dept. of the Navy.

Fay, R. R., and A. N. Popper. 2000. Evolution of hearing in vertebrates: the inner ears and processing. Hearing Research **149**:1-10.

Finneran, J. J. 2003. Whole lung resonance in a bottlenose dolphin (*Tursiops truncatus*) and white whale (*Delphinapterus leucas*). Journal of the Acoustical Society of America **114**:529-535.

Flinn, R. D., A. W. Trites, E. J. Gregr, and I. R. Perry. 2002. Diets of fin, sei, and sperm whales in British Columbia: An analysis of commercial whaling records, 1963-1967. Marine Mammal Science **18(3)**:663-679.

Francis, R. C., and S. R. Hare. 1994. Decadal-scale regime shifts in the large marine ecosystems of the North-east Pacific: a case for historical science. Fisheries Oceanography **3(4)**:279-291.

Fujino, K. 1960. Immunogenetic and marking approaches to identifying sub-populations of the North Pacific whales. The Scientific Reports of the Whales Research Institute **15**:84-142.

Fujino, K. 1964. Immunogenetic and marking approaches to identifying subpopulations of the North Pacific whales. The Scientific Reports of the Whales Research Institute **15**:85-141.

Gambell, R. 1979. The blue whale. Biologist **26**:209-215.

Gambell, R. 1985a. Sei whale *Balaenoptera borealis*. Pages 155-170 *in* S. H. Ridgway and S. R. Harrison, editors. The Sirenians and Baleen Whales. Academic Press, London, England.

Gambell, R. 1985b. Fin Whale *Balaenoptera physalus* (Linnaeus, 1758). Pages 171-192 *in* S. H. Ridgway and R. Harrison, editors. Handbook of Marine Mammals: The Sirenians and Baleen Whales. Academic Press, London, England.

Gaskin, D. E. 1982. The Ecology of Whales and Dolphins. Heinemann, London, England.

Gauthier, J. M., C. D. Metcalfe, and R. Sears. 1997. Chlorinated organic contaminants in blubber biopsies Northwestern Atlantic balaenopterid whales summering in the Gulf of St. Lawrence. Marine Environmental Research **44**:201-223.

Gregr, E. J., L. Nichol, J. K. B. Ford, G. Ellis, and A. W. Trites. 2000. Migration and population structure of northeastern Pacific whales off coastal British Columbia: An analysis of commercial whaling records from 1908-1967. Marine Mammal Science **16(4)**:699-727.

Gregr, E. J., and A. W. Trites. 2001. Predictions of critical habitat for five whale species in the waters of coastal British Columbia. Canadian Journal of Fisheries and Aquatic Science **58**:1265-1285.

Gregr, E. J. 2002. Whales in Northern BC: Past and Present. Pages 74-78 *in* T. Pitcher, M. Vasconcellos, S. Heymans, C. Brignall, and N. Haggan, editors. Information Supporting Past and Present Ecosystem Models of Northern British Columbia and the Newfoundland Shelf. Fisheries Centre, University of British Columbia, Vancouver.

Gregr, E. J. 2004. Marine mammals in the Hecate Strait ecosystem. Canadian Technical Report of the Fisheries and Aquatic Sciences **2503**:56p.

Hain, J. H. W., M. A. M. Hyman, R. D. Kenney, and H. E. Winn. 1985. The role of cetaceans in the shelf-edge region of the northeastern United States. Marine Fisheries Review **47(1)**:13-17.

Hain, J. H. W., M. J. Ratnaswamy, R. D. Kenney, and H. E. Winn. 1992. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. Report of the International Whaling Commission **42**:653-669.

Herman, A. W., D. D. Sameoto, and A. R. Longhurst. 1981. Vertical and horizontal distributional patterns of copepods near the shelf break south of Nova Scotia. Canadian Journal of Fisheries and Aquatic Sciences **38**:1065-1076.

Hobbs, K. E., D. C. G. Muir, and E. Mitchell. 2001. Temporal and biogeographic comparisons of PCBs and persistent organochlorine pollutants in the blubber of fin whales from eastern Canada in 1971-1991. Environmental Pollution **114**:243-254.

Horwood, J. 1987. The sei whale: population biology, ecology and management. Croom Helm, New York, NY.

Ivashin, M. V., and A. A. Rovnin. 1967. Some results of the Soviet whale marking in the waters of the North Pacific. Norsk Hvalfangst-Tidende **57(6)**:123-129.

IWC. 1990. Report of the Scientific Committee. Reports of the International Whaling Commission **41**:51-216.

IWC. 1996. Report of the sub-committee on Southern Hemisphere baleen whales, Annex E. Reports of the International Whaling Commission **46**:117-131.

IWC. 2004. Annex K. Report of the Standing Working Group on Environmental Concerns. Report of the Scientific Committee of the International Whaling Commission. Meeting held in Sorrento Italy, 29 June – 10 July 2004. *Accessed* December 17, 2004, 2004 *at* www.iwcoffice.org/documents/sci_com/SCRepFiles2004/56annexk.pdf.

Jensen, A. S., and G. K. Silber. 2004. Large whale ship strike database. NMFS-OPR-, U.S. Department of Commerce, Silver Spring. 37

Jepson, P. D., M. Arbelo, R. Deaville, I. A. P. Patterson, P. Castro, J. R. Baker, E. Degollada, H. M. Ross, P. Herráez, A. M. Pocknell, F. Rodríguez, F. E. Howie, A.

Espinosa, R. J. Reid, J. R. Jaber, V. Martin, A. A. Cunningham, and A. Fernández. 2003. Gas bubble lesions in stranded cetaceans. Nature **425**:575.

Jonsgård, Å., and K. Darling. 1977. On the biology of the Eastern North Atlantic sei whale, *Balaenoptera borealis* Lesson. Report of the International Whaling Commission **Special Issue 1**:124-129.

Kawamura, A. 1980. A review of food of the Balaenopterid whales. The Scientific Reports of the Whales Research Institute **34**:59-91.

Kawamura, A. 1982. Food habits and prey distributions of three rorqual species in the North Pacific Ocean. The Scientific Reports of the Whales Research Institute **32**:59-91.

Ketten, D. R., J. Lien, and S. Todd. 1993. Blast injury in humpback whales: evidence and implications. Journal of the Acoustical Society of America **94**:1849-1850.

Ketten, D. R. 2004. Marine Mammal Auditory systems: A summery of audiometric and anatomical data and implications for underwater acoustic impacts. International Whaling Commission. 27-31

Laist, D. W., A. R. Knowlton, J. G. Mead, A. S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science **17(1)**:35-75.

Leatherwood, S., R. R. Reeves, W. F. Perrin, and W. E. Evans. 1988. Whales, dolphins and porpoises of the Eastern North Pacific and adjacent Arctic waters: A guide to their identification. Dover Publications Inc., New York, NY.

Ljungblad, D. K. B., B. Wursig, S. L. Swartz, and J. M. Keene. 1988. Observations on the behavioural responses of bowhead whales (*Balaena mysticetus*) to active geophysical vessels in the Alaskan Beaufort Sea. Arctic **41**:183-194.

Madsen, P. T., B. Mohl, B. K. Nielsen, and M. Wahlberg. 2002. Male sperm whale behaviour during exposures to distant seismic survey pulses. Aquatic Mammals **28**:231-240.

Malakoff, D. 2003. Judge blocks navy sonar plan. Science **301**:1305.

Malme, C. I., P. R. Miles, P. Tyack, C. W. Clark, and J. E. Bird. 1985. Investigation of the potential effects of underwater noise from petroleum industry activities on feeding humpback whale behaviour. BBN Rep. 5851: OCS Study MMS 85-0019 for U.S. Minerals Management Service, Anchorage, Alaska.

Malme, C. I., and P. R. Miles. 1987. The influence of sound propagation conditions on the behavioural responses of whales to underwater industrial noise. Journal of the Acoustical Society of America **1**:97.

Masaki, Y. 1977. The separation of the stock units of sei whales in the North Pacific. Report of the International Whaling Commission **Special Issue 1**:71-79.

McCauley, R. D., J. Fewtrell, and A. N. Popper. 2003. High intensity anthropogenic sound damages fish ears. Journal of the Acoustical Society of America **113**:638-642.

Mizroch, S. A., D. W. Rice, and J. M. Breiwick. 1984. The Fin Whale, *Balaenoptera physalus*. Marine Fisheries Review **46(4)**:20-24.

Moore, S. E., K. M. Stafford, M. E. Dahlheim, C. G. Fox, H. W. Braham, J. J. Polovina, and D. E. Bain. 1998. Seasonal variation in reception of fin whale calls at five geographic areas in the North Pacific. Marine Mammal Science **14**:617-627.

Muir, D. C. G., B. Braune, B. DeMarch, R. Norstrom, R. Wagemann, L. Lockhart, B. Hargrave, D. Bright, R. Addison, J. Payne, and K. Reimer. 1999. Spatial and temporal trends and effects of contaminants in the Canadian Arctic marine ecosystem: a review. Science of the Total Environment **230**:84-144.

Myrberg, A. A. 1990. The effects of man-made noise on the behaviour of marine animals. Environment International **16**:575-586.

Nasu, K. 1966. Fishery oceanography study on the baleen whaling grounds. The Scientific Reports of the Whales Research Institute **20**:157-209.

Nemoto, T., and A. Kawamura. 1977. Characteristics of food habits and distribution of baleen whales with special reference to the abundance of North Pacific Sei and Bryde's whales. Report of the International Whaling Commission **Special Issue 1**:80-87.

Nieukirk, S. L., K. M. Stafford, D. K. Mellinger, R. P. Dziak, and C. G. Fox. 2004. Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean. Journal of the Acoustical Society of America **115**:1832-1843.

NRC. 2003. Ocean Noise and Marine Mammals. *in* N. R. Council, editor. National Academies Press, Washington, D.C.

O'Shea, T. J., and R. L. J. Brownell. 1994. Organochlorine and metal contaminants in baleen whales - a review and evaluation of conservation implications. Science of the Total Environment **154**:179-200.

Oshumi, S., and S. Wada. 1974. Status of whale stocks in the North Pacific, 1972. Report of the International Whaling Commission **25**:114-126.

Payne, M. P., D. N. Wiley, S. B. Young, S. Pittman, P. J. Clapham, and J. W. Jossi. 1990. Recent fluctuations in the abundance of baleen whales in the sourthern Gulf of Maine in relation to changes in selected prey. Fisheries Bulletin **88(4)**:687-696.

Payne, R. S. 2004. Long-range communication in large whales, ocean noise and synergistic impacts. International Whaling Commission. 22-23

Pike, G. C., and I. B. MacAskie. 1969. Marine Mammals of British Columbia. Fisheries Research Board of Canada Bulletin 171, Ottawa, ON.

Reeves, R. R., P. J. Clapham, R. L. J. Brownell, and G. K. Silber. 1998. Recovery plan for the blue whale (*Balaenoptera musculus*).

Reeves, R. R., B. S. Stewart, P. J. Clapham, and J. A. Powell. 2002. Guide to Marine Mammals of the World, First edition. Alfred A. Knopf, Inc., New York, NY.

Reeves, R. R., J. Berger, and P. J. Clapham. in press. Killer Whales as Predators of Large Baleen Whales and Sperm Whales. *in* J. A. Estes, R. L. Brownell, D. P. DeMaster, D. F. Doak, and T. M. Williams, editors. Whales, whaling and ocean ecosystems. University of California Press, Berkley, CA.

Rice, D. 1974. Whales and whale research in the eastern North Pacific. Pages 170-195 *in* W. E. Schevill, editor. The whale problem. Harvard University Press, Cambridge, Mass.

Rice, D. 1977. Synopsis of biological data on the sei whale and Bryde's whale in the eastern North Pacific. Report of the International Whaling Commission **Special Issue 1**:333-336.

Rice, D. W. 1998. Marine Mammals of the World: Systematics and Distribution. The Society for Marine Mammalogy, Lawrence, KS.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson. 1995. Marine mammals and noise. Academic Press, San Diego, California.

Roemmich, D., and J. McGowan. 1995. Climate warming and the decline of zooplankton in the California current. Science **267**:1324-1326.

Ross, P. S. 2002. The role of immunotoxic environmental contaminants in facilitating the emergence of infectious diseases in marine mammals. Human and Ecological Risk Assessment **8(2)**:277-292.

RSC. 2004. Report of the Expert Panel on Science Issues Related to Oil and Gas Activities, Offshore British Columbia. Royal Society of Canada, Ottawa, ON. 155

Sanpera, C., M. Gonzalez, and L. Jover. 1996. Heavy metals in two populations of North Atlantic fin whales (*Balaenoptera physalus*). Environmental Pollution **91(3)**:299-307.

Sears, R., and J. Calambokidis. 2002. Update COSEWIC status report on the Blue Whale *Balaenoptera musculus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa. 32

Stafford, K. M., S. L. Nieukirk, and C. G. Fox. 2001. Geographical and seasonal variation of blue whales calls in the North Pacific. Journal of Cetacean Research and Management **3**:65-76.

Stone, C. J. 2003. The effects of seismic activity on marine mammals in UK waters, 1998-2000. Joint Nature Conservation Committee, Peterborough, UK. 78

Tarpy, C. 1979. Killer whale attack! National Geographic **155**:542-545.

Tomaszeski, T. 2004. Navy generated sound in the ocean. *Accessed* February 14, 2005 *at* http://www.mmc.gov/sound/plenary1/pdf/plenary%201_tomaszeski.pdf.

Tomilin, A. G. 1967. Mammals of the U.S.S.R. and adjacent countries. Volume IX, Cetacea. Izdat Akad. Nauk SSSR, Jerusalem.

Trites, A. W., P. A. Livingston, M. C. Vasconcellos, S. Mackinson, A. M. Springer, and D. Pauly. 1999. Ecosystem change and the decline of marine mammals in the Eastern Bering Sea: testing the ecosystem shift and commercial whaling hypotheses. Fisheries Centre Research Reports **7(1)**:106.

von Ziegesar, O., E. Miller, and M. E. Dahlheim. 1994. Impacts on humpback whales in Prince William Sound. Pages 173-191 *in* T. R. Loughlin, editor. Marine mammals and the Exxon Valdez. Academic Press, San Diego CA.

VPA. 2004. Port Operations web site. *Accessed* February 18, 2004 *at* http://www.portvancouver.com/the_port/roberts.html.

Wainwright, P., G. F. Searing, and S. Carr. 1998. Environmental assessment of military training in Maritime forces Pacific exercise areas. Prepared for Canadian Forces Base Esquimalt. Environmental Risk Management Office, Victoria, British Columbia.

Waring, G. T., J. M. Quntal, S. L. Swartz, and (eds.). 2001. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2001. NOAA Technical Memorandum **NMFS-NE-168**:162-164.

Woodley, T. H., and D. E. Gaskin. 1996. Environmental characteristics of north Atlantic right and fin whale habitat in the lower Bay of Fundy, Canada. Canadian Journal of Zoology **74(1)**:75-84.

13 GLOSSARY OF TERMS

Anthropogenic: involving the impact of man on nature.

Balaenopterid(s): whales from the order Cetacea, suborder Mysticeti, family Balaenopteridae. Balaenopterids, together with the families Balaenidae and Eschrichtiidae comprise the baleen whales.

Baleen whale: whales from the order Cetacea, suborder Mysticeti, with a fringe-like sieve called “baleen” to collect and retain food.

Baleen: a horny substance growing in the mouth of whales of the suborder Mysticeti forming a fringe-like sieve to collect and retain food.

Biomass: the amount of living matter in the form of one or more kinds of organisms present in a particular habitat.

Caudal peduncle: the narrow region of the body immediately in front of the tail.

Cetacea: the order containing whales, dolphins, and porpoises.

Cetacean: of, or relating to, the Cetacea.

Chevrons: two diagonal stripes meeting at an angle (‘^’).

Conspecific(s): of the same species.

Copepod: a minute aquatic crustacean.

COSEWIC: Committee on the Status of Endangered Wildlife in Canada (www.COSEWIC.gc.ca).

Critical Habitat: the habitat necessary for the survival and recovery of a listed wildlife species and that is identified as the species’ critical habitat in the recovery strategy or in an action plan for the species.

Crustaceans: a class of marine or freshwater arthropods, including lobsters, crabs, shrimps, water fleas and barnacles.

DFO: Fisheries & Oceans Canada.

Ecological: of, or having to do with, the environments of living things or with the pattern of relations between living things and their environments; of or relating to the interdependence of organisms.

Ecosystem: an ecological community considered together with the nonliving factors of its environment considered as a unit.

Ectoparasite: an external parasite.

Endangered: facing imminent extirpation or extinction.

Endoparasite: an internal parasite.

Euphausiids: a family of small crustaceans resembling shrimp.

Extirpated: no longer existing in the wild in Canada, but occurring elsewhere.

Fluke: one of the lobes of a whale's tail.

Foraging: to wander or rove in search of food.

Hydrophones: an electroacoustic transducer for listening to sound transmitted through the water.

Immunotoxic: poisonous to the immune system.

Krill: planktonic crustaceans and larvae.

Longevity: a long duration of individual life.

Mandible(s): lower jaw, jawbones.

Matrilineal: relating to, based on, or tracing descent through the maternal line.

Mysticetes: whales of the order Cetacea, suborder Mysticeti, comprising the baleen whales.

NMFS: National Marine Fisheries Service (US).

Organochlorine: of, relating to, or constituting an organic compound of chlorine.

Pathogenic: causing, or capable of causing, disease.

Pelagic: of, relating to, or living in the open ocean.

Piscivorous: feeding on fishes.

Precautionary approach: recognizing that the reduction or loss of the species should not be postponed for lack of full scientific certainty.

Primary production: the first in order of development, as in plankton.

Regime: a regular pattern of occurrence, as in weather or ocean conditions.

Recovery: the process by which the decline of an endangered, threatened or extirpated species is stopped or reversed, and threats reduced to improve the likelihood of the species' persistence in the wild.

Rorquals: whales of the family Balaenopteridae (Baleanopterids).

Rostrum: the anterior projecting element of a baleen whale's skull.

SARA: the *Species at Risk Act*.

Secondary production: the second in order of development, as in those animals that feed on plankton.

Shelf-break: of, or relating to, the edge of the continental shelf at which the sea floor begins to descend steeply toward the bottom of the ocean basin.

Synergistic: such that the total effect is greater than the sum of the two or more effects taken independently.

Threatened: likely to become endangered if limiting factors are not reversed.

Trophic: of, or relating to, a (specified) type of nutrition.

Umbilicus: a small depression in the middle of the abdomen marking the point of attachment of the umbilical cord (~navel).

Upwelling(s): to well up, to move or flow upward, as in ocean currents.

Viable: capable of living.

Zooplankton: the passively floating or weakly swimming animal life of a body of water.

APPENDIX I RECORD OF COOPERATION AND CONSULTATION

Pacific blue, fin and sei whales are aquatic species under federal jurisdiction, managed by Fisheries and Oceans Canada (DFO): 200 - 401 Burrard Street, Vancouver, BC., V6C 3S4.

There are few people in Canada with scientific, traditional or local knowledge of blue, fin and sei whales, as sightings are relatively rare, particularly of blue and sei whales. Recovery will need to be predominantly research-focused until more information is gathered on abundance and distribution, critical habitat and threats.

To assist in the development of this Recovery Strategy, DFO brought together a small group of technical experts to develop an initial draft of this Recovery Strategy. On the advice of the Species at Risk Coordinator at the BC Aboriginal Fisheries Commission, a letter was sent to all coastal First Nations seeking their interest in the development of the Recovery Strategy. The Province of BC provided an expert and Parks Canada provided a technical review. In addition, Natural Resources Canada and the Department of National Defence provided input to the Recovery Strategy. There are no wildlife management boards that function within the distribution of these species.

Additional input was sought through the internet, both the initial draft (August 2005) of this proposed Recovery Strategy and a feedback form were available. In addition to a public news release announcing the development of the Recovery Strategy, the news release was specifically sent to a marine mammal list serve (MARMAM) with a broad international distribution to marine mammal researchers and interests, the Vancouver Aquarium AquaNews newsletter, and to a distribution list of whale-related contacts provided to DFO in recent years from environmental groups, non-governmental organizations, government agencies, and the eco-tourism sector.

Four First Nations organizations responded with an interest in the Recovery Strategy, including Chemainus Fisheries, Mowachaht/Muchalaht Fisheries, Nuu-chah-nulth Tribal Council Fisheries and Heiltsuk Tribal Council. Concerns were expressed from the Musqueam Indian Band Fisheries on Ministerial responsibilities under *SARA*, but no comments were provided on the Recovery Strategy specifically. Whale Watch Operators Association NW and a member of the public submitted comments, and assistance in recovery was also offered. Three external reviewers with expertise on whales provided a scientific (‘peer’) review of the initial draft. The input received has been incorporated into this document wherever possible.

Technical assistance:

Edward Gregr, Marine Ecologist, SciTech Consulting; John Calambokidis, Research Biologist, Cascadia Research; Laurie Convey, Resource Management Biologist, Fisheries and Oceans Canada, South Coast Area; John Ford, Marine Mammal Scientist, Fisheries and Oceans Canada, Pacific Biological Station; Lisa Spaven, Research Technician, Cetacean Research Program, Fisheries and Oceans Canada, Pacific Biological Station; Ian Perry, Research Scientist, Fisheries & Oceans Canada, Pacific Biological Station; Mark Zacharias, Manager, Ocean Sciences Office, British Columbia Ministry of Sustainable Resource Management.

External review:

Lance Barrett-Lennard, Marine Mammal Scientist, Vancouver Aquarium Marine Science Centre; Richard Sears, Mingan Island Cetacean Study; Greg Silber, Coordinator, Recovery Activities for Endangered Large Whale Species, Office of Protected Resources, NOAA/NMFS, National Oceanic & Atmospheric Administration.

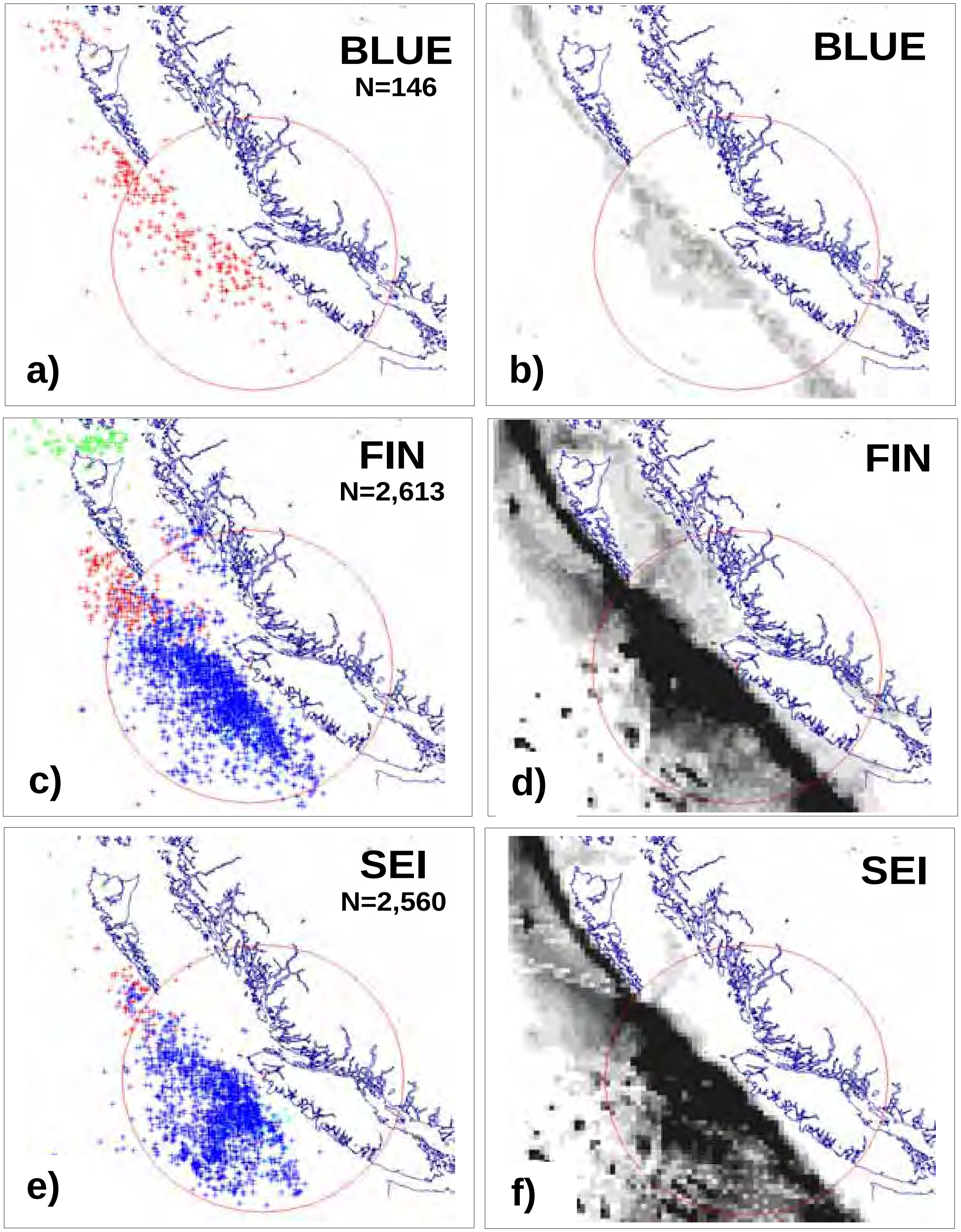


Figure 1: Distribution of historic kills (left) and habitat model predictions (right) for blue, fin, and sei whales. Circle shows 150 nm from Coal Harbour, the only operating whaling station during the period when the majority of kill locations were recorded. Predictions are shaded from high to low probability (dark to light) (from Gregr and Trites 2001).

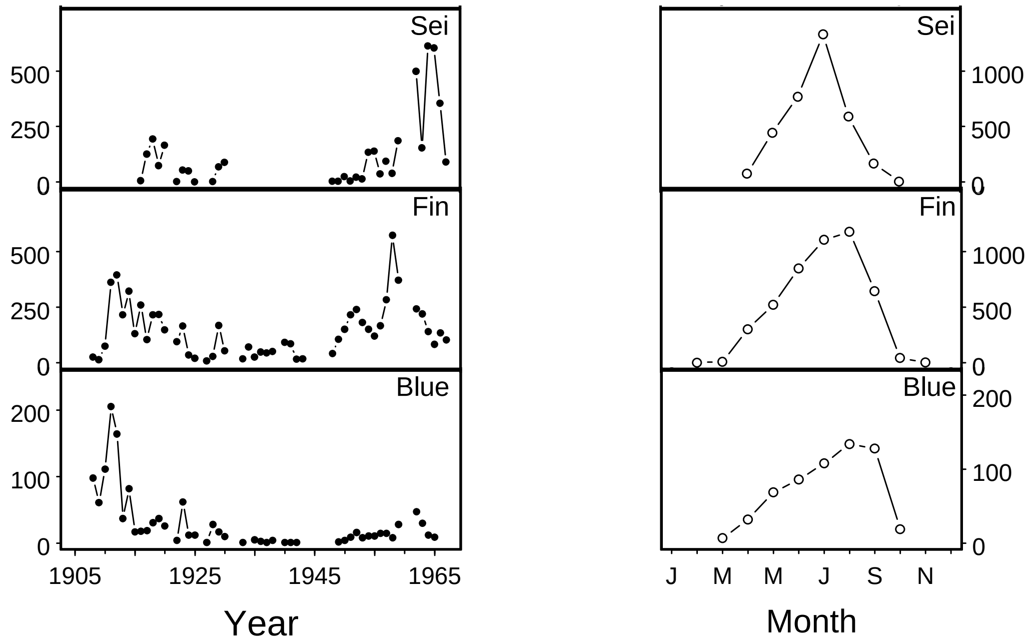
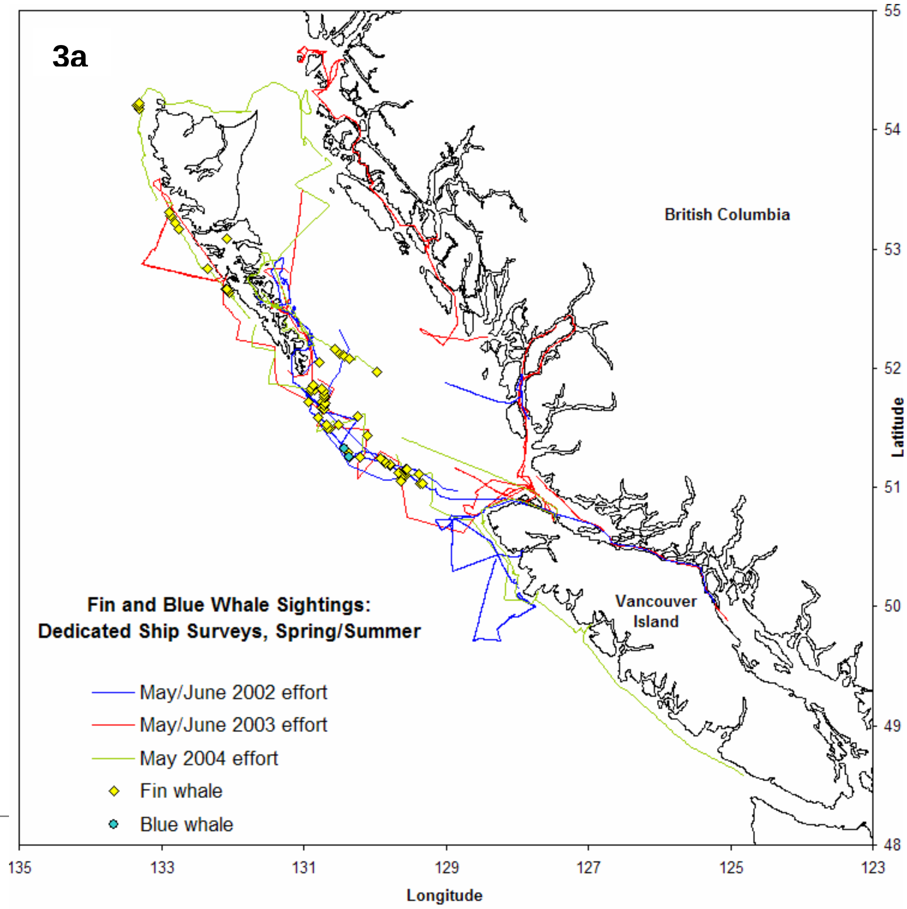


Figure 2: Annual and monthly catches of sei, fin, and blue whales by British Columbia coastal stations (Gregr *et al.* 2000).

Figure 3a: Survey effort and sightings from spring/early summer research cruises from 2002 to 2004 showing 2 blue and 75 fin whale sightings (courtesy of CRP-DFO, Nanaimo, unpubl. data).



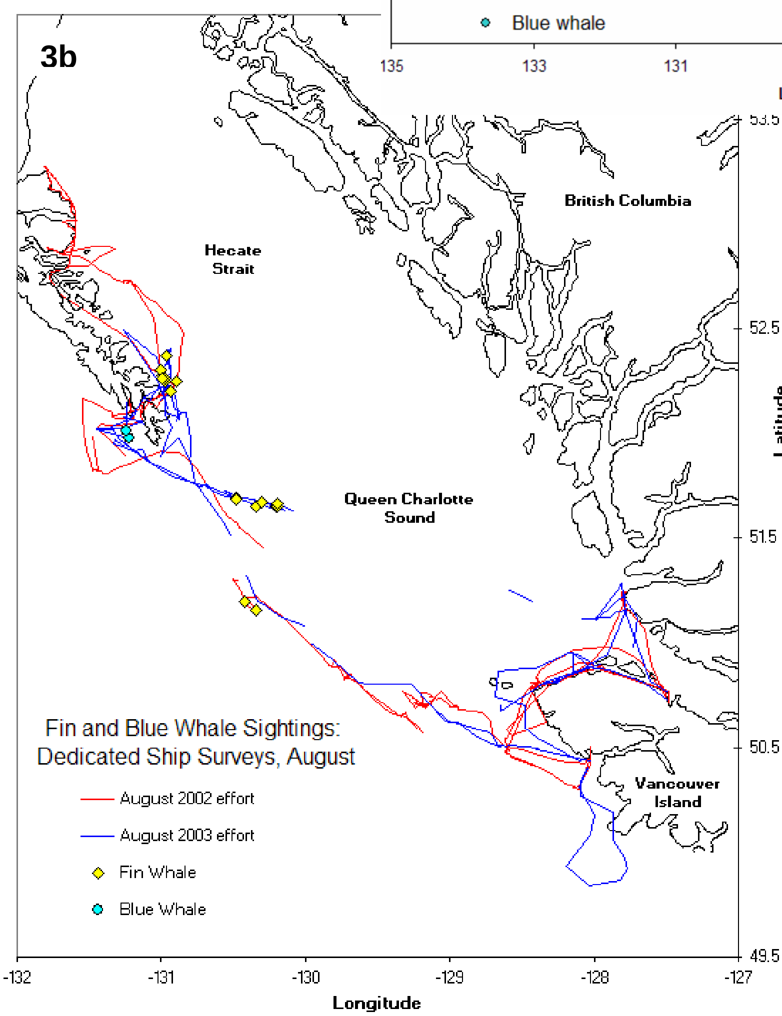


Figure 3b: Survey effort and sightings from August research cruises in 2002 and 2003 showing 2 blue and 12 fin whale sightings (courtesy of Cascadia Research and CRP-DFO, Nanaimo, unpubl. data).

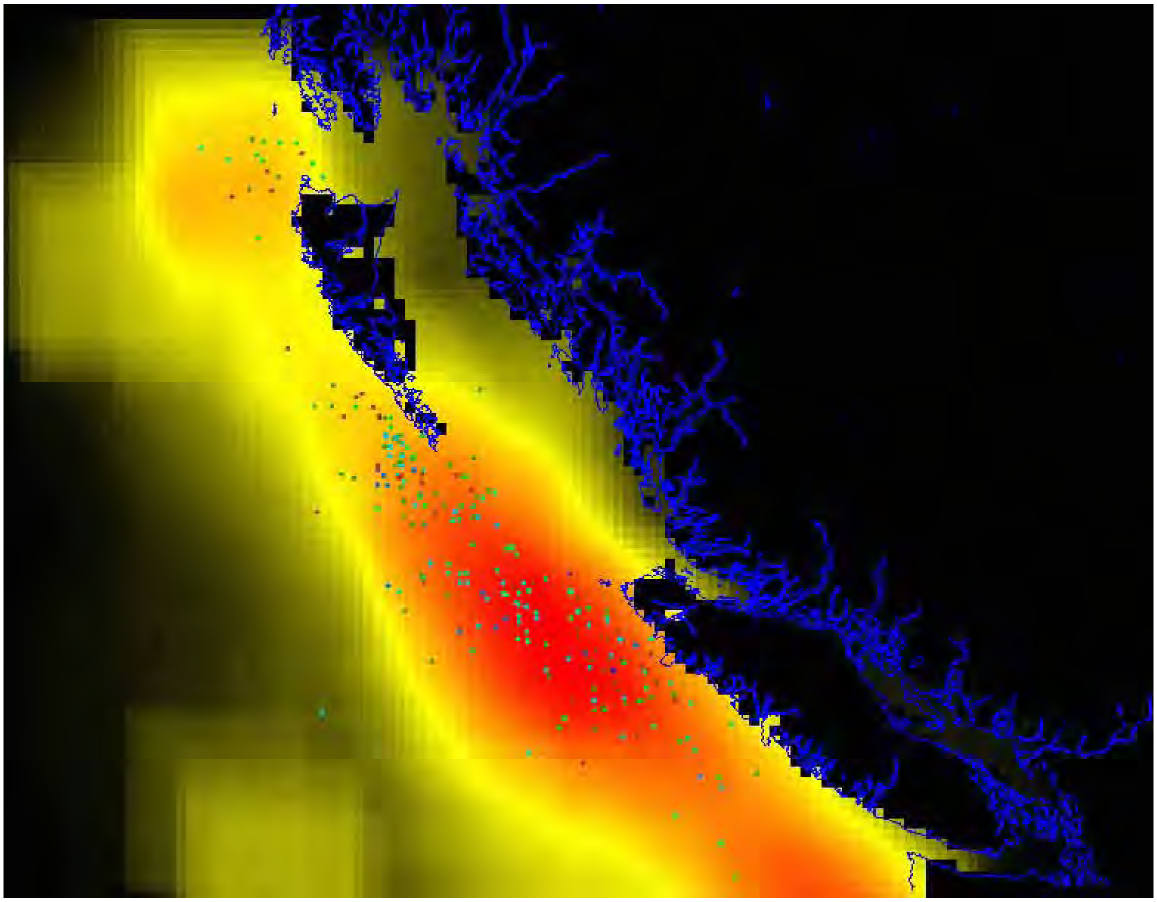


Figure 4: Generalized prediction of blue whale habitat showing all recorded kills (coloured dots) by British Columbia whaling stations. Predictions are shaded from high (red) through yellow to low (black) (DFO-CRP, unpubl. data).