Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Pacific Region
Canadian Science Advisory Secretariat
Science Advisory Report 2011/078

INFORMATION RELEVANT TO THE ASSESSMENT OF CRITICAL HABITAT FOR BLUE, FIN, SEI AND NORTH PACIFIC RIGHT WHALES IN BRITISH COLUMBIA

Fin Whale

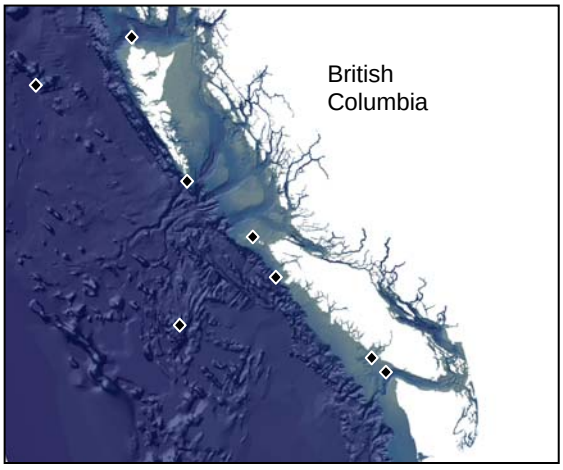

Figure 1: Location of Fisheries and Ocean Canada, Cetacean Research Program's passive acoustic monitoring deployments made from 2005 to 2011.

Context :

The Blue whale was listed as Endangered in the Pacific before the Species at Risk Act (SARA) came into effect in 2003 and that status was reaffirmed by COSEWIC in 2005. Fin Whales in the Pacific were listed as Threatened under SARA in 2006, the Sei whale was listed as Endangered in 2005 and the North Pacific Right whale was listed as Endangered in 2006. A Recovery Strategy was completed in 2006 for the Blue, Fin, and Sei Whales and a draft Recovery Strategy was developed for the North Pacific Right whale in 2009. A draft Action Plan for these species has also been prepared but Critical Habitats have not yet been identified. A schedule of studies to support identification of Critical Habitat is included in both the Recovery Strategy and the Action Plan, however, the Action Plan development process also requires an in-depth understanding of the current state of knowledge and documentation of the effort thus far to identify Critical Habitat. This document addresses this requirement and presents the available information and current state of knowledge regarding habitat(s) for these species which can then be incorporated into the draft Action Plan for Blue, Fin, Sei, and North Pacific Right Whales as required under SARA S. 49(1)(a)

This Science Advisory Report is from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, [National Marine Mammal Peer Review Committee meeting, October 17 to 21, 2011). Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

SUMMARY

- Blue Whales, Fin Whales, Sei Whales and North Pacific Right Whales were severely depleted by commercial whaling in the North Pacific. Hunting of Right Whales commenced in the late 1800s and of the other species in the early 1900s and continued until 1967 in Canadian Pacific waters and into the 1970s in other parts of the North Pacific.
- Until 2002, BC whaling data from 1908 to 1967 and a few incidental sightings collected by the British Columbia Cetacean Sightings Network (BCCSN) and NOAA Platforms of Opportunity Program (NOAA POP) comprised the only basis of information about these species in British Columbia (BC) waters
- The occurrence of Fin Whales, Blue Whales and Sei Whales in BC waters has been confirmed since 2002 from Fisheries and Oceans Canada (DFO) ship-based visual surveys and acoustic monitoring. However, visual surveys (2002-2010) did not afford equal and systematic coverage of all BC waters.
- The function of habitat in BC for these species is mainly for foraging. These highly migratory species are thought to migrate from lower latitude breeding areas to higher latitude productive waters to forage.
- BC waters may serve additional functions for Fin Whales because this species appears to occupy northern latitudes year-round.
- BC whaling data indicate much of the whaling effort was focused west of the continental shelf off Vancouver Island and Haida Gwaii (formerly Queen Charlotte Islands), areas that have received little DFO ship survey effort to date.
- The development of a remote acoustic monitoring network that monitors selected areas along BC's continental shelf and west of the continental shelf is still relatively new and data are as yet limited.
- Current information derived from ship surveys, acoustic monitoring and photo-identification (photo-ID) is insufficient to identify important habitat areas for these cetacean species in BC waters.
- Dedicated line transect surveys, acoustic monitoring, photo-ID and satellite tagging studies, particularly on the continental slope and west of the continental shelf, will be required to better understand seasonal distribution of these species in order to identify Critical Habitat.

BACKGROUND

Blue Whales, Fin Whales, Sei Whales, and North Pacific Right Whales are listed under SARA. Shore-based whaling in British Columbia (BC) (1908 to 1967) was directed at these and other whale species. North Pacific Right Whales had already been depleted by whaling in the 19th century but continued to be taken into the 20th century when encountered. Shore-based commercial whaling was also underway in Alaska, Washington and California and pelagic whaling in the North Pacific, using factory ships, commenced in the 1930s. Japanese and Soviet factory ships operated until the mid 1970s. As a result of whaling pressure, these species' populations were severely reduced.

Prior to the implementation of a cetacean survey program in 2002, the main sources of data on occurrence and distribution of these species in BC waters came from BC whaling records.

There are very few data available on occurrence of these species for the period following the cessation of whaling and the start of surveys in 2002.

Blue Whales in the northeastern Pacific winter in the Sea of Cortes, along the Pacific coast of the Baja Peninsula and over the Costa Rica Dome, but additional wintering areas likely exist. Productive waters in high latitudes of the northeastern Pacific are thought to represent feeding habitat for this species from spring to early winter. The migratory habits of Fin Whales are less clear. Analyses of North Pacific historic catch data and recent acoustic data show that the species is regularly found north of 40° N in winter months and it is possible that in addition to foraging Fin Whales may breed in northern latitudes. Little is known about the distribution of Sei Whales in the northeastern Pacific. This species is thought to move to lower latitudes during winter months to breed and move to higher latitudes in spring and summer to feed. Intensive whaling of North Pacific Right Whales is considered the main causes of an extremely reduced population in the North Pacific. With few sightings of North Pacific Right Whales little is known about wintering or summering areas of the species.

Blue, Fin, Sei and North Pacific Right Whales feed on zooplankton and small fish and have evolved to efficiently consume large volumes of this prey to support their metabolic needs. Blue whales feed on euphausiids, North Pacific Right Whales on copepods. Fin and Sei whales have somewhat broader diets and each feed on euphausiids, copepods and schooling fish. These whale species are highly mobile, ranging over large ocean areas but the need to forage where suitable prey concentrations occur is thought to be the primary reason for their distribution in higher latitude waters. These species likely seek suitable concentrations of prey that occur at scales of less than 10 to 100s of km and for periods of 1 to 10 days, and are the result of dynamic oceanographic processes such as fronts, eddies and upwellings that concentrate prey.

Current understanding of distribution, abundance, and seasonal occurrence of Blue, Fin, Sei and North Pacific Right Whales in BC is based primarily on data collected by DFO's Cetacean Research Program (CRP), Pacific Biological Station. These data are from ship-based visual surveys, remote acoustic monitoring, photo-identification of individuals using natural markings. In addition to these current data sources, data from the BC historical whaling database and sightings from the British Columbia Cetacean Sightings Network (BCCSN) and the US National

Oceanic and Atmospheric Administration's Platforms of Opportunity Program (NOAA POP) as well as published literature were reviewed.

Ship-Based Visual Surveys

Between 2002 and 2010, over 1,800 hours of dedicated survey effort covering almost 40,000 km were completed to collect sightings of cetaceans using standardized line transect observation and data collection protocols for large vessel platforms. Surveys, however, were not systematic with respect to coverage and most surveys had multiple survey objectives including studies of species likely to be encountered inshore on the continental shelf, e.g. Killer Whales and Humpback Whales. Thus surveys were not dedicated to the study of large oceanic baleen whale species.

Passive Acoustic Monitoring

Underwater acoustic monitoring is a valuable tool for determining seasonal occurrence and relative abundance of cetaceans by detecting their distinctive vocalizations. Remote passive acoustic stations allow for monitoring broad ocean areas over extended periods and during sea and weather conditions when visual surveys would not be possible. Since 2005, acoustic monitoring devices have been deployed by DFO at eight locations and times along BC's outer coast (**Figure 1**). These devices are typically deployed for up to one year after which they are recovered for analysis.

Photo-identification

Photo-identification is a method to identify individual whales of a species by documenting unique scars, nicks, pigmentation patterns evident on a prominent area of the body that can be reliably photographed (e.g., tail fluke, dorsal fin). Photo-identified individuals can be tracked between years and within years and seasons. Photo-identification data can be used in mark-recapture analysis to estimate population abundance as well as in studies of movement patterns and site fidelity. Photo-identification of Blue Whales and Fin Whales relies on photographs taken of the dorsal fin region. Small numbers of photo-IDs were obtained of Blue Whales and Fin Whales during DFO ship surveys, usually from small skiffs deployed in areas of whale concentration.

BC Historical Whaling Database

Whaling records from 1908 to 1967 were compiled from company and archival documents. The database includes specific data on each whale captured where such details were found. Over 24,000 kills are recorded in the database but approximately half of the catch was taken before 1948 and many details were not recorded. Consequently information on the geographic distribution of catch and effort are largely unknown for the whaling period prior to 1948.

BC Cetacean Sightings Network (BCCSN)

The BCCSN is a collaborative program between the Vancouver Aquarium and DFO. The BCCSN maintains a database of sightings reported by mariners, fisheries observers, researchers, Canadian Coast Guard, and tour operators.

National Oceanic and Atmospheric Administration, Platforms of Opportunity Program (NOAA, POP)

The POP is a US marine mammal sighting program. Data are obtained through both opportunistic sightings and dedicated US marine mammal surveys from a number of sources including: NOAA vessels, US Coast Guard vessels, US Fish and Wildlife Service vessels, various research vessels, and the National Marine Fisheries Service (NMFS) North Pacific Groundfish Observer Program.

ANALYSIS

Blue Whale

There is no estimate of the number of Blue Whales occupying BC waters. However, recent matches of 3 of 10 Blue Whales photographed off BC with photographs taken off southern California suggest whales in BC and California are part of the same northeast Pacific population and their presence in BC is indicative of re-establishment of historic feeding grounds. An estimated 2,800 Blue Whales occur off California. In BC whales were encountered and photographed in August in all but one instance (June). Similar seasonality is revealed by acoustic data. Blue Whale calls were detected in September 2007 in data from La Pérouse Bank off southwest Vancouver Island, but no Blue Whale calls were recorded at Union Seamount west of the continental shelf off northwest Vancouver Island (**Figure 1**) during continuous monitoring February to July of 2006. The results from La Pérouse Bank are consistent with findings over a broader region of the northeastern Pacific in which the majority of calls occurred August to December. BC whaling records indicate 1,378 Blue Whales were killed from 1908 to 1965. Whales were hunted from April to the end of September but the catch of Blue Whales peaked in August and September. During DFO ship surveys from 2002 to 2008, Blue Whales were sighted on six occasions and were encountered in three general areas: near the continental shelf break between Vancouver Island and Haida Gwaii, in about 1,000 m of water, west of southern Haida Gwaii along the shelf break 10-11 km from shore, and in approximately 2,200 to 2,500 m of water 40 to 60 km southwest of Cape St. James and the southern tip of Haida Gwaii (**Figure 2**). These areas overlap with the easternmost extent of the geo-referenced subset of historical whale catch data, which were distributed mainly west of the continental shelf, an area of little recent survey effort.

Blue Whale diet information in BC waters comes from a subset of whaling records (1963 and 1965). Of 41 Blue Whales examined, 22 contained prey remains which were identified as krill. Observations of animals in BC in 2005 and 2006 suggested foraging on a zooplankton prey layer at 100 to 160 m depth.

Although foraging is likely the primary function of habitat for this species in Canadian Pacific waters, there are very few sightings and photo-IDs and large areas of their historic distribution have not been surveyed. Therefore it is not possible at this time to identify specific habitat areas.

Fin Whale

There is no estimate of the number of Fin Whales occupying BC waters, although Williams and Thomas (2007) present an estimate of 496 (95% *CI*: 201-1222, *CV* = 0.46) Fin Whales in Dixon Entrance, Hecate Strait and Queen Charlotte Sound.

During DFO ship surveys from 2002 to 2010, Fin Whales were the third most frequently encountered species and were sighted in all seasons. During 24 ship surveys from 2002 to 2010, 346 sightings were recorded. Fin Whale calls were detected at Union Seamount throughout the period February to July of 2006 and at La Pérouse Bank throughout the monitoring period May to September 2007. Together these findings support recent publish information about Fin Whales in the North Pacific suggesting these animals remain north of 40°N throughout the year.

Fin Whales were considered the most abundant large whale species on the BC coast during the whaling era and 7,520 were taken between 1908 and 1967. Over the course of the whaling season there was an increase in the number of whales killed as well as a decrease in distance from shore, suggesting movement of Fin Whales into BC waters from spring through summer. Length data suggest that much of the catch was of immature animals. Stomach contents from Fin Whales taken in BC in 1963 through 1967 were primarily euphausiids although there was some annual variation with a higher percentage of copepods, fish and squid in 1964 and 1965 samples than in the other years.

During DFO ship surveys 2002 to 2010, Fin Whales were encountered over the continental shelf west of Vancouver Island and Haida Gwaii, in Queen Charlotte Sound, southern Hecate Strait and Dixon Entrance. Fin Whales were also encountered in the confined waterways of Caamano Sound and Squally Channel on the northern mainland coast. Historically Fin Whales were killed in all of these areas but most of the catch, for which location of capture is known, was taken west of the continental shelf, an area that has received limited ship survey effort. Caamano Sound and adjoining confined waterways on the northern mainland coast is also an area where Fin Whales occurred historically, based on whaling records. Although Fin Whales were sighted during at least one ship survey annually from 2002 to 2010, survey effort was not spatially or temporally consistent enough to facilitate identification of critical or important habitats.

Sei Whale

There is no estimate of the number of Sei Whales occupying BC waters. There have been only two sightings of Sei Whales in BC waters in recent years, one sighting in Dixon Entrance and one sighting off southeast Haida Gwaii.

During the BC whaling era, 3,779 Sei Whales were taken, mostly during the 1960s off the west coast of Vancouver Island. Off the coast of Washington, Oregon and California, extensive line transect surveys have recently been undertaken (1991 to 2005), yet only five sightings of Sei Whales were recorded. The estimate of abundance from these sightings is 46 (*CV* = 0.61) animals. In earlier decades Sei Whales appear to have been much more abundant and were the fourth most common whale species harvested off California during the 1950s and 1960s.

Sei Whales are often observed in the same foraging areas for many years and then disappear for prolonged periods of time. Episodic influxes of Sei Whales into areas are not uncommon and have been reported in the literature. The large number of Sei Whales that were taken west of the continental shelf during the 1960s suggests such a phenomenon may have taken place in BC waters.

Stomach contents from Sei Whales taken off BC during 1963 to 1967 shows considerable inter-annual variation. Copepods predominated in 1963, 1964 and 1965 but euphausiids and saury dominated in 1966 and various fishes in 1967. There were also within-season differences in diet suggesting Sei Whales responded readily to seasonal changes in prey species abundance.

Sei whale calls are not always distinctive and readily identifiable, but possible Sei whale calls were detected intermittently throughout the monitoring periods on the acoustic recorders from Union Seamount (February to September 2006) and La Pérouse Bank (May to July 2007).

With very little survey effort where Sei Whales were historically hunted in BC and only two recent sighting records, no conclusions can be made about the distribution of Sei Whales.

Research should focus on increased acoustic monitoring and ship survey effort of historic whaling grounds.

North Pacific Right Whale

The North Pacific Right whale is the most critically endangered whale species and relatively little is known of its distribution in the North Pacific. Six were taken in BC waters between 1914 and 1929. Despite an international agreement protecting them after 1937, a seventh animal was taken in BC in 1951. There have been no confirmed sightings in Canadian Pacific waters since 1951, although there have been a few sightings in adjacent waters. Intensive historic whaling in the mid 19th century followed by illegal Soviet pelagic whaling in the 1960s and 1970s are the main causes of an extremely reduced population in the North Pacific.

Whaling records indicate the North Pacific Right Whales were taken mainly west of the continental shelf and primarily north of 52° N. No North Pacific Right whale calls were detected by passive acoustic monitoring at Union Seamount or La Pérouse Bank. Right Whales feed on copepods. However, North Pacific Right Whales feed on several different species of copepods suggesting that these whales may have a more diverse diet than their North Atlantic counterpart.

Based on a recently published photo-ID mark-recapture analysis, there are an estimated 31 (95% CI 23-54) North Pacific Right Whales in the Bering Sea. With limited ship survey effort and acoustic monitoring in offshore areas of BC there is not yet information with which to identify Critical Habitat for this species. Research should focus on increased acoustic monitoring in offshore areas followed by dedicated ship surveys once Right Whales are detected.

Habitat

Several large regions of the BC marine waters overlap the distribution of historical whaling catch and sightings obtained during DFO ship surveys. These are western Dixon Entrance, Queen Charlotte Sound, southern Hecate Strait, and west coast Haida Gwaii and west coast Vancouver Island. The following describes oceanographic patterns and processes that are important features of these regions that could sustain and concentrate prey thereby supporting the foraging function of these areas for baleen whales.

West coast Vancouver Island

The main input to this region is the outflow of nutrient rich surface waters through the Strait of Juan de Fuca, which pumps nutrients onto the continental shelf year-round regardless of seasonal winds. It is primarily this phenomenon that makes this a biologically productive oceanographic area even during El Niño -Southern Oscillation (ENSO) events. Seaward of the continental shelf, as well as near the shelf break, a mid-summer euphausiid bloom occurs with a strong late-summer to fall peak occurrence of two dominant euphausiid species (*Euphausia pacifica* and *Thysanoessa spinifera*). However the spatial distribution of zooplankton within this region can vary by one or more orders of magnitude of biomass over a few kilometres. Canyon features in particular support and entrain dense patches of zooplankton.

Queen Charlotte Sound and Hecate Strait

Three deep-water troughs are important to the pattern of inflow and outflow in the region (**Figure 2**). The mouth of Moresby Trough has the most turbulent waters of the continental shelf along Canada's Pacific coast. High euphausiid biomass is often found over steep sea floor slopes, which include the continental slope and margins of these deep troughs leading from the outer coast into Queen Charlotte Sound. Although there have not been zooplankton drift or accumulation studies in this region, it is possible that strong outflows from Moresby Trough have eddies that form near slopes which could contribute to concentrating plankton. Nearer the coast, strong outflow from Hecate Strait and vertical mixing through Moresby Trough moves nutrient rich waters towards southern Haida Gwaii and create conditions favourable to support substantial zooplankton aggregations.

To the south, northerly winds push surface water west of Cook Bank. This flow passes the northern tip of Vancouver Island and moves into the Pacific with one branch moving south along the northwest coast of Vancouver Island. The returning flow moves through Goose Island Trough carrying nutrient rich waters and likely phytoplankton and zooplankton along the north slope of Cook Bank.

Off Aristazabal Island a cold-water plume originating from wind driven upwelling develops in July and persists through August. The plume flows southward from Aristazabal Island and then southwest through Mitchell Trough. Enhanced productivity from this plume in summer may make the region off Laredo Sound and Caamano Sound attractive to Fin Whales, which have been encountered in these areas during recent DFO ship surveys and were hunted in the area historically.

Dixon Entrance

Waters of Dixon Entrance and adjacent canyons and troughs on the continental shelf support aggregations of zooplankton with peaks in abundance in summer as well as in spring. The Rose Spit eddy in eastern Dixon Entrance brings surface material from the west into eastern Dixon Entrance but the pattern of estuarine flow likely allows vertically migrating zooplankton to remain in the entrance. There is little detailed oceanographic information available for western Dixon Entrance and it is less clear why this area would be productive, although Learmonth Bank may support dense prey patches by trapping food along the sloping bottom.

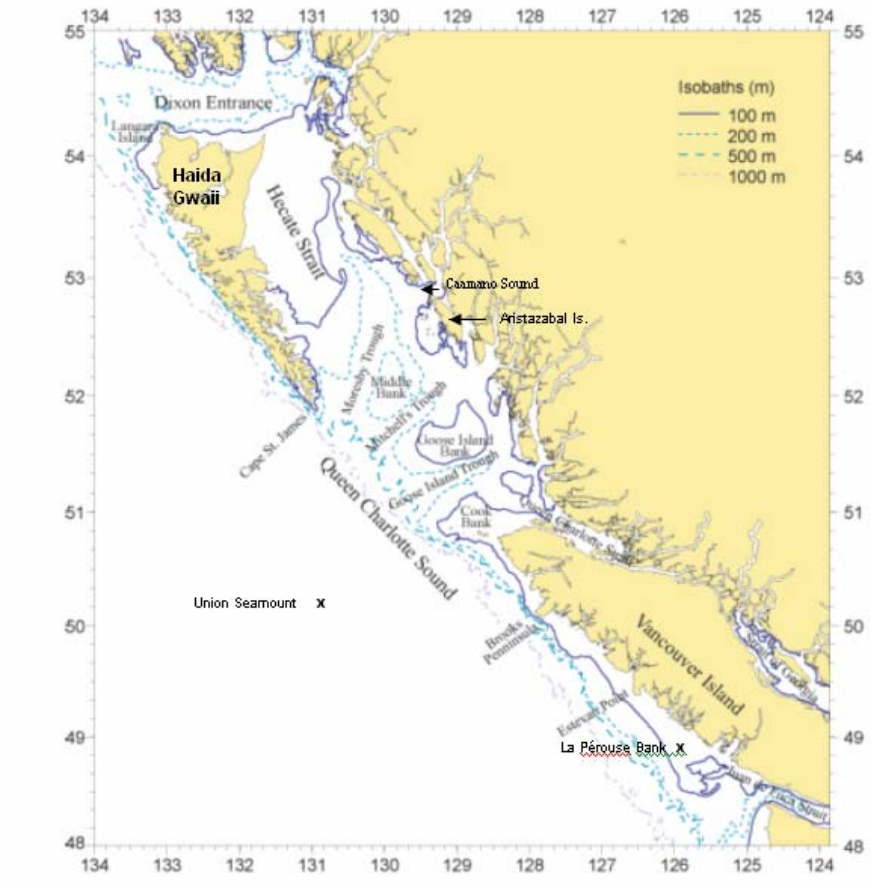

Figure 2. Pacific coast of Canada showing water bodies and oceanographic troughs and place names mentioned in the text

Threats to potential Critical Habitat

Although this assessment has not identified candidate Critical Habitat areas, anthropogenic activities that would interfere or hinder the function of foraging by affecting prey occurrence and abundance and/or displacement or disruption of foraging whales should be considered threats to critical habitat for these species in BC. Anthropogenic activities that may result in threats to habitat would include, but are not limited to, oil spills, vessel traffic, fishing, seismic surveys, pile driving or other high intensity low frequency acoustic alterations of the environment that impact communication or foraging or breeding.

Sources of Uncertainty

Almost half of the BC whaling catch between 1908 and 1967 lacks geographic coordinates that would demonstrate the distribution of catches and effort. Therefore, while the catch that is geo-referenced came largely from areas west of the continental shelf, it is possible that some of the earlier catch was taken closer to shore and that whaling effort moved offshore following depletion of continental shelf stocks. Were this the case, this might alter the view of the representativness of DFO ship survey effort to date, (which has largely been limited to inshore and on the continental shelf) in terms of documenting distribution and relative abundance of these oceanic species in Canadian Pacific waters.

Acoustic monitoring is a valuable method for monitoring the occurrence of species, however, acoustic data alone can not inform our understanding of seasonal occurrence, as a species may be present but non vocal.

CONCLUSIONS AND ADVICE

Since 2002, the occurrence of Fin Whales, Blue Whales and Sei Whales has been confirmed in BC waters. The presence of North Pacific Right Whales has not yet been confirmed. Whaling records suggest these species were largely distributed in oceanic waters beyond the continental shelf and for right whales primarily north of 52°N but there has been limited survey effort west of the continental shelf break. During DFO surveys only portions of the coast could be surveyed on each cruise. Survey coverage was determined by the cruise length, by weather and by the sea conditions encountered, and at times, by the range restrictions of the ship as well as multiple objectives of the cruise. More information in the form of sightings from dedicated line transect surveys, acoustic monitoring and photo-ID studies west of the continental shelf is required to determine distribution of these species in order to identify Critical Habitat.

There are comparatively more sightings for Fin Whales than for the other three species yet data are still not sufficient to model habitat associations or to identify areas of persistent occurrence. Recent sightings of Fin Whales in Caamano Sound and adjoining waterways on the northern mainland coast appears to be re-occupation of historic habitat based on whaling data. Because Fin Whales may be present year-round, the function of BC habitat to them is less clear as it may support other life processes in addition to foraging.

The following are recommended research approaches needed to obtain an understanding of habitat use and future identification of Critical habitat.

- There is insufficient information on the seasonal distribution of Fin Whales in BC waters and the life processes this region supports (e.g., foraging, migration, calving). *Continued and expanded passive acoustic monitoring is needed to clarify the seasonal occurrence of this species in BC.*
- There is insufficient information about habitat features with which Fin Whales and their prey are associated. *Expanded survey effort is needed in areas of Fin Whale occurrence, particularly in Hecate Strait and Caamano Sound. Study approaches should include systematic visual surveys, photo-identification, satellite tagging and collection of hydroacoustic data to document potential prey.*
- There has been relatively little systematic survey effort to date west of the continental shelf where most Blue, Fin and Sei Whales were taken during the BC whaling era. *Focus ship survey effort further offshore on historic whaling grounds. Collect hydroacoustic data during ship surveys to investigate association between whales and prey biomass densities. Continue to expand the passive acoustic monitoring network to monitor offshore areas.*
- The current occurrence of the North Pacific Right whale in Canadian Pacific waters remains to be confirmed, and once confirmed survey effort will be needed to determine distribution. *Continue and expand the passive acoustic monitoring network to more effectively monitor offshore areas.*
- Concurrent data on whale distribution and oceanographic processes at appropriate spatial and temporal scales are lacking. *As sufficient survey sighting data become*

available, investigate the association between oceanographic processes, as proxies of prey abundance and whale distribution.

OTHER CONSIDERATIONS

Whaling records provide an incomplete picture of historic whale distribution because the distribution of whaling effort was influenced by restrictions on the distance that ships could travel from the whaling stations. Furthermore, whalers likely selected areas where they had had past success and targeted species according to their economic profitability.

SOURCES OF INFORMATION

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Nichol, L.M. and J.K.B. Ford. 2012. Information relevant to the assessment of critical habitat for Blue, Fin, Sei and North Pacific Right Whales in British Columbia. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/137. vi + 31 p.

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ISSN 1919-5079 (Print)
ISSN 1919-5087 (Online)

La version française est disponible à l'adresse ci-dessus.

CORRECT CITATION FOR THIS PUBLICATION

DFO. 2012. Information relevant to the assessment of critical habitat for Blue, Fin, Sei and North Pacific Right Whales in British Columbia. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/078.