Mariner's Guide

TO WHALES, DOLPHINS, AND PORPOISES OF WESTERN CANADA

COASTAL OCEAN RESEARCH INSTITUTE

Credits
This document was prepared by the Coastal Ocean Research Institute at the Vancouver Aquarium Marine Science Centre

Scientific Advisors
Dr. Lance Barrett-Lennard, Coastal Ocean Research Institute
Dr. John Ford, Fisheries and Oceans Canada

Coordination
Caitlin Birdsall, Vancouver Aquarium Marine Science Centre
Orla Robinson, Vancouver Fraser Port Authority
Trevor Andrews, Vancouver Fraser Port Authority
Jason Scherr, Prince Rupert Port Authority

Research, Production and Writing
Bailey Eagan, Coastal Ocean Research Institute
Caitlin Birdsall, Coastal Ocean Research Institute
Tessa Danelesko, Coastal Ocean Research Institute

Cartography
Tessa Danelesko, Coastal Ocean Research Institute
With assistance from Beatrice Proudfoot unless otherwise noted, between January 2016 and July 2016.

Survey data for this project were contributed by Fisheries and Oceans Canada (1955-2015) and Stantec for Pacific Northwest LNG Ltd. (2014-2016). Opportunistically collected data were obtained from the B.C. Cetacean Sightings Network (1931-2015). Over 93,000 sightings records were used in the analysis for this Guide. Maps were created using ArcGIS [GIS software]. Version 10.4.1 Redlands, CA: Environmental Systems Research Institute, Inc., 2015.

Project Advisors
Leslie James and Gordon Nettleton, BC Ferries
Bonnie Gee and Robert Lewis-Manning, BC Chamber of Shipping
Kevin Vail and Dale Hansen, BC Coast Pilots
Paulo Ekkebus, Pacific Pilotage Authority
Veronique Nolet, Marine Mammal Observation Network (ROMM)

Early assistance was provided by Caroline Gravel and the Shipping Federation of Canada, sharing knowledge gained from the production of "Mariner's Guide to Whales in the Northwest Atlantic"

Data Sources
B.C. Cetacean Sightings Network
Fisheries and Oceans Canada
Stantec for Pacific Northwest LNG Ltd.

Graphic design and production
Ryan Murray, Vancouver Aquarium Marine Science Centre

Photo credit
Cover photo Mark Malleson. Except as noted, all other photos by the Vancouver Aquarium Marine Science Centre

Species Illustrations
Uko Gorter

845 Avison Way Vancouver, British Columbia V6G 3E2
1.866.472.9663 | sightings@vanaqua.org | vanaqua.org

ISBN 978-0-9695529-1-8 (Print Version);
ISBN 978-0-9695529-2-5 (Digital Version)

This Guide was inspired and guided by *Réseau d'observation de mammifères marins (ROMM). 2014. A Mariner's Guide to Whales in the Northwest Atlantic. Rivière-du-Loup, Quebec. Shipping Federation of Canada and Dalhousie University. 74 p.*

This project was undertaken with the financial support from:

PORT OF PRINCE RUPERT
PORT of vancouver
COASTAL OCEAN RESEARCH INSTITUTE
vancouver aquarium™

Prefaces

The island-studded coast of British Columbia features pristine water, dramatic shorelines, deep fjords, mist-shrouded mountains, and forests aplenty. Indigenous people have lived on this shoreline for millennia, feeding on a rich bounty of fish and shellfish and developing cultural traditions that continue to nourish them. The coast continues to support British Columbians in modern times — it serves as a highway for commerce, has some of the most productive fisheries in the world, and offers unparallelled recreational and ecotourism activities. It is no wonder, then, that British Columbians treasure their coast and are tireless in their efforts to conserve its natural values.

More than 20 species of marine mammals — from sea otters to mighty blue whales — call the B.C. coast home. Many of these species are listed as threatened or endangered, and active efforts are helping their populations recover. For some species, such as the humpback whale, these efforts are successful and recovery is well underway. For others recovery is slow, and for others still, such as the North Pacific right whale, population numbers remain perilously low.

One of the most significant human-caused threats whales face is injury or death from vessel collisions. One might expect the whales to hear the ships approach and take evasive actions to avoid them, and indeed this does occur sometimes. However, whales often have difficulty estimating the speed and bearing of ships and/or recognizing the risk they present, and collisions are tragically frequent.

“”
One of the most significant human-caused threats whales face is injury or death from vessel collisions.

The purpose of this guide is to help mariners reduce their risk of striking and killing, or seriously injuring a cetacean (whale, dolphin or porpoise). It includes descriptions of frequently encountered whales and dolphins, locations along the coast where cetacean densities are highest, and simple measures they can take to greatly reduce their risk of striking a whale, dolphin or porpoise.

I have yet to meet a mariner who doesn't feel terrible if his or her ship hits a cetacean, and who, all things being equal, wouldn't avoid such an event if possible. So I know the motivation to reduce strikes is there — the key is knowing how to do it. To that end, I hope that bridge crew on vessels transiting through B.C. coastal waters will use the information in this guide to reduce the risk of hitting a whale on their watch. I also hope it will encourage mariners to record sightings of cetaceans (see page 16) and pass them on so researchers can improve sightings maps over time.

Finally, I'd like to thank those who helped in the preparation of this guide — notably Vancouver Aquarium marine mammal researchers Caitlin Birdsall, Bailey Eagan, and Tess Danelesko; the Ports of Prince Rupert and Vancouver for funding its production; and their environmental program managers Jason Scherr and Orla Robinson for their support, advice, and helpful reviews.

Dr. Lance Barrett-Lennard,
Head Marine Mammal Scientist
Coastal Ocean Research Institute
Vancouver Aquarium Marine Science Centre

British Columbia's waters are full of natural beauty and wildlife. Not only do our waters sustain diverse populations of whales, porpoises and dolphins, but they also offer west coast mariners a place to work and play.

The safety of wildlife populations is essential to a healthy and fully functioning marine environment. A number of at-risk cetacean species frequent these west coast waters and are known to be vulnerable to both vessel collisions and noise disturbance.

> The safety of wildlife populations is essential to a healthy and fully functioning marine environment.

With projected future growth in Canada's trade demands, as well as projected population growth on the west coast, movements of all types of vessels are anticipated to increase. Canadian port authorities are mandated under the *Canada Marine Act*, to facilitate Canada's trade objectives, ensuring goods are moved safely, while protecting the environment and considering local communities. These are some of the reasons why Vancouver Fraser Port Authority and the Port of Prince Rupert have partnered to create this Mariner's Guide.

This guide is intended to increase awareness about the potential impacts of vessel activities on cetaceans in this region, and highlight how mariners can help reduce these impacts. Collaborating with marine mammal experts from the Vancouver Aquarium and scientists from Fisheries and Oceans Canada, we hope this guide will be a valuable tool for all mariners; whether it be commercial vessel captains, coastal pilots, recreational boaters, fishers or whale watchers.

Thank you for reading. Enjoy these shared waters!

Jason Scherr
Manager, Environmental Sustainability
Port of Prince Rupert

Duncan Wilson
Vice President, Corporate Social Responsibility
Vancouver Fraser Port Authority

Contents

Introduction

Marine transportation, or carriage of goods and people by water, has played a significant role in developing Canada's west coast over the centuries. Commercial vessel movements remain an essential part of life on the west coast today, serving both Canadian import and export markets, and British Columbia's many island and coastal communities and economies.

British Columbia's productive coastal ecosystem sustains numerous populations of cetaceans (whales, dolphins, porpoises) and sea turtles. It is also home to Canada's Pacific Gateway, moving people and goods within British Columbia and beyond, to more than 160 world economies.

Not only does reliable marine transportation support B.C.'s and Canada's economies, and move British Columbians safely and efficiently, it remains the most carbon-efficient mode of transportation. It produces fewer air emissions for each ton of goods transported per kilometre, compared to air or road transport. Nevertheless, because of the scale of marine transportation activities regionally and globally, the industry continuously seeks opportunities to improve sustainability and environmental performance and reduce potential environmental impacts.

To this end, the purpose of the *Mariner's Guide to Whales, Dolphins and Porpoises of Western Canada* is to promote a safer coexistence of vessels and cetaceans along the British Columbia coast. The information it provides will help vessel crew members identify key cetacean and sea turtle species, understand the potential threats their vessels pose to these species, and take action to minimize those threats.

Maps highlight areas where greater vigilance is required based on each species' known seasonal distribution and relative abundance.

Finally, the guide encourages mariners to share cetacean and sea turtle sighting information, which will help to conserve vulnerable species in B.C. waters by providing data that inform scientists and managers about their occurrence, distribution and relative abundance. This information is continually used for conservation-based research projects.

In this guide, the term cetacean will be used to describe whales, dolphins and porpoises collectively. Although not a cetacean, later in the guide, we will also include information on leatherback sea turtles, a visitor to our coast also impacted by vessel traffic.

When Vessels Meet Cetaceans

There is an urgent need to protect British Columbia's vulnerable cetacean populations. Impacted by anthropogenic threats, 12 of the 27 populations or species of cetaceans (and sea turtles) found in B.C are listed as "At Risk" by Canada's Species at Risk Act (SARA). At-risk species in B.C. include:

- Endangered: blue, sei, North Pacific right, southern resident killer whale, leatherback sea turtle
- Threatened: fin whale, northern resident killer whale, offshore killer whale and Bigg's (transient) killer whale
- Special Concern: grey, humpback, harbour porpoise[49]

Potential vessel impacts on cetaceans include vessel strikes, disturbance, underwater noise and pollution. The importance of reducing these vessel-associated impacts is highlighted in the SARA Recovery Strategies and Management Plans for all 12 of these listed species'[10-17, 20]. Actions detailed in this guide are essential to address and mitigate these threats and help conserve these populations.

The Species at Risk Act (SARA) is a piece of Canadian federal legislation. SARA was created to prevent Canadian indigenous species, subspecies, and distinct populations from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species, and encourage the management of other species to prevent them from becoming at risk.

SARA Definitions

Endangered: Species facing imminent extirpation or extinction.

Threatened: Species which are likely to become endangered if nothing is done to reverse the factors leading to their extirpation or extinction.

Special concern: Species which may become threatened or endangered because of a combination of biological characteristics and identified threats.

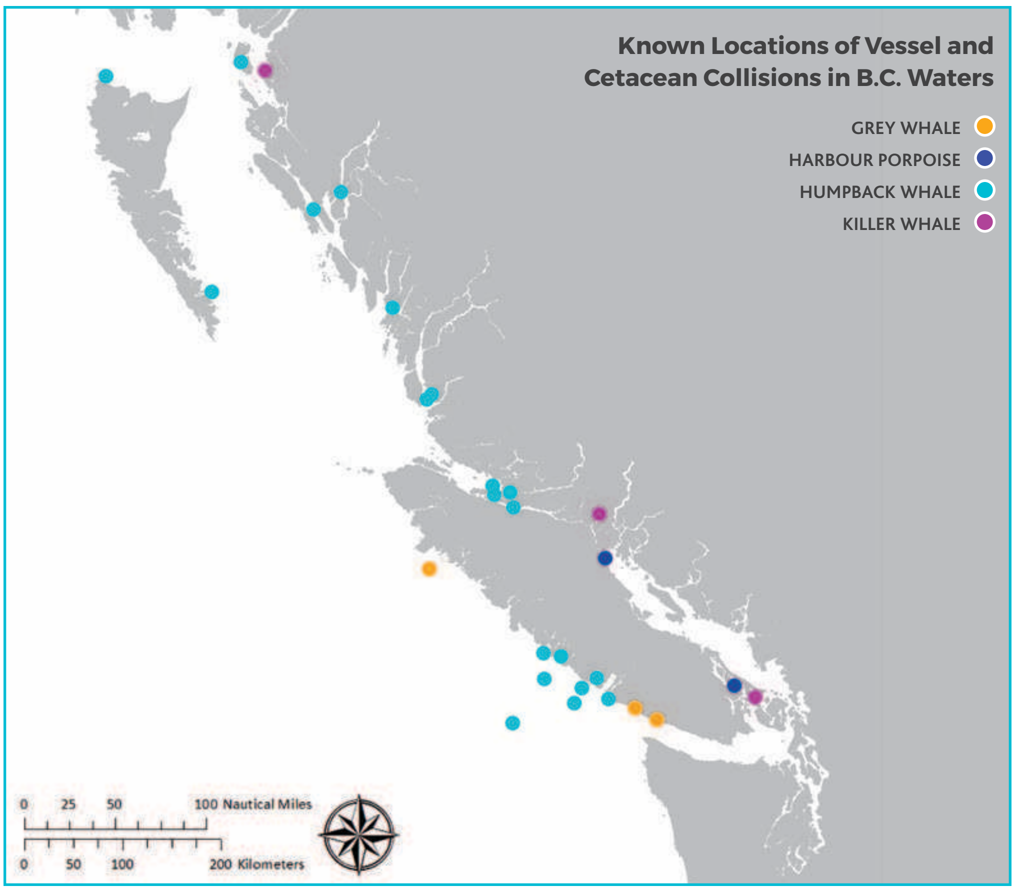
Extirpated: Species that no longer exist in the wild in Canada, but exist elsewhere in the wild[49].

VESSEL STRIKES

The waters of the eastern North Pacific are host to high densities of both cetaceans and marine traffic[39,56]. Cetaceans are vulnerable to being struck and injured or killed by vessels. Based on data collected from many of the world's oceans and examination of floating or beach-cast carcasses, vessel strikes are a recognized cause of mortality for a variety of cetaceans, many of which are found in B.C. waters[26,29].

Thirty cetacean-vessel collisions categorized as "definite" or "probable" were reported to the B.C. Marine Mammal Response Network hotline and investigated by Fisheries and Oceans Canada from 2004-2011 These collisions involved killer whales, humpback whales, grey whales, fin whales and harbour porpoise[48]. The majority of these witnessed and reported strikes involved smaller vessel (less than 15m), however, this number likely underrepresents the frequency of vessel strikes and the involvement of larger vessels. Smaller vessels are more likely to detect, and therefore report, a strike because the impact in more easily felt and visibility of animals off the bow is superior[27, 29]. Many strikes undoubtedly go undetected, especially by large vessels or with small species, or unreported, resulting in an underestimation of this threat in B.C.

Maps featured on page 23 to 51 will give readers a sense of high density areas for various species of cetaceans found off the coast of B.C. and where encounters would most likely occur.



In B.C., PLEASE REPORT any confirmed or suspected cetacean strike, or carcasses observed at sea, to the B.C. Marine Mammal Response Network at 1.800.465.4336. This information is extremely valuable in improving the understanding of this issue and developing mitigation strategies to avoid strikes in the future. See page 23 for more details.

FACTORS THAT INCREASE THE RISK OF COLLISION

Studies have shown that while all vessel types are implicated in vessel-cetacean collisions, those involving large and fast-moving vessels have a more severe impact and a higher chance of killing the cetacean[29].

Vessels over 80 metres long, travelling faster than 14 knots, are the most likely to kill cetaceans in the event of a strike[29]. Studies have demonstrated that travel below 10 knots greatly decreases the likelihood of fatal vessel strikes, and that travel over 17.5 knots greatly increases that risk[26,48].

Mitigating Vessel Strikes

Reducing speed in areas where vessels and cetaceans overlap may decrease the probability of a strike[42,47], as slower speeds increase the likelihood of detecting and avoiding cetaceans and allows more time for the animal to avoid the oncoming vessel. For example, speed restrictions in the eastern U.S. that require vessels greater than 65 metres in length to travel at speeds of 10 knots or less in areas frequented by endangered North Atlantic right whales have decreased strike-related mortality of this species by 80-90%[4].

Decreasing vessel speed at night when visibility is low has also been proposed as a potential mitigation measure[35].

Understanding the distribution of cetaceans helps identify and map high-risk areas for vessel strikes, and a large amount of these valuable data come from sightings reported by mariners on the water. You can help researchers learn more about high density whale-areas by reporting your sightings (see page 16 for information on how to do so).

SOUFFLEURS D'ECUME

VESSEL DISTURBANCE

Cetacean populations are vulnerable to general disturbance by vessels. Large and small vessels may disturb and alter activities essential to cetacean survival, such as foraging (searching for food), surfacing, resting, predator avoidance, communicating, socializing, mating and nurturing calves[32, 54]. Interrupting these activities negatively affects individuals. In small populations (e.g. southern resident killer whales), these impacts on individuals can have population-level effects.

Mitigating Vessel Disturbance

To reduce disturbance, vessels should keep a distance of at least 100 metres, although behavioural responses to vessels may be observed when vessels are 200-250 meters from cetaceans[8, 37].

VESSEL NOISE

In the North Pacific Ocean, underwater noise has doubled in intensity every decade for the past 60 years[22]. Motorized vessels contribute to underwater noise and may reduce the ability of cetaceans to detect prey, communicate, navigate, rest, avoid danger, mate and reproduce.

In high vessel traffic areas, whale communication and echolocation can be almost completely masked by noise[9]. Vessel noise can also increase a whale's stress level, and cause it to move away from or avoid entering an area[8, 46].

Mitigating Vessel Noise

Vessel noise can be decreased by operating below cavitation inception speed and avoiding rapid acceleration, as well as rerouting when in the immediate vicinity of cetaceans and known sensitive marine areas.

Additionally, the IMO guidelines[25] provide information on how to reduce vessel noise through maintaining clean hulls and propellers, insulating vessel engines and making use of resilient mountings for onboard machinery, as well as incorporating vessel quieting methods and materials during re-fits and new vessel construction.

AIR POLLUTION FROM VESSELS

Marine engines burning diesel make sizeable contributions to emissions of sulphur dioxide (SO_2), particulate matter (PM2.5), and nitrogen oxides (NO_X) in B.C.[42b]. Unlike terrestrial mammals, cetaceans do not have sinuses to filter the air they breathe or a sense of smell to help them detect and potentially avoid airborne pollutants such as exhaust gases (e.g. CO_X, SO_X, NO_X). When whales do breathe in airborne pollutants, elevated lung pressure associated with diving causes pollutants to enter the blood more rapidly than in non-diving animals. Additionally, stable atmospheric inversion layers that commonly occur during the summer months trap air pollutants and concentrate them above the water's surface, exposing cetaceans to higher concentrations[28].

Mitigating Air Pollution

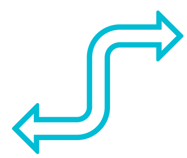
All vessel owners and operators can reduce their impact through the use of clean-burning fuels, and emission-reducing technologies. Adherence to emission limits and fuel specifications designated by the International Maritime Organization's MARPOL Annex VI and North American Emissions Control Area for ocean-going vessels are important steps to reducing air pollutant exposure [25b].

MINIMIZE LARGE VESSEL STRIKES AND DISTURBANCES

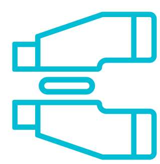
Acknowledging engineering and navigational limitations, and that safety is paramount, the following strategies are suggested to help reduce the impact of large vessels on cetacean populations. They should be employed when appropriate, feasible and safe to do so.

1. **When cetaceans are observed or reported in your path,** or in known high-density areas, **consider reducing speed to 10 knots or less,** if possible and safe. The risk of striking cetaceans greatly increases with vessel speed.

2. **When possible, make gradual course changes away from the cetacean location or direction of travel.** If you sight a large aggregation of cetaceans that makes it impossible to avoid the group entirely, try to pass through the least dense part of the aggregation.



3. **Maintain a sharp lookout for cetaceans in all coastal waters,** paying particular attention when visibility is low. If possible, post extra crew on the bow of the vessel to watch for cetaceans.

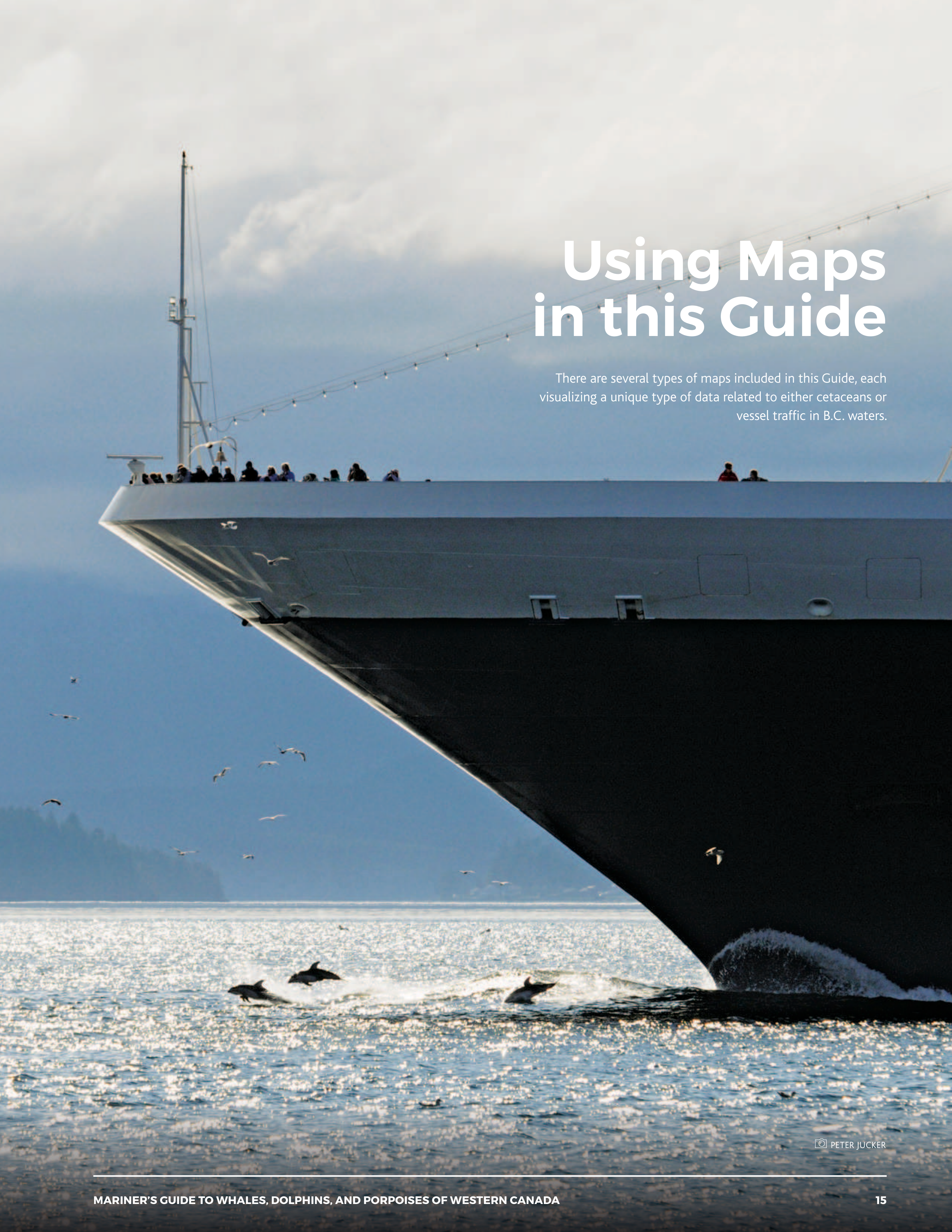


4. Should groups of dolphins or porpoises choose to ride the bow wave of your vessel, **avoid sudden speed or course changes.**

5. **Review the International Maritime Organization's guidelines[25] for vessel noise reduction** to find out how activities such as vessel maintenance, propeller design and selection, as well as selection and mounting of engines and machinery can lead to a quieter vessel.

Using Maps in this Guide

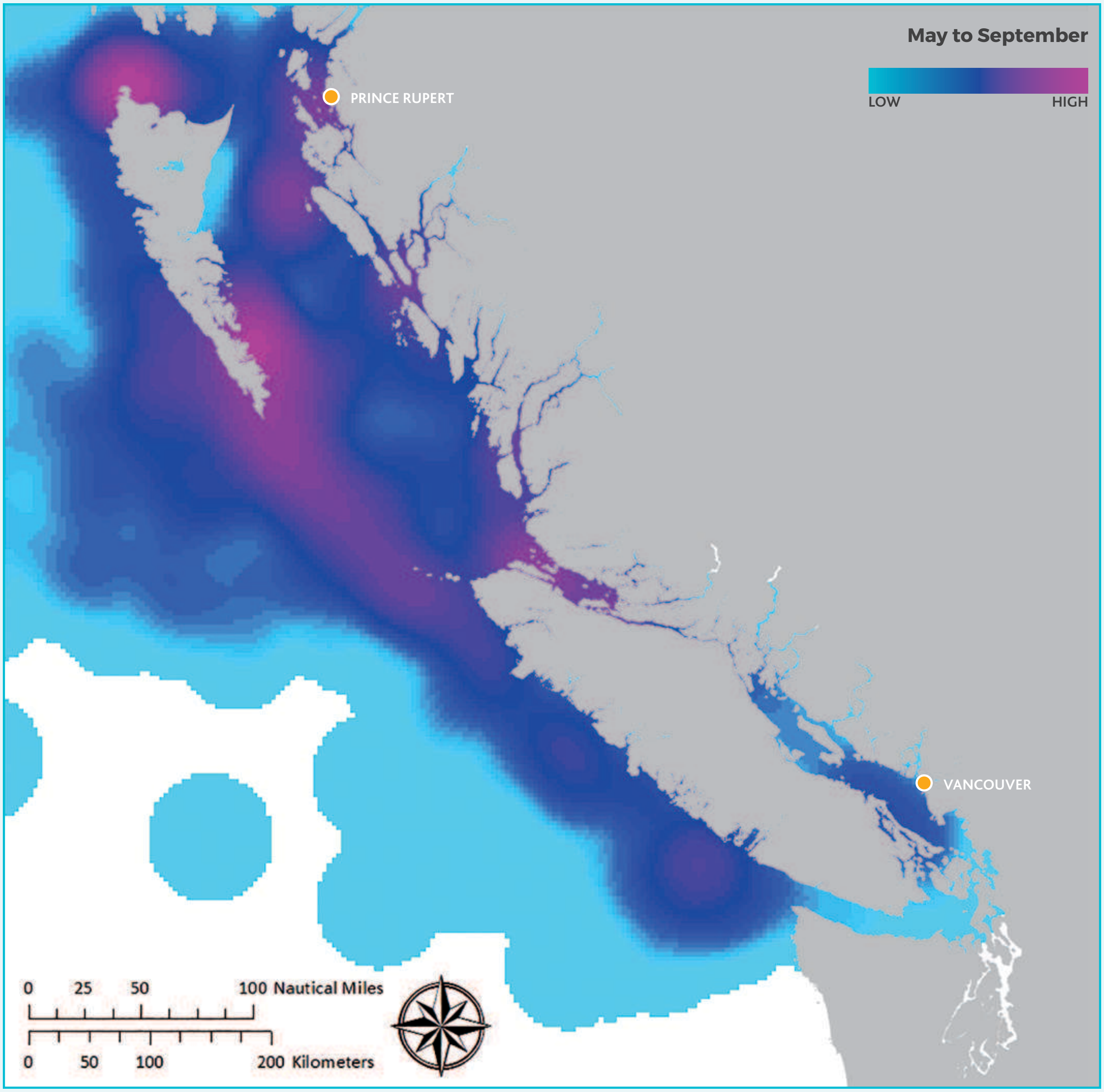
There are several types of maps included in this Guide, each visualizing a unique type of data related to either cetaceans or vessel traffic in B.C. waters.

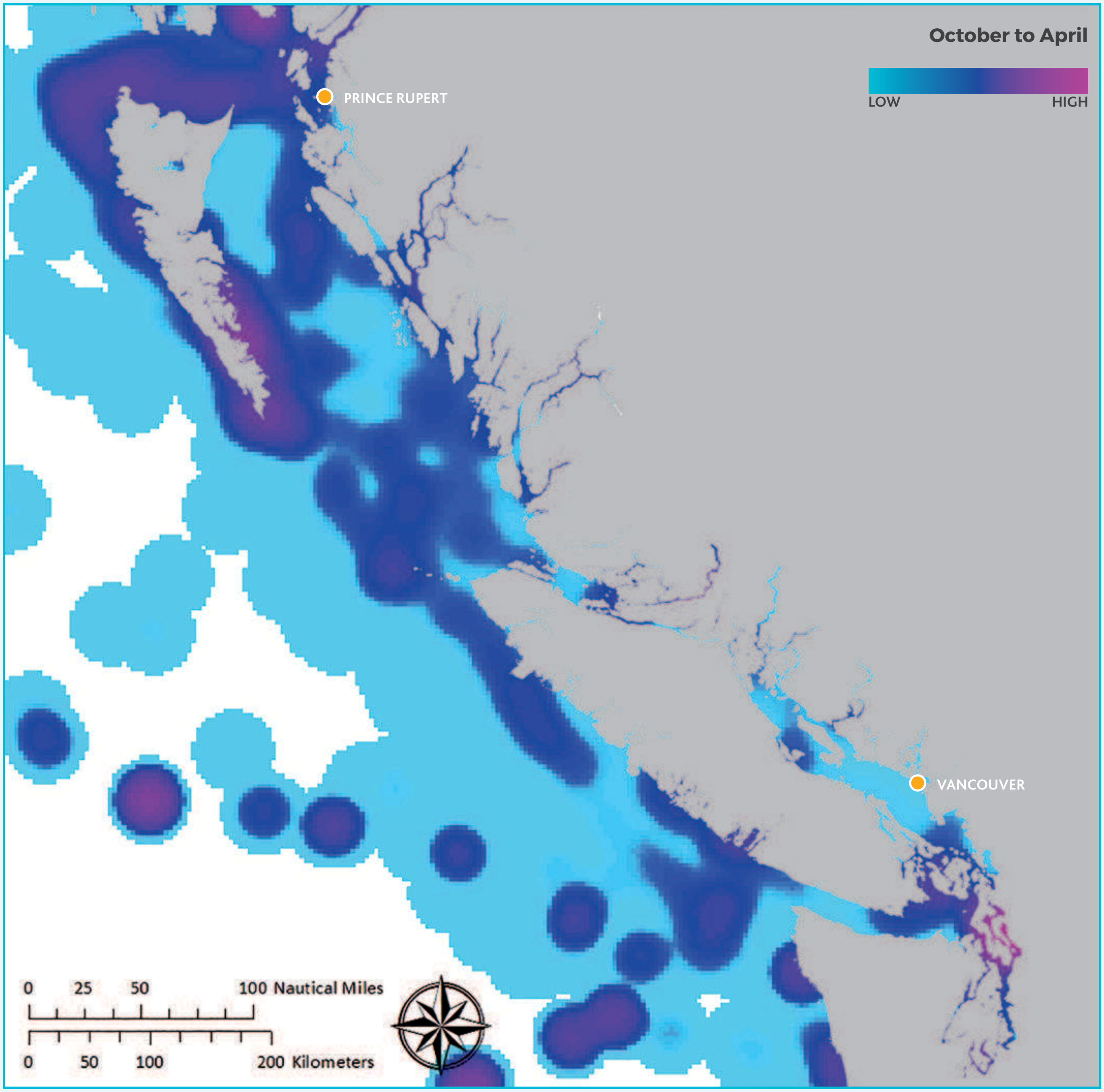


PETER JUCKER

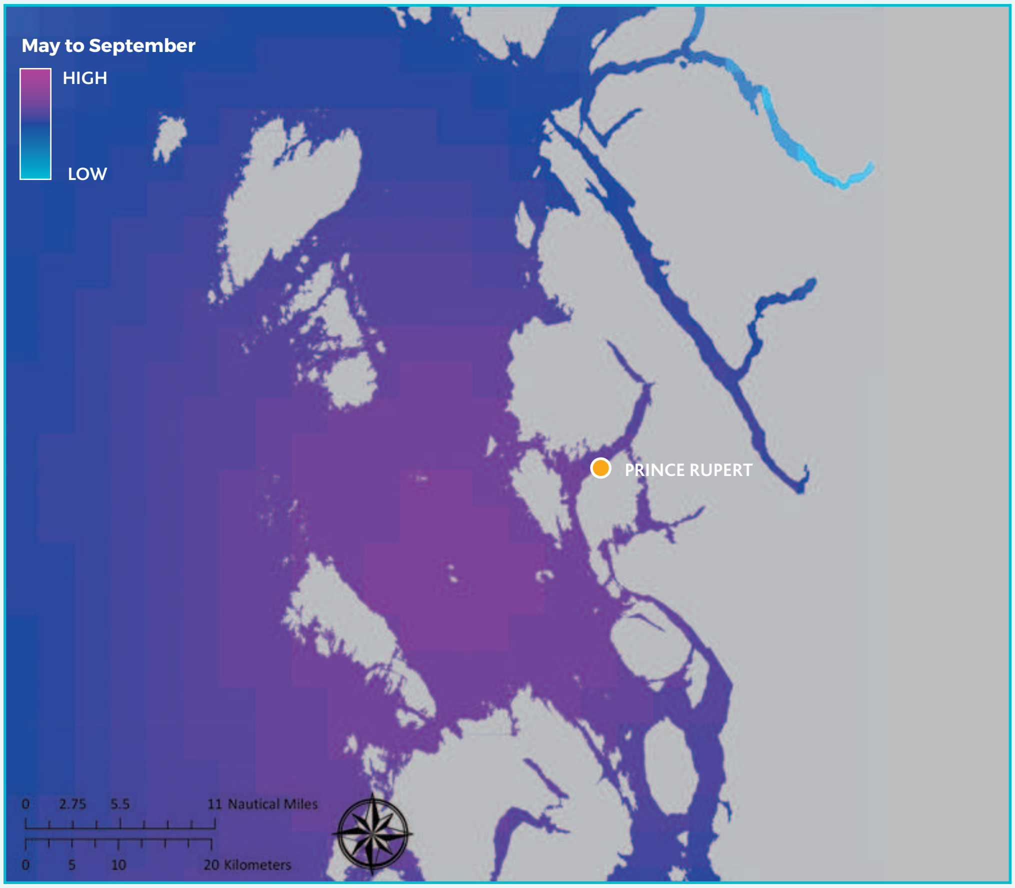
Relative Abundance of Cetaceans in B.C. Waters

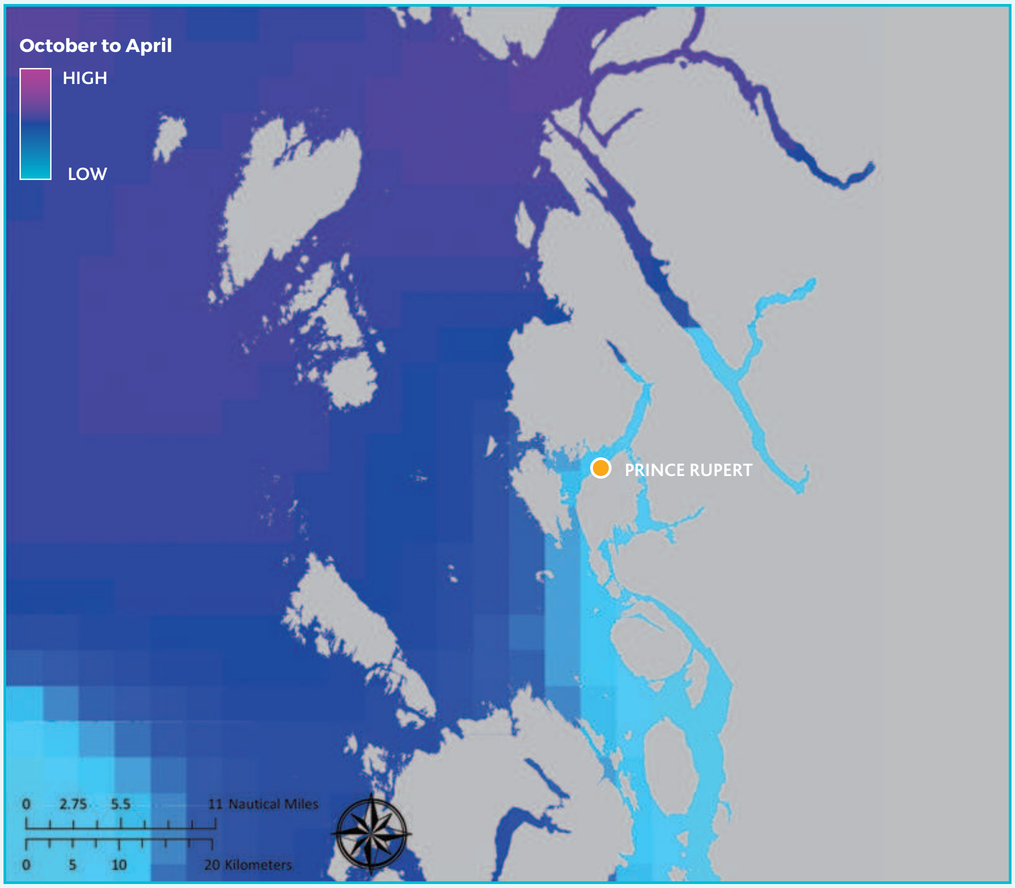
These maps highlight cetacean hotspots. Areas symbolized by the high end of the colour scale denote areas of high abundance, where the chance of a vessel encountering that particular species, or group of species, is highest. Both opportunistically collected data, which were corrected to account for the distribution of observer effort[43], and systematic survey data were used in the creation of these maps. The goal of these maps is to make mariners aware of where they are most likely to encounter cetaceans in B.C. waters. It is important to note that cetaceans are wide-ranging and highly mobile, and while these figures may serve as a guide to highlight areas of higher density, a cetacean encounter can occur anywhere in marine waters at any time. To ensure accurate estimates of relative abundance were displayed on each map, only data that was rated as high species identification confidence was used from the opportunistically collected dataset. Additionally, density values were smoothed to minimize potential anomalies resulting from very high or very low effort values and to prevent adjacent cells from having significantly different values.



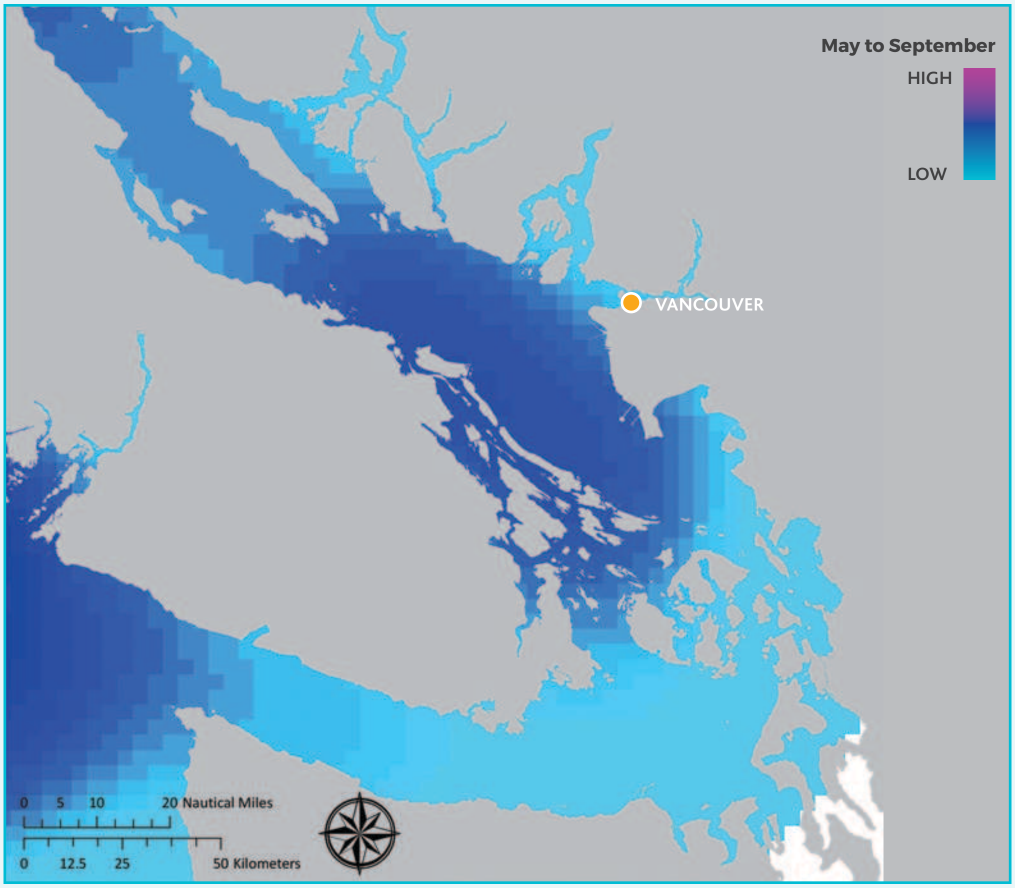

October to April
LOW
HIGH
PRINCE RUPERT
VANCOUVER
0 25 50 100 Nautical Miles
0 50 100 200 Kilometers

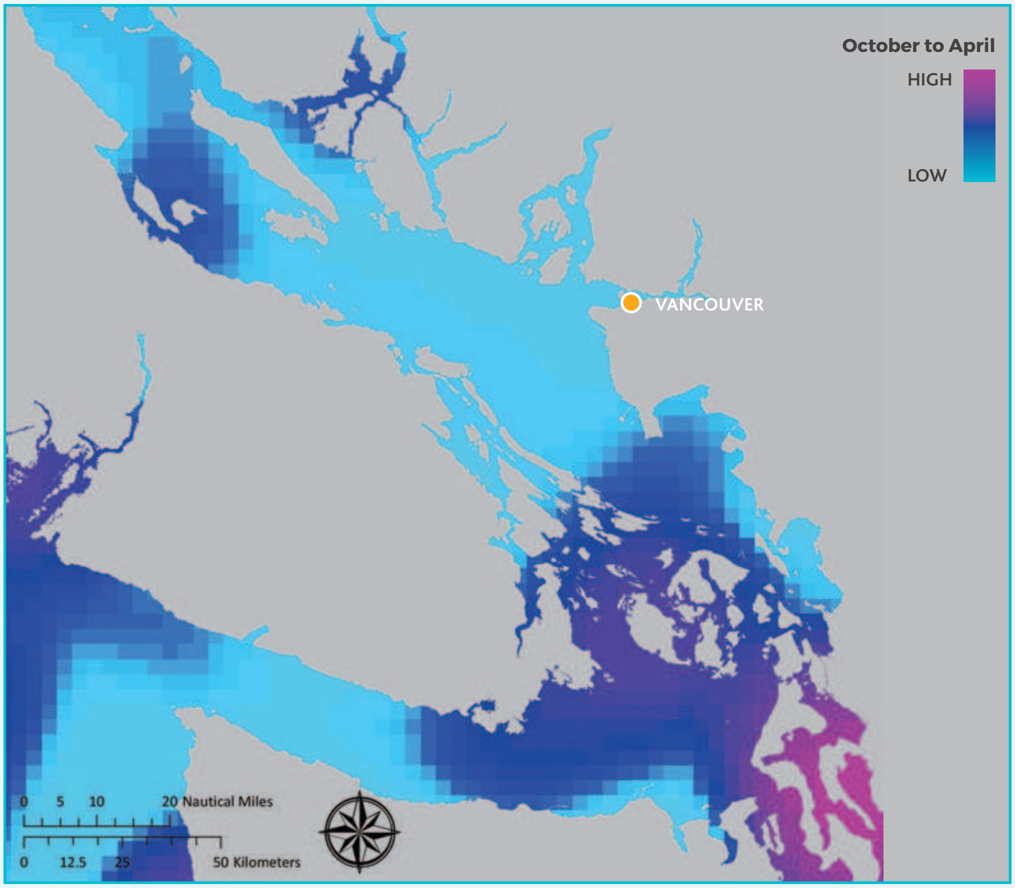
Relative Abundance of Cetaceans Along the Approach to Prince Rupert





Relative Abundance of Cetaceans Along the Approach to Port of Vancouver

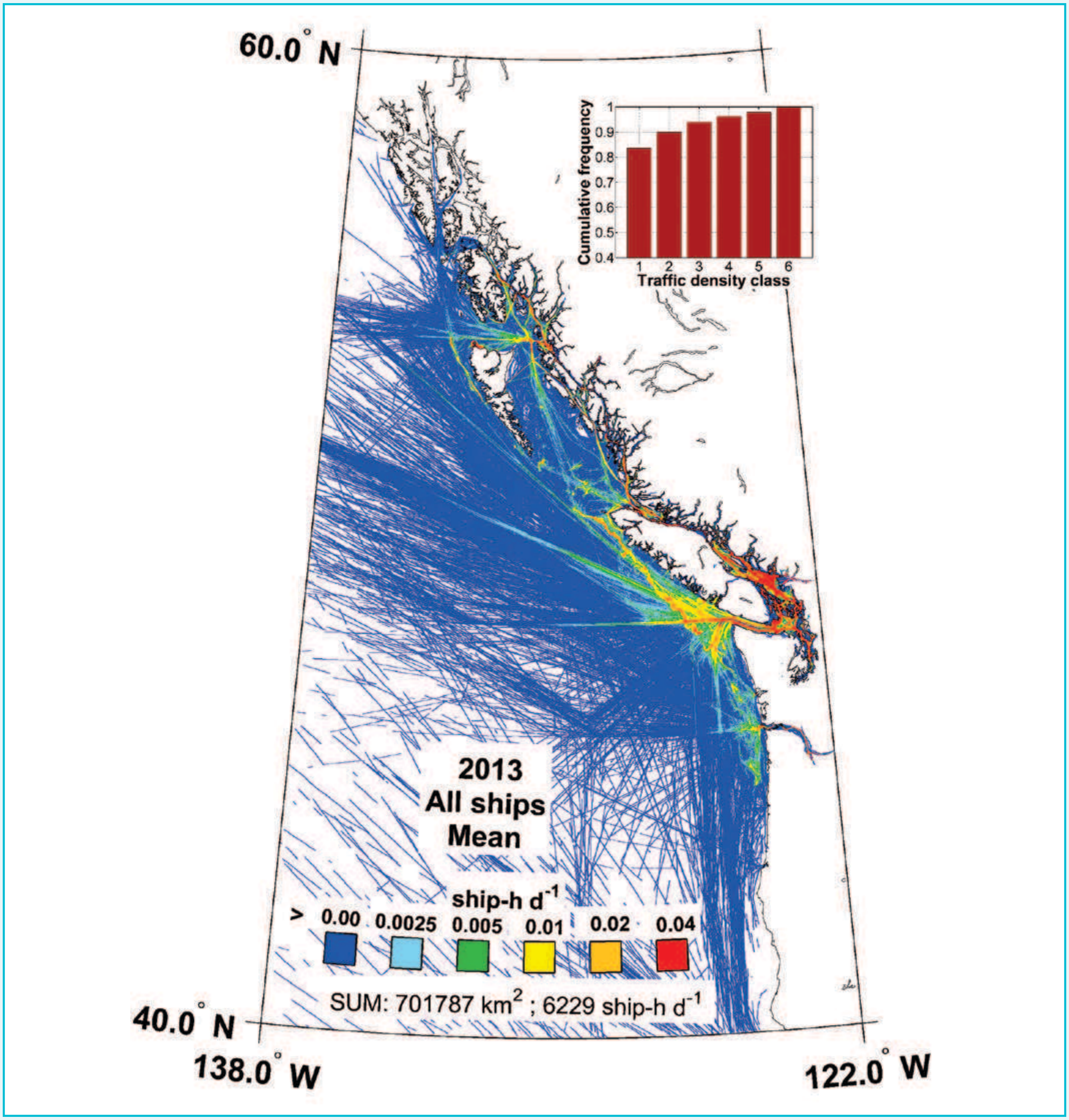




AIS Vessel Traffic Density Off the West Coast of Canada for 2013

Traffic density in time and space is visualized in five distinct categories, with dark blue symbolizing zero to very low density, and red symbolizing high density.

This figure (below) may be helpful to reference when reviewing the maps of cetacean and sea turtle abundance as a means of identifying areas where vessels and cetaceans and sea turtles both occur in high density. The data displays all AIS mean traffic density in 2013. Additionally, the number of squared kilometres containing traffic is provided below the palette as well as the sum of the daily traffic. The histogram shows traffic density per kilometre squared, with each bar corresponding sequentially to the traffic density intervals of the map palette (ie. > 0 to 0.0025 ship-h per 1km² grid cell is represented by traffic density class 1 and > 0.04 ship-h per 1km² is represented by traffic density class 6).



Simard, Y., Roy, N., Giard, S., and Yayla, M. 2014. Canadian year-round shipping traffic atlas for 2013: Volume 3, West Coast. Can. Tech. Rep. Fish. Aquat. Sci. 3091(Vol.3)E: xviii + 327 pp.


BCFerries
Quadra Queen II

Report Your Cetacean Sightings

Many populations of cetaceans are at risk in B.C. Report your sightings to help provide valuable information. By reporting your sightings, you are helping researchers better understand the distribution and abundance of these species.

What to Report

YOUR NAME AND CONTACT INFORMATION

SPECIES

DATE AND TIME

LOCATION
Latitude/Longitude coordinates if available

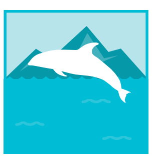
NUMBER OF ANIMALS

BEHAVIOUR OF ANIMALS

SEA STATE, WIND SPEED, AND VISIBILITY

BREACH

FLUKE



PORPOISE

TRAVEL

TAIL/PECTORAL SLAP

BOWRIDE

SPYHOP

FEED

Report your Sightings

WILDWHALES.ORG

1.866.I.SAW.ONE (1.866.472.9663)

SIGHTINGS@VANAQUA.ORG

WHALEREPORT SMARTPHONE APP
iOS and Android devices

Whale-Vessel Strikes and Marine Mammals in Distress

Fisheries and Oceans Canada is responsible for assisting marine mammals and sea turtles in distress. If your vessel strikes a whale, or if you observe a sick, injured, distressed or entangled marine mammal in B.C. waters, please contact the B.C. Marine Mammal Response Network Incident Reporting Hotline immediately:

1.800.465.4336 or VHF Channel 16

What to Report

YOUR NAME AND CONTACT INFORMATION

SPECIES

DATE AND TIME

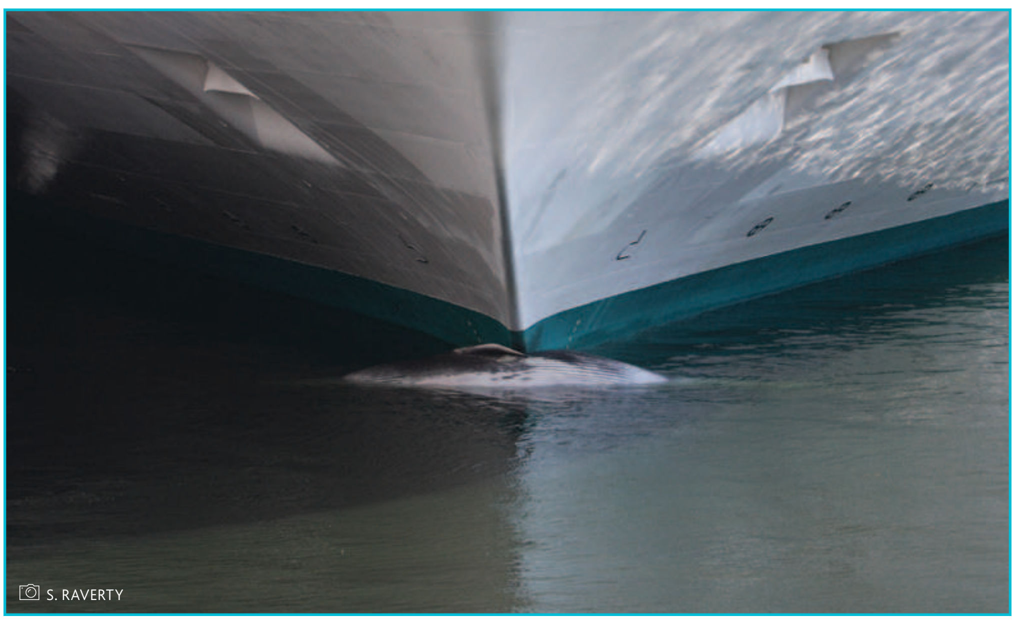
LOCATION
Latitude/Longitude coordinates if available

ANIMAL ALIVE/DEAD

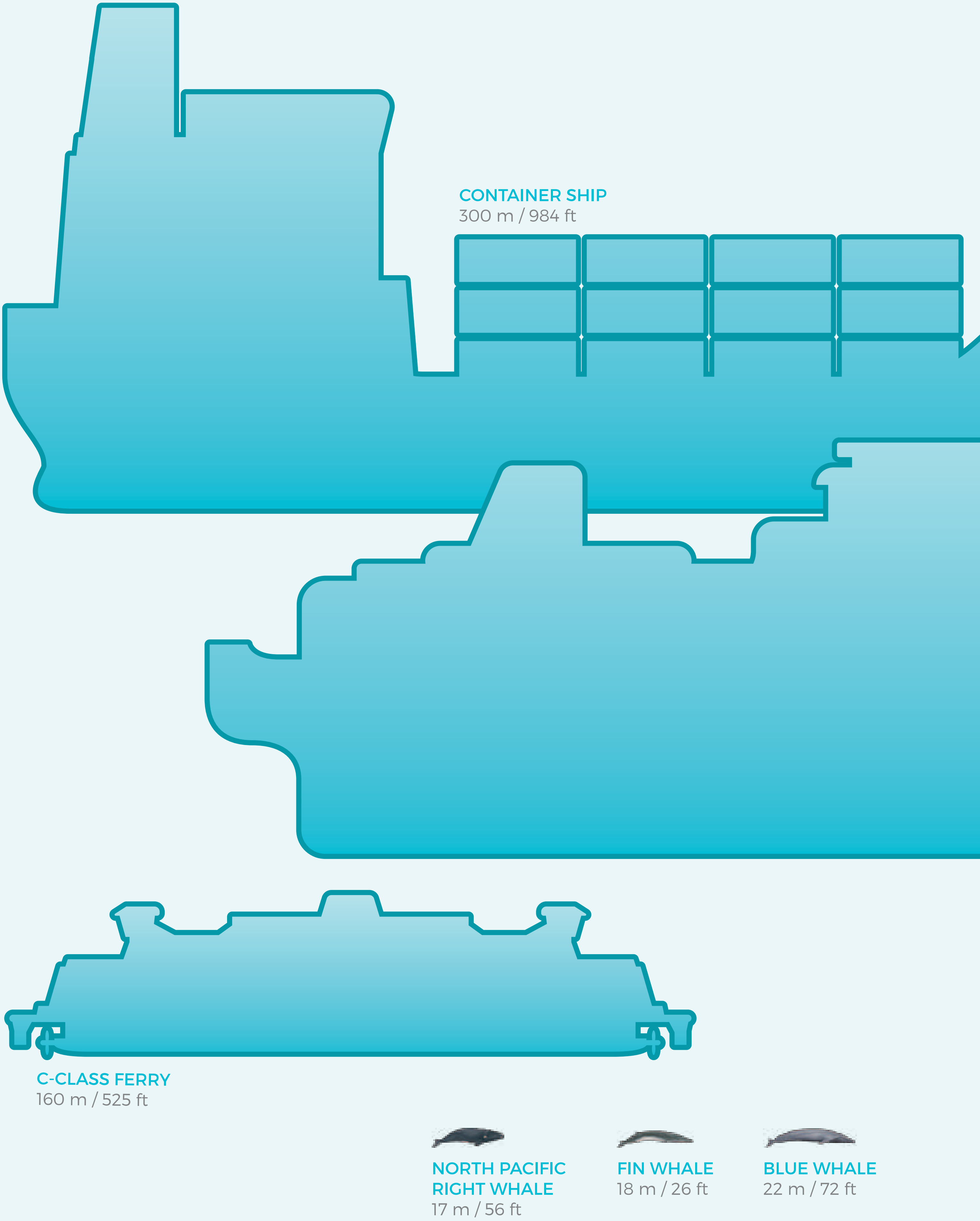
NATURE OF INJURY

PICTURES/VIDEO TAKEN

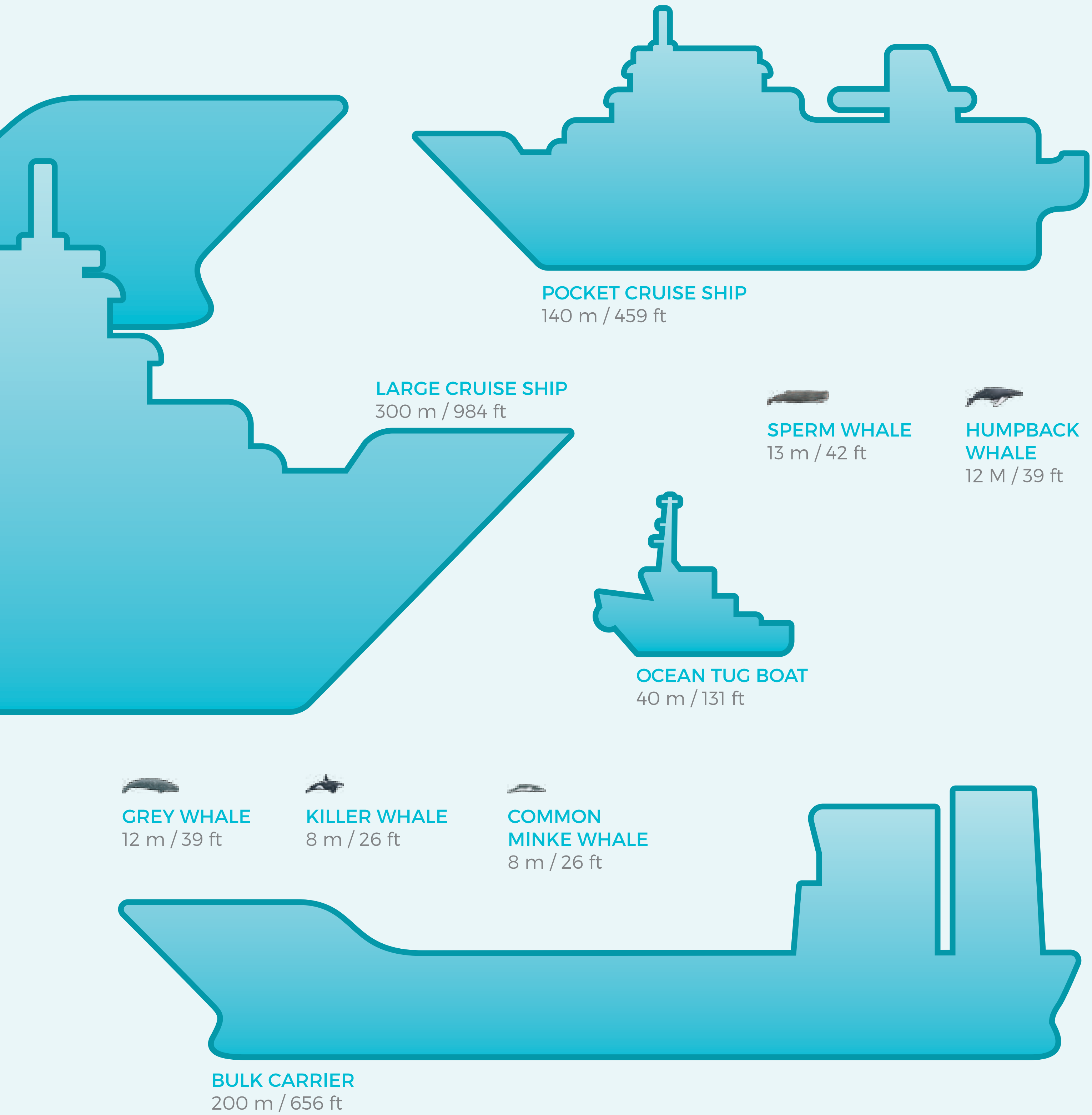
DIRECTION OF ANIMAL'S TRAVEL



S. RAVERTY


CONTAINER SHIP
300 m / 984 ft
C-CLASS FERRY
160 m / 525 ft
NORTH PACIFIC RIGHT WHALE
17 m / 56 ft
FIN WHALE
18 m / 26 ft
BLUE WHALE
22 m / 72 ft

How does your vessel compare to a whale?



Cetaceans of British Columbia

Cetaceans (whales, dolphins and porpoises) are divided into the baleen whales (Mysticetes) and toothed whales (Odontocetes). Toothed whales, as the name implies, have teeth which vary in shape and size depending on the species. Toothed whales have highly developed biological sonar known as echolocation. They have only one blow hole opening on the top of their heads. Baleen whales do not have teeth. Instead, their mouths contain baleen which is made up of keratin-based, comb-like plates that filter the water for food. They have a blowhole with two openings on the top of their heads.

In the following section, average adult length measurements come from Ford 2014 and species statuses are displayed with the year of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessment or designation by the Species at Risk Act (SARA).

SARA was created to protect Canada's vulnerable wildlife species and uses COSEWIC as an independent organization tasked with recognizing and assessing at-risk species. COSEWIC assessments are considered the initial step in listing a species as SARA protected, and the federal government will use such assessments to determine if COSEWIC assessed species qualify for protection under SARA. In this guide we have listed COSEWIC statuses in cases where a particular species has been assessed by COSEWIC but not listed under SARA.

Baleen Whales

HUMPBACK WHALE

Megaptera novaeangliae

Average Adult Length: 12 m / 40 ft

SARA Status 2013

Not at Risk	Special Concern	**Threatened**	Endangered	Extirpated
NR	SC	**TH**	EN	EX

Dorsal Fin

Short with a broad base and variable in shape, located 2/3 of the way along the back of the body.

Appearance

Grey to black on top, with varying amounts of white on underside, throat and pectoral fins. Thick body shape. Distinct pectoral fins, nearly 1/3 as long as body, colour can range from all black to all white, leading edges are scalloped. Distinctive knobs present on top of head. Underside of tail can range from all black to mostly white. Bushy-shaped blow.

Behaviour

Usually lifts tail flukes when making a deep dive. Can be active and acrobatic at surface.

Distribution

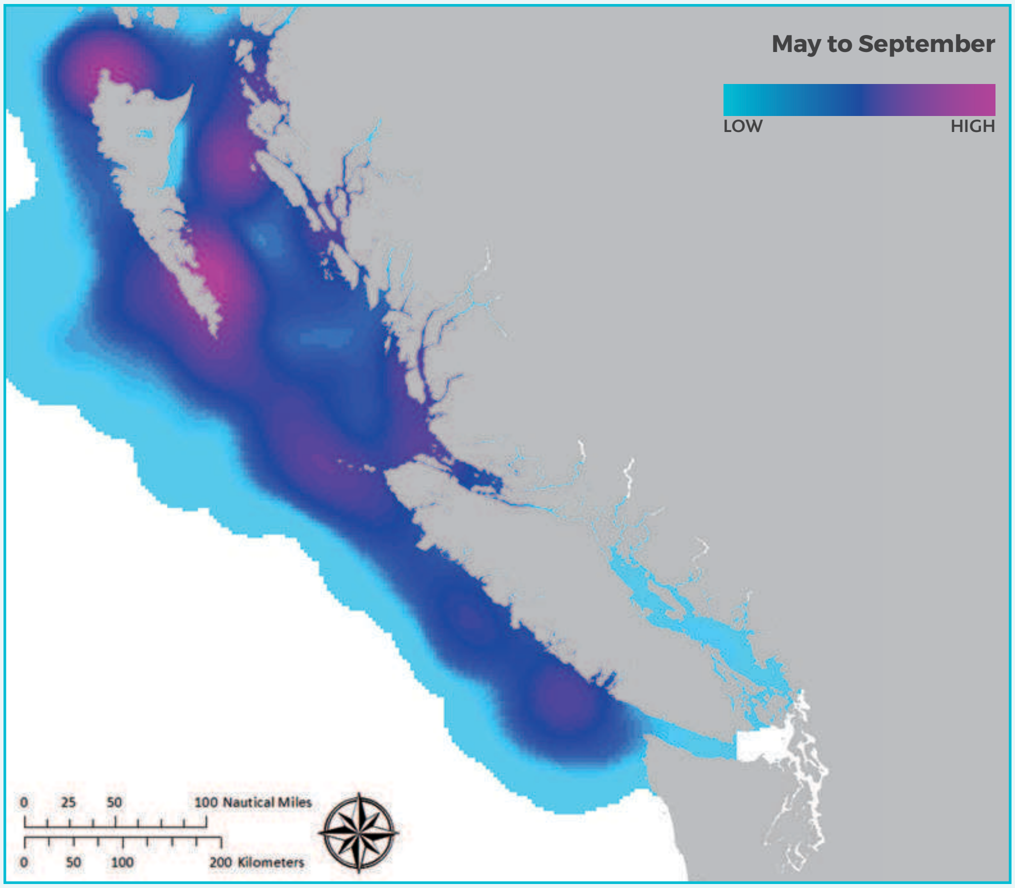
Found in all the world's oceans. North Pacific population is highly migratory and can be found in coastal shelf waters of northern Japan, Russia, Alaska, B.C. and the west coast of the United States during summer months. Breeding grounds are near islands or reefs in Hawaii, Mexico, Central America and Asia during winter months.

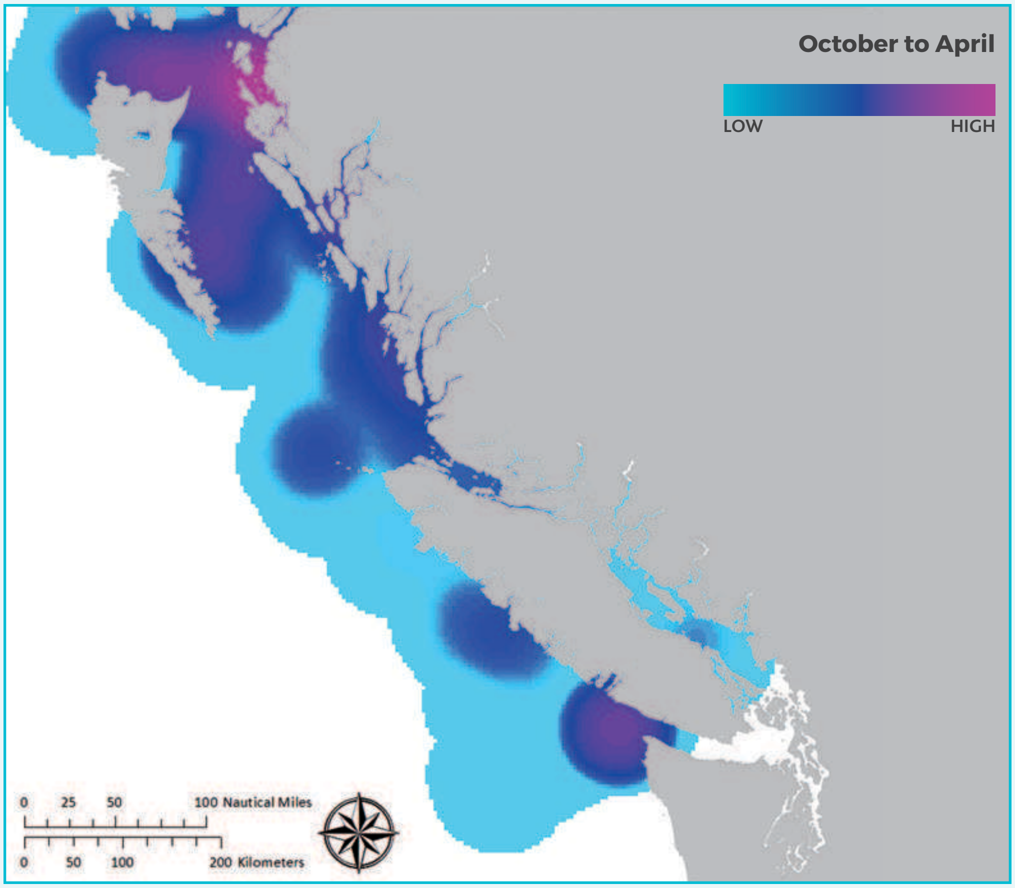
Vulnerability of the Species

Humpback whales experience the second highest strike rate of any whale species worldwide because they are relatively abundant and they often feed at or near the surface[29]. Additionally, vessel noise may disturb humpback whales and cause them to move away from the best feeding areas[16].

Further threats to humpback whales include entanglement, toxic spills and prey reduction[16].

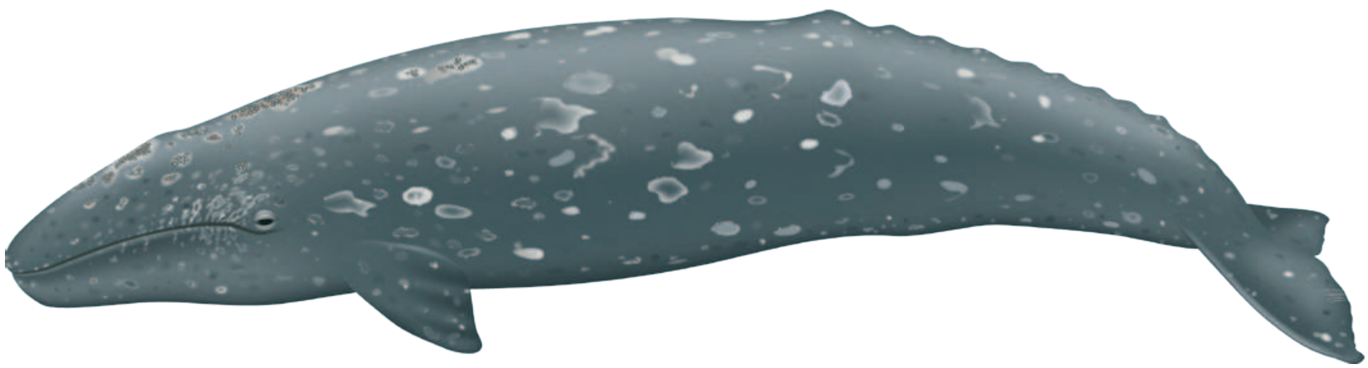
Relative Abundance of Humpback Whales in B.C. Waters





GREY WHALE

Eschrichtius robustus



Average Adult Length: 11-12 m / 36-40 ft

SARA Status 2010

Not at Risk	Special Concern	Threatened	Endangered	Extirpated
NR	**SC**	TH	EN	EX

Dorsal Fin

No dorsal fin, has knuckle-like bumps on lower back.

Appearance

Mottled grey skin with scarring and varied pigmentation. Body and head are covered with patches of barnacles. Tail fluke has convex trailing edge with a deep notch in the middle. Heart or v-shaped blow.

Behaviour

Occasionally lifts tail flukes when making a deep dive. Often feeds close to shore.

Distribution

Only found in the North Pacific Ocean; eastern and western populations are distinct. The eastern population's migratory range spans from Baja California and the northwestern coast of Mexico's mainland to the Chukchi and Beaufort seas in the Arctic. On their northward migration, they usually pass the coast of B.C. starting in early spring and are found close to shore except when crossing open bodies of water (e.g. Queen Charlotte Sound and Hecate Strait). On the southbound migration in late-fall/early-winter, the whales travel further offshore. A small population remains resident in B.C. throughout the summer months[19].

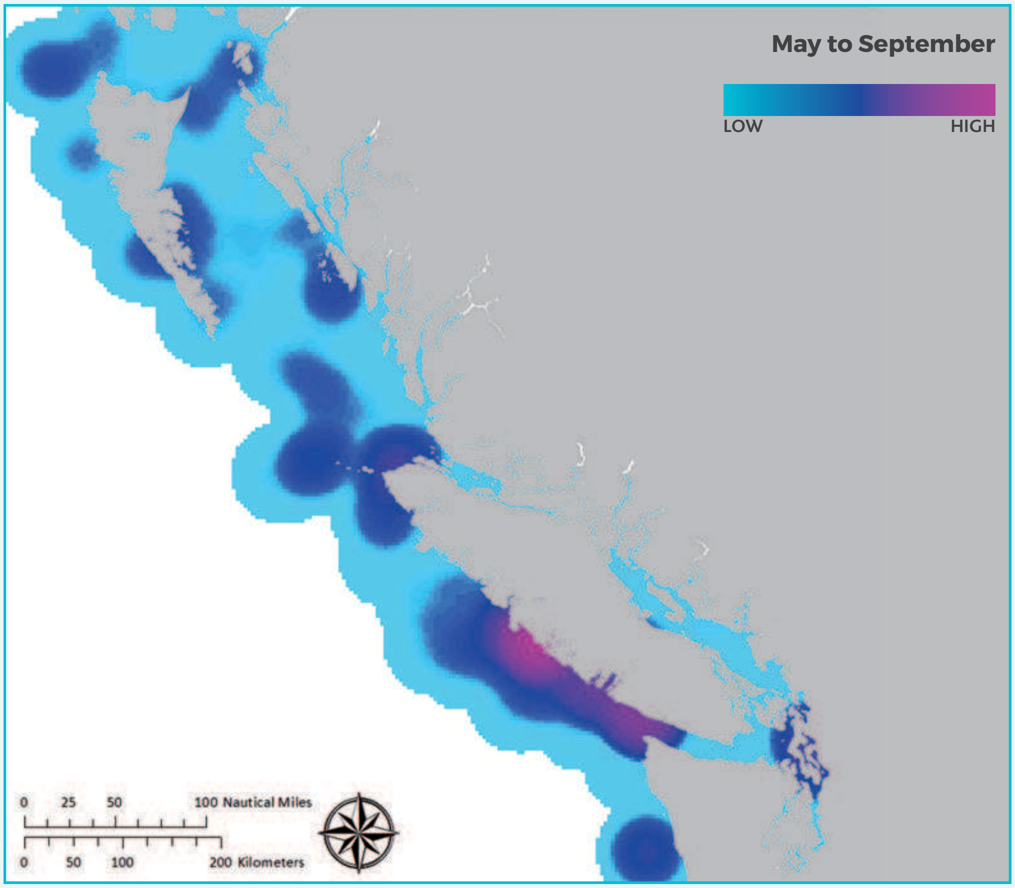
Vulnerability of the Species

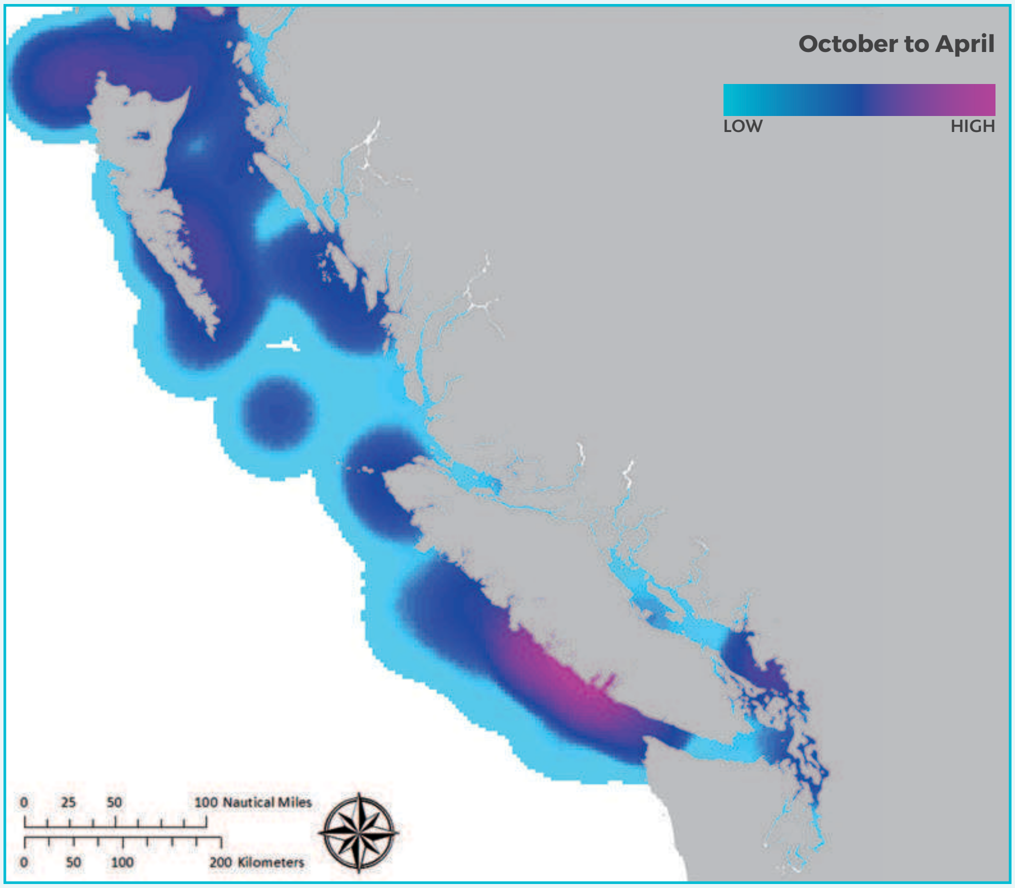
Like most large whale species, grey whales are threatened by vessel strikes[29]. While their tendency to travel close to shore in shallower waters may decrease their likelihood of interacting with large vessel traffic, recent studies have demonstrated that grey whale migration includes Hecate Strait and Dixon Entrance, both active shipping areas[18].

Additionally, vessels may contribute toward acoustic and physical disturbance of grey whales, potentially disrupting feeding behaviours or displacing them from their habitat[13].

Further threats include increased human activity in breeding lagoons, environmental variability, disruption and destruction of feeding habitat, toxic spills, physical disturbance, fossil fuel exploration and extraction, prey reduction, pollution, and entanglement in fishing gear (especially crab traps due to shallow water distribution)[13].

Relative Abundance of Grey Whales in B.C. Waters





FIN WHALE

Balaenoptera physalus

Average Adult Length: 17-18 m / 56-59 ft

SARA Status 2013

Not at Risk	Special Concern	Threatened	Endangered	Extirpated
NR	SC	**TH**	EN	EX

Dorsal Fin
Prominent and sickle-shaped, located far back on body.

Appearance
Dark grey back, often with lighter grey swirled markings behind the head. Right lower lip is white while left is dark. Streamlined body shape with tapered head. Skin may have a brownish tinge caused by diatoms. Tall, narrow blow.

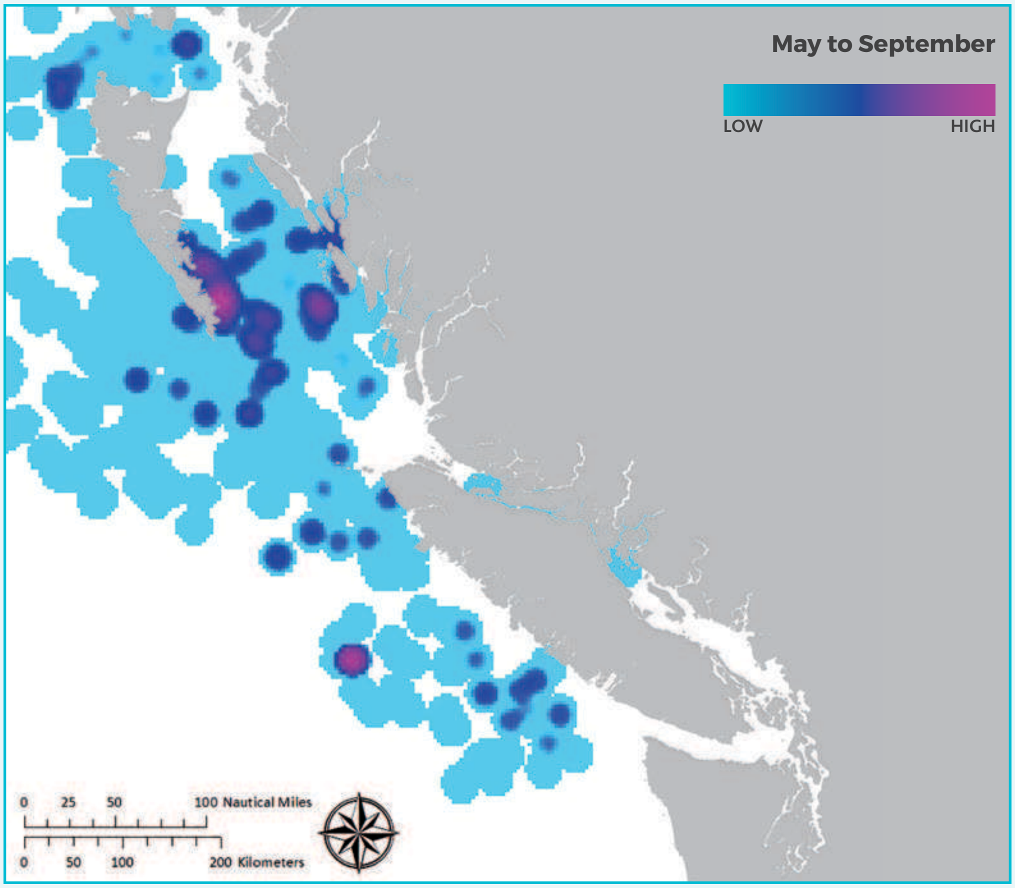
Behaviour
Usually does not lift tail when diving. Fast swimmer.

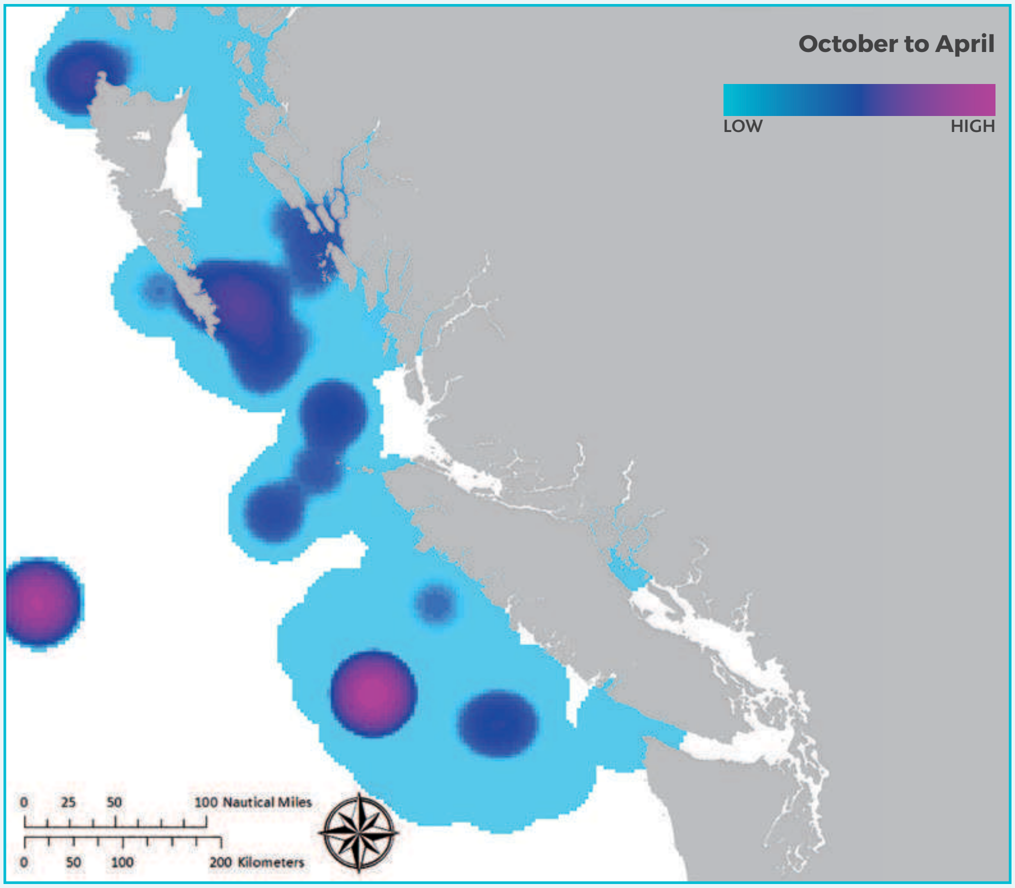
Distribution
Found in all the world's oceans. The North Pacific population has been reported from the Gulf of California to the Gulf of Alaska (potentially two separate populations). Migrate to high latitudes in the summer for feeding, and to warm waters in the winter for breeding. Found mostly near or off the continental shelf, occasionally in near-shore deep water.

Vulnerability of the Species
Fin whales are the most commonly struck whale species world-wide[29, 26, 6], and vessel strikes are the greatest human-caused threat to fin whales in B.C. As fin whales are distributed along the shelf-break, they are in locations that frequently coincide with shipping lanes[20]. Additionally, vessel noise may cause disturbance and mask the low-frequency calls of fin whales[17].

Further threats to fin whales include entanglement in fishing gear and debris, pollution, and habitat displacement by changes in ocean climate and prey distributions[17].

Relative Abundance of Fin Whales in B.C. Waters





COMMON MINKE WHALE

Balaenoptera acutorostrata

Average Adult Length: 8 m / 26 ft

COSEWIC Status 2006

Not at Risk	Special Concern	Threatened	Endangered	Extirpated
NR	SC	TH	EN	EX

Dorsal Fin
Sharply curved dorsal fin, located far back on body.

Appearance
Dark grey back, often with lighter grey swirled markings behind the head. Distinctive white band on top of each pectoral flipper. Pointed head with prominent nose ridge. Body slender and streamlined. Blows rarely visible.

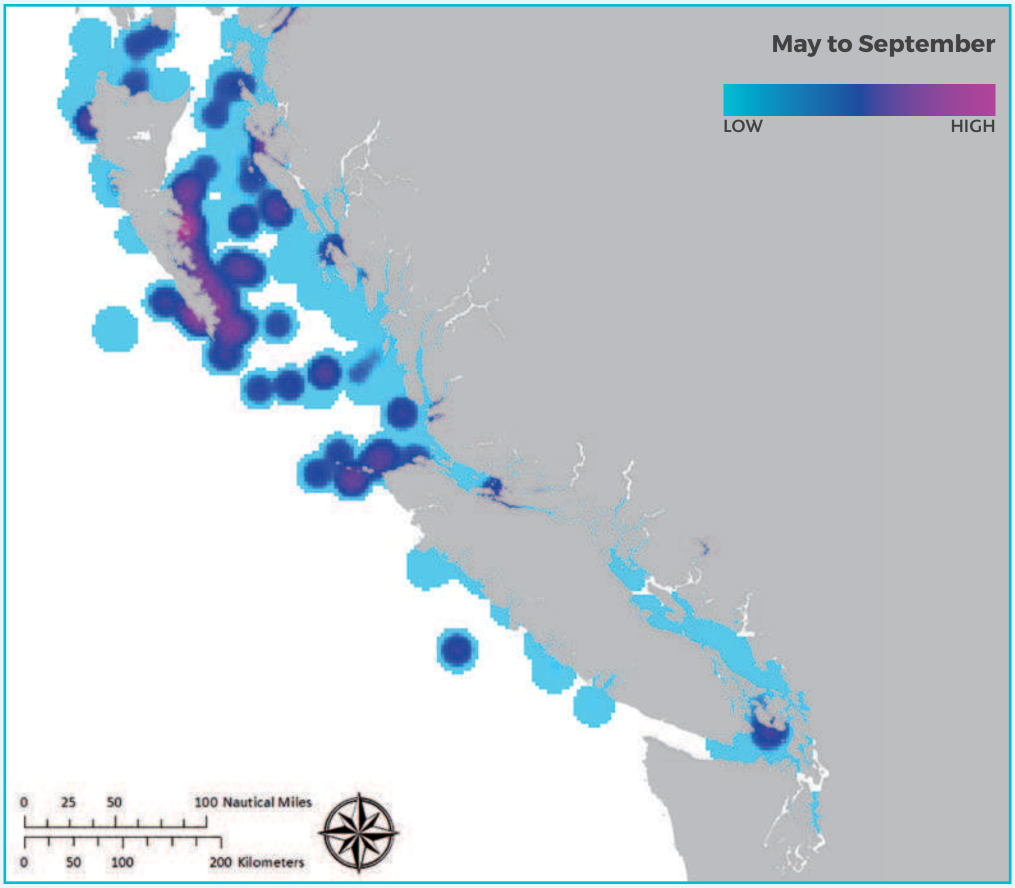
Behaviour
Usually elusive and solitary. Surfaces 1-2 times between dives.

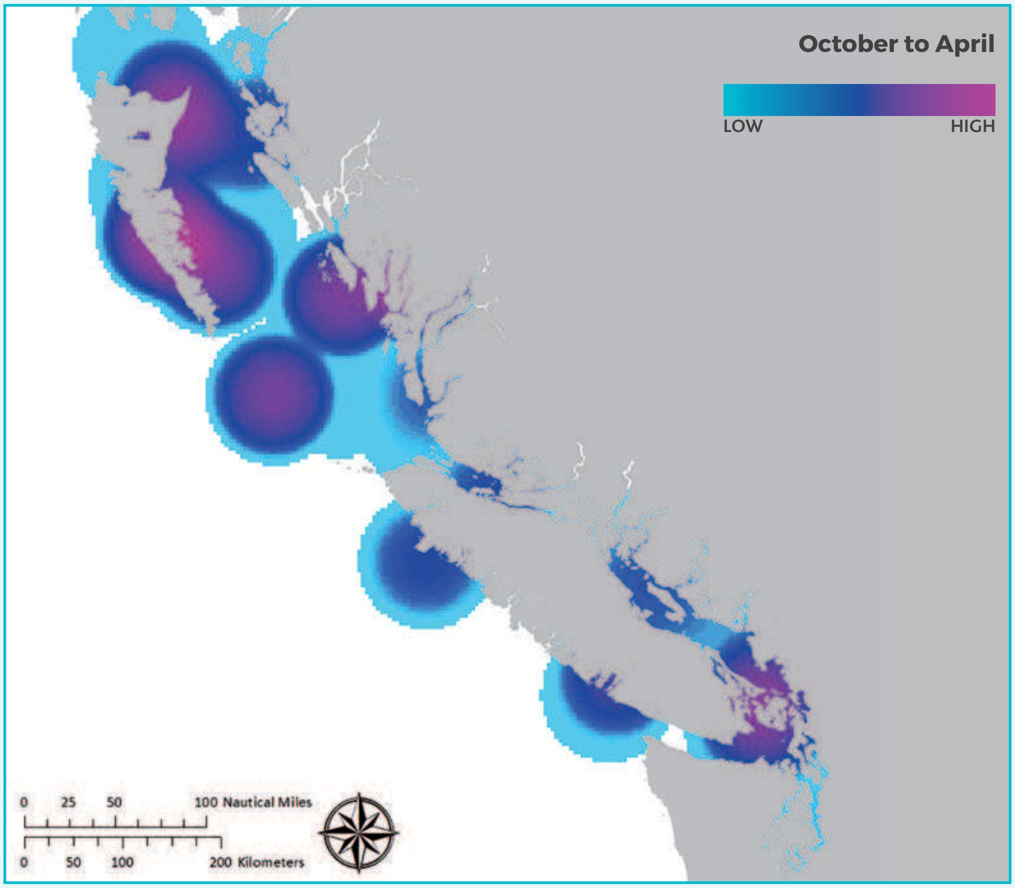
Distribution
Distributed in both the northern and southern hemispheres, and have been observed year round in B.C., although more commonly seen in summer months. Found in shallow coastal areas and can be found offshore.

Vulnerability of the Species
Vessels can negatively affect minke whales due to risk of strikes[50], and pose threats associated with pollution and disturbance.

Entanglement in fishing gear is one of the largest human-caused threats to minke whales in B.C.[19].

Relative Abundance of Minke Whales in B.C. Waters





BLUE WHALE

Balaenoptera musculus

Average Adult Length: 21-22 m / 69-72 ft

SARA Status 2013

Not at Risk	Special Concern	Threatened	**Endangered**	Extirpated
NR	SC	TH	**EN**	EX

Dorsal Fin
Variable shape, often rounded at tip. Very small relative to body.

Appearance
Blue grey, mottled colouring. Dorsal fin generally not seen until long after blow appears and head has submerged. Head is broad and flat with a raised "splashguard" in front of blowhole. Column-shaped blow 9 m (30 ft) tall.

Behaviour
Often raises tail when diving.

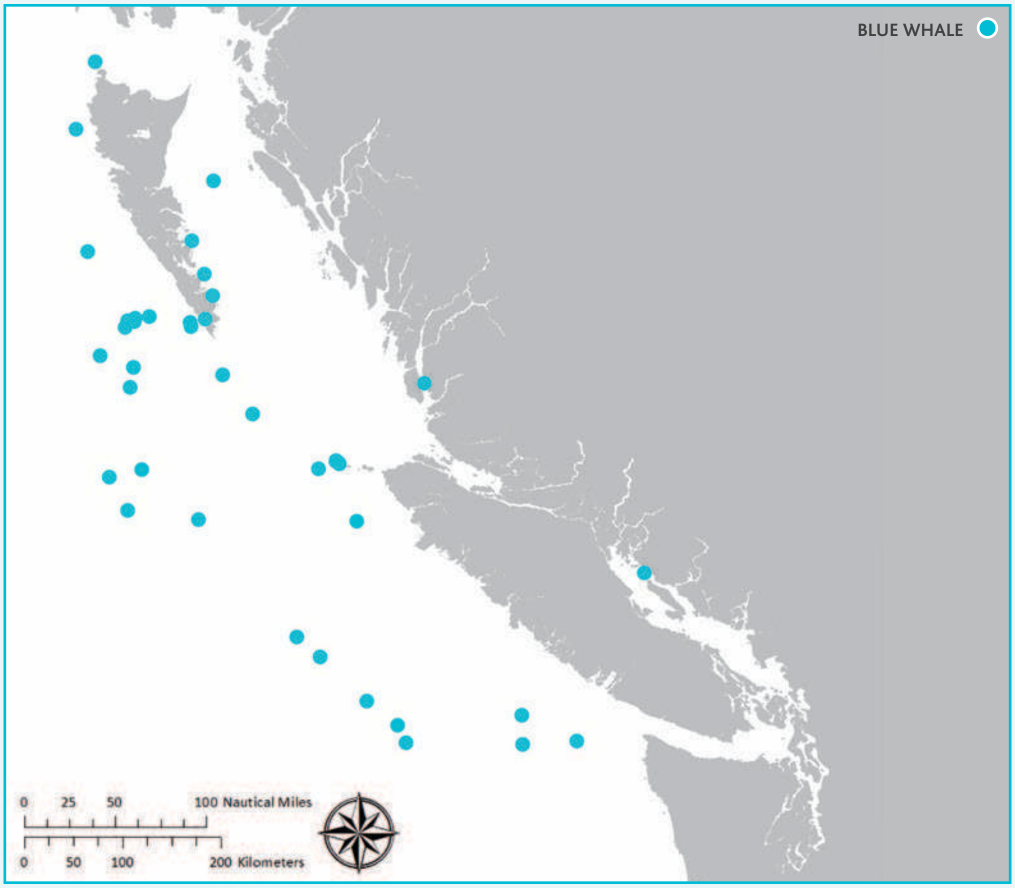
Distribution
Found in all the world's oceans. The eastern North Pacific population ranges from Central America to the Gulf of Alaska. Seasonal movements are not fully understood, but it is generally accepted that the species migrates south to Baja California (especially the Gulf of California) and west of Costa Rica in the winter, moving north off California, B.C. and the Gulf of Alaska in the spring and summer. Primarily found in offshore waters, occasionally in coastal and shelf waters.

Vulnerability of the Species
Vessel strikes are one of the most significant human-caused threats to blue whales. Blue whales may be particularly vulnerable to strikes due to their tendency to feed at the surface and their slow and shallow dive response to vessels[33]. Blue whales spend more time at or near the surface at night when they are more difficult to see and avoid[2].

Additionally, vessels pose a threat to blue whales due to acoustic disturbance, which may mask their communication calls[17].

Further threats to blue whales include entanglement in fishing gear and debris, pollution, and habitat displacement caused by changes in ocean climate or food web[17].

Blue Whale Sightings in B.C. Waters



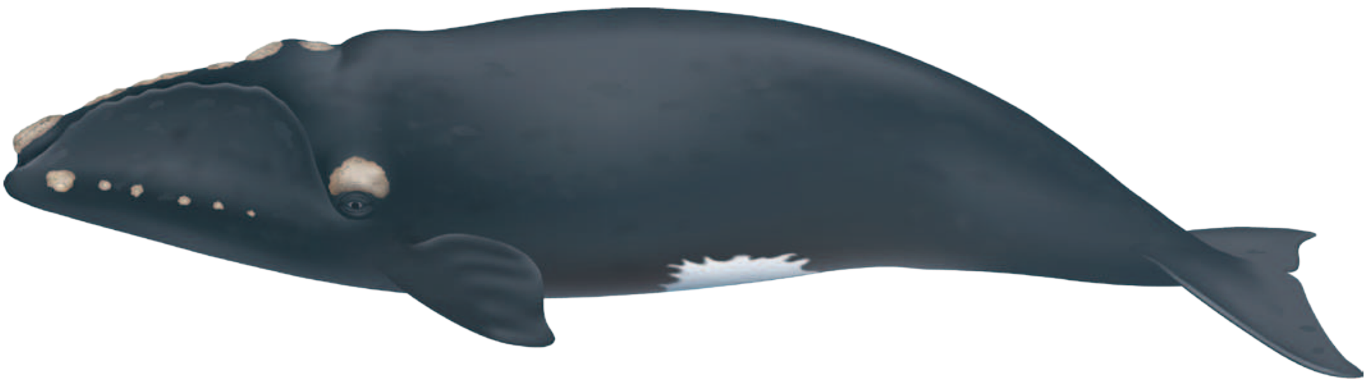
ALANA PHILLIPS

ALANA PHILLIPS

C. CROSSMAN

NORTH PACIFIC RIGHT WHALE

Eubalaena japonica



Average Adult Length: 17 m / 56 ft

SARA Status 2011

Not at Risk	Special Concern	Threatened	Endangered	Extirpated
NR	SC	TH	EN	EX

Dorsal Fin
No dorsal fin present and no dorsal ridge evident.

Appearance
Dark grey to black body with large, white callosities (small, irregular knobs of calloused skin) on the head. White patches on the side of the belly. Very rotund shape with short pectoral flippers. Mouth line is strongly arched downwards. Tail flukes are very triangular. Wide, V-shaped blow.

Behaviour
May raise tail when diving. Feeds by swimming slowly along the surface with mouth agape.

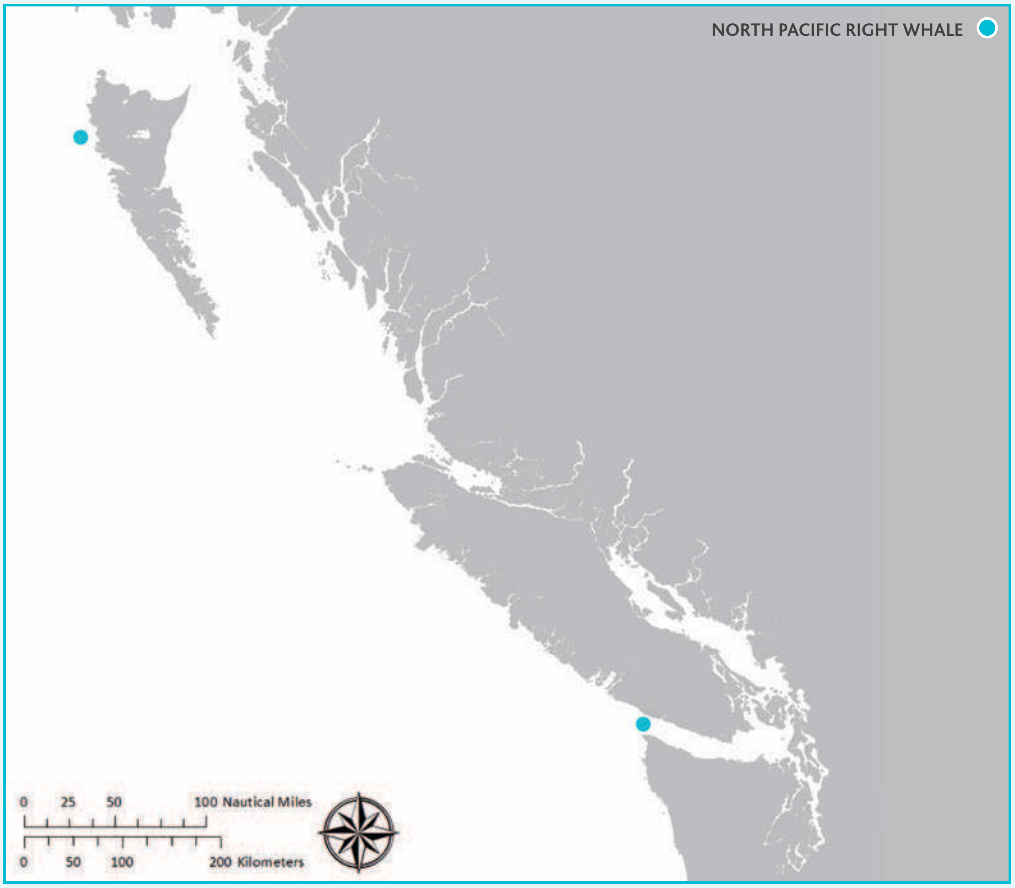
Distribution
Extremely rare. Historically found across the entire North Pacific (eastern and western North Pacific populations considered discrete).

Vulnerability of the Species
Small population size is a critical threat to North Pacific right whales, making their species especially vulnerable to threats such as vessel strikes, as the loss of one individual could have drastic effects on the population's chances of recovery[29]. In the North Atlantic, it has been found that vessel strikes are the most significant human-caused source of injury and mortality for right whales[26]. Right whales show very low responsiveness to vessels[38], have slow swimming speeds, and spend a significant amount of time at the surface resting, feeding, nursing and mating, making them very vulnerable to strikes[29].

Further threats to North Pacific right whales include entanglement in fishing gear, noise and pollution[17, 44].

NOTE: North Pacific right whales are extremely rare. Two sightings in 2013 of two different individual animals were the first confirmed observations of this species in over 60 years. **If you see one, please call 1 866 I SAW ONE immediately.** They are featured in this guide due to their significant vulnerability to vessel collisions and to highlight the importance of reporting this species.

North Pacific Right Whale Sightings in B.C. Waters




J. PILKINGTON

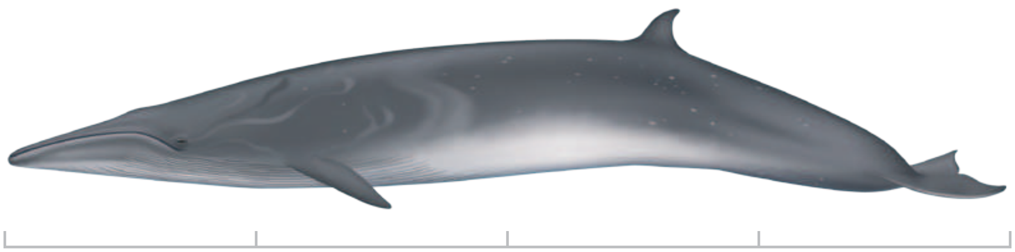

J. PILKINGTON


J. PILKINGTON

LESS COMMON BALEEN WHALES

SEI WHALE

Balaenoptera borealis



Average Adult Length: 13 m / 43 ft

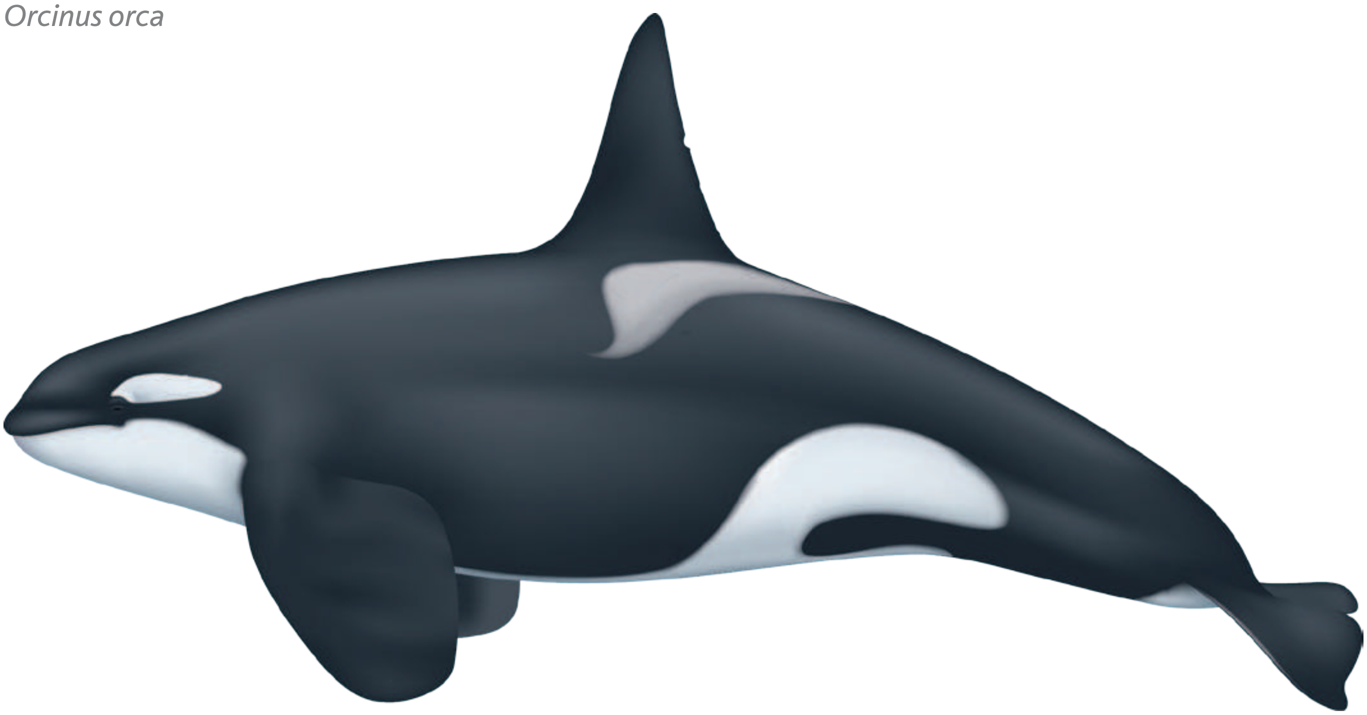
Description

Dark to bluish grey, often with grey to white circular scars. Dorsal fin is strongly curved towards back, generally more erect compared to a fin whale, and positioned less than 2/3 from the front of the body. Lower jaw is dark on both sides of the head.

Toothed Whales

KILLER WHALE / ORCA

Orcinus orca



Average Adult Length: 6-8 m / 20-26 ft

Southern Resident SARA Status 2011	Northern Resident SARA Status 2011	Bigg's SARA Status 2007	Offshores SARA Status 2009
Endangered NR	Threatened TH	Threatened TH	Threatened TH

Dorsal Fin

Short and curved in juvenile and female whales, tall in mature males up to 1.8 m in height.

Appearance

Distinctive pattern with black on the back, white on the belly, white-grey "saddlepatch" behind the dorsal fin and white "eyepatch" located just behind the eye. Tail flukes are black on top and white underneath.

Behaviour

Can be very acrobatic and active at the surface.

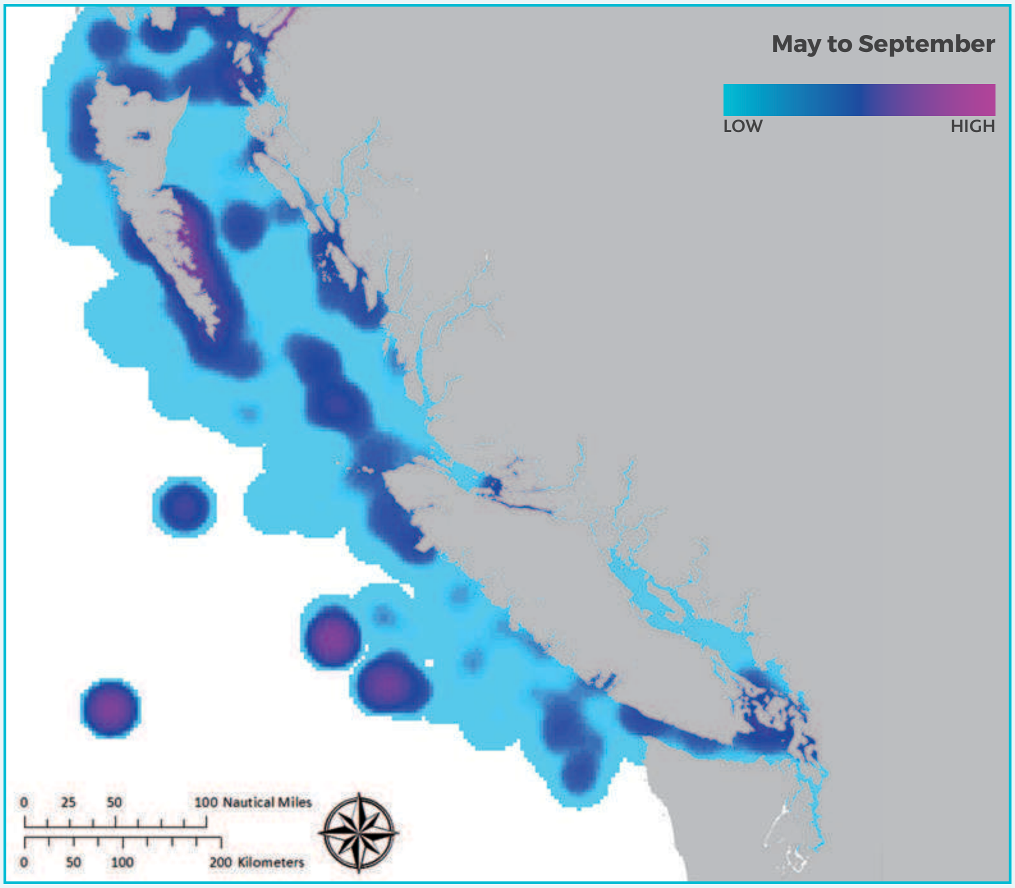
Distribution

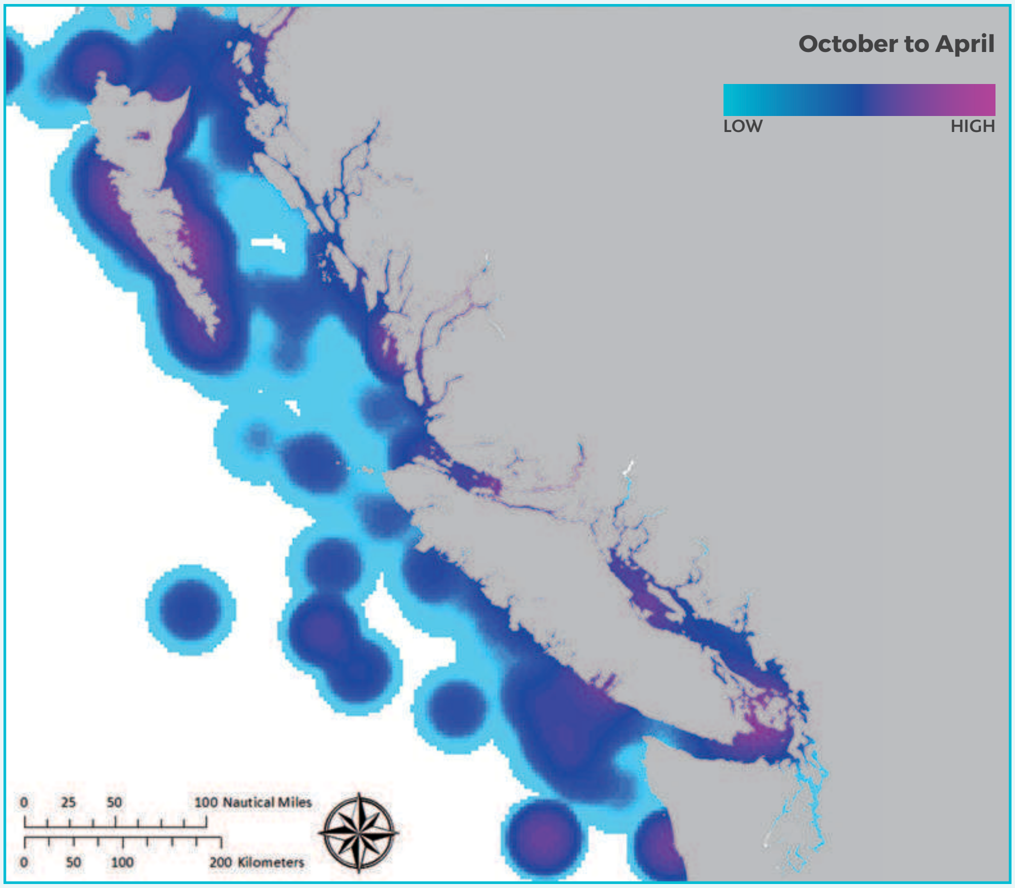
Three types of killer whales exist in B.C.: resident killer whales, Bigg's killer whales and offshore killer whales. Resident killer whales are observed throughout B.C. waters, but are most common south and east of Vancouver Island and in larger channels and passages on the central and north coast. They are usually seen in groups of 10 or more. Bigg's killer whales are more commonly seen in smaller groups, often very close to shore, among islands, and in or near bays and inlets. Offshore killer whales are usually found in groups of 10 to 50 or more and are most commonly seen in continental shelf waters west of Vancouver Island and Haida Gwaii[19]. In B.C., killer whales are subject to intensive whale watching by private and commercial vessels in the summer months, and vessel crews may be alerted to their presence by clusters of small vessels.

Vulnerability of the Species

The greatest impact of vessels on killer whales is noise and physical disturbance, which impairs and masks both their communication and echolocation, and can interrupt important behaviours such as foraging, group cohesion, resting and mating[8, 54]. Vessel strikes are relatively rare, but when they occur they usually cause serious injury or death (Spaven *et al.* 2013). Further human-caused threats to killer whales include injuries associated with depredation (whales taking fish off fishing lines), entanglement in fishing gear, contaminants and pollution, and competition for fish stocks[15, 11, 10].

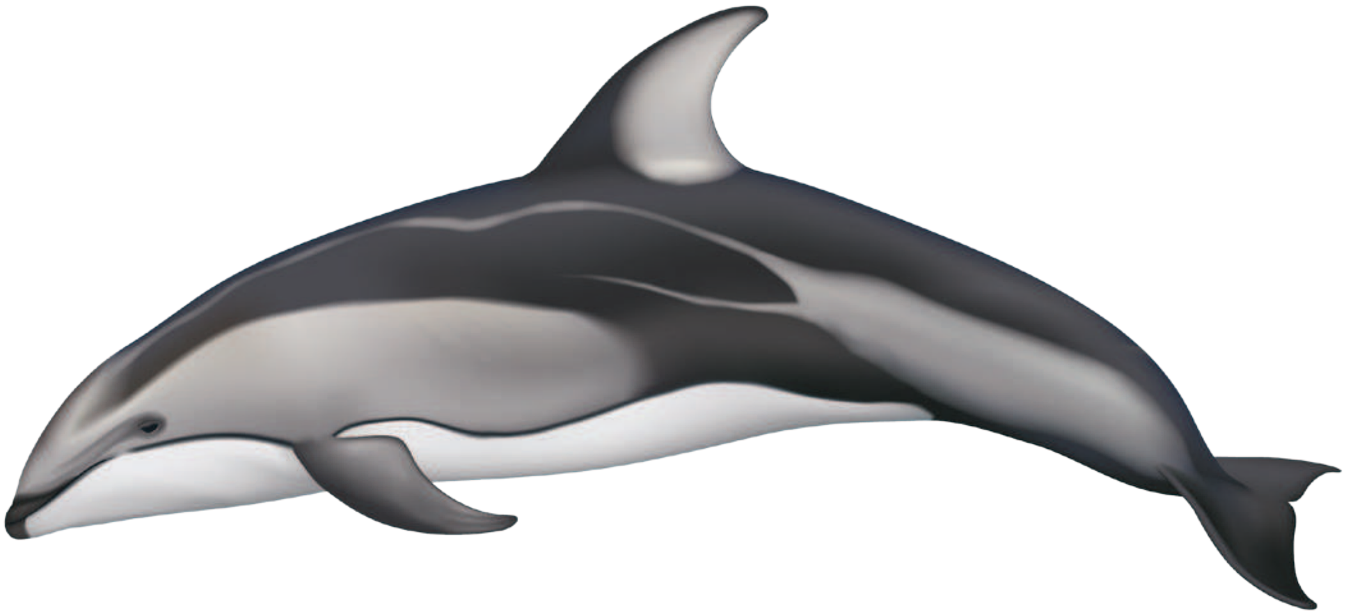
Relative Abundance of Killer Whales in B.C. Waters





PACIFIC WHITE-SIDED DOLPHIN

Lagenorhynchus obliquidens



Average Adult Length: 2.5 m / 8 ft

COSEWIC Status 1990

Not at Risk	Special Concern	Threatened	Endangered	Extirpated
NR	SC	TH	EN	EX

Dorsal Fin

Grey and white bi-coloured, very curved, located in the middle of the back.

Appearance

Back is dark-grey to black, sides are striped light and dark grey, and belly is white. Tip of the beak is black, and visible when out of water.

Behaviour

Often leap completely clear of water. Create a "rooster-tail" of spray when swimming quickly. Often in groups of 50 or more.

Distribution

Only found in the North Pacific. The eastern North Pacific population occurs from southern Gulf of California to the Gulf of Alaska. It is the most abundant cetacean species in B.C., found in most coastal and offshore waters of the province.

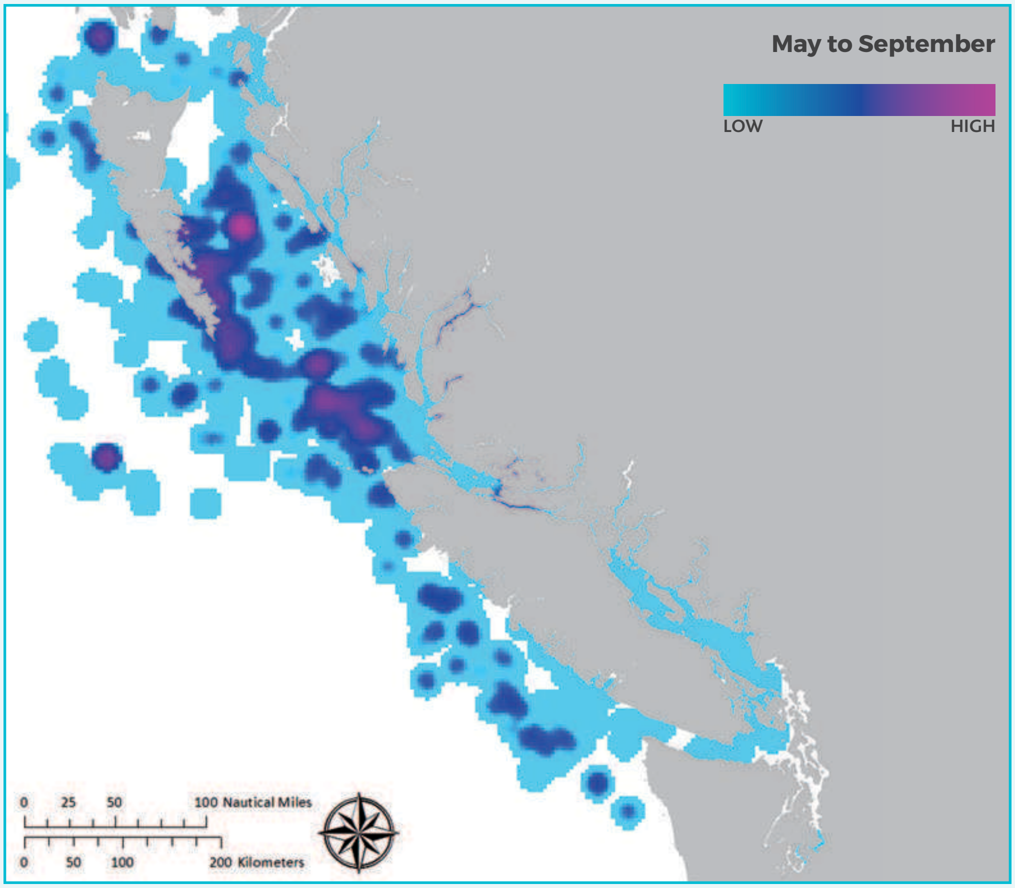
Vulnerability of the Species

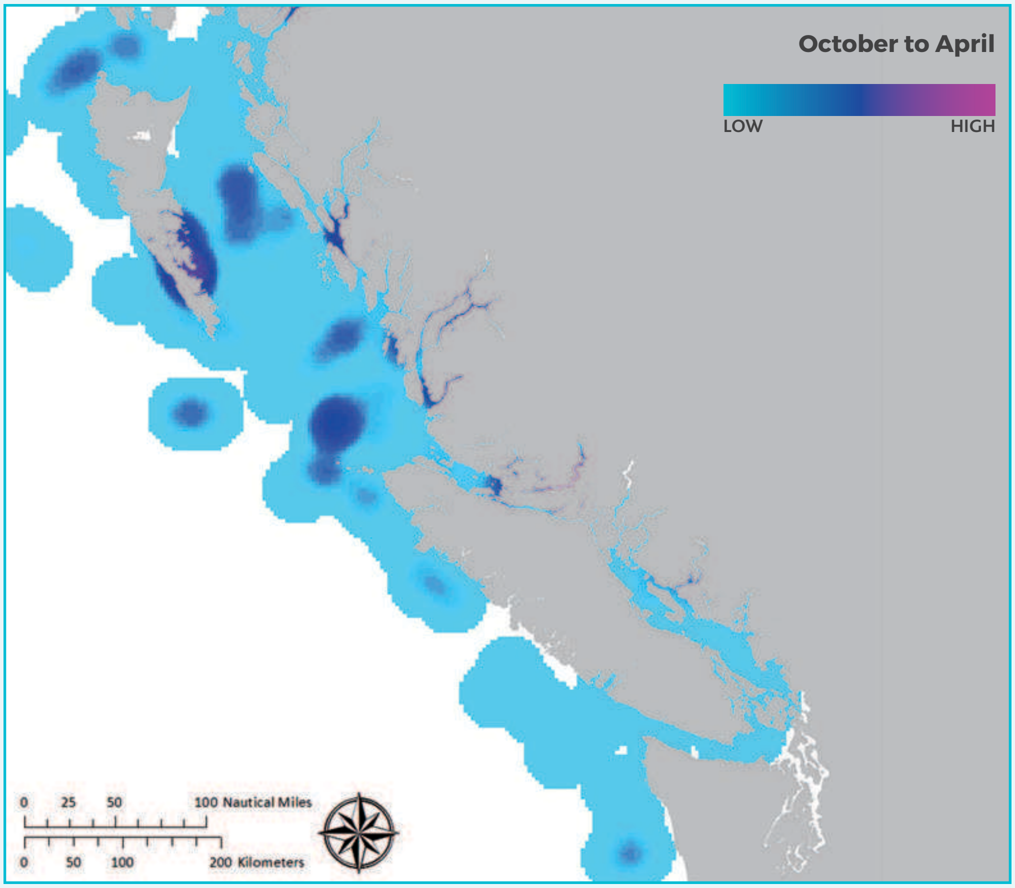
Researchers and ecotourism professionals in British Columbia have observed Pacific white-sided dolphins with injuries or scars consistent with vessel strikes, although the prevalence of strikes to this species is believed to be low[21,23].

Pacific white-sided dolphins have a tendency to approach vessels and bow-ride, which may increase the risk of vessel strikes.

Historically, bycatch from drift gillnet fisheries for salmon and squid caused a significant decline to Pacific white-sided dolphin populations. The moratorium placed on the practice in 1993 greatly decreased mortality due to bycatch[18].

Relative Abundance of Pacific White-Sided Dolphins in B.C. Waters





HARBOUR PORPOISE

Phocoena phocoena

Average Adult Length: 1.5 m / 5 ft

SARA Status

Not at Risk	Special Concern	Threatened	Endangered	Extirpated
NR	SC	TH	EN	EX

Dorsal Fin

Triangular, blunt, uniformly grey.

Appearance

Uniform colouration, dark grey-brown back with a lighter belly and speckled greyish white area along the sides. Lighter sides or belly not usually seen when surfacing. Chunky body with small pectoral flippers.

Behaviour

Often inconspicuous and travel slowly. Generally spotted alone or in small groups of 2-3. Larger aggregations may occur occasionally.

Distribution

Found in the North Pacific, North Atlantic and the Black Sea. Pacific population ranges from Point Conception California, north through B.C. and Alaska to the southern Beaufort and Chukchi Sea, and west to Japan. Present in B.C. year-round in shallow waters, as well as on the outer coast.

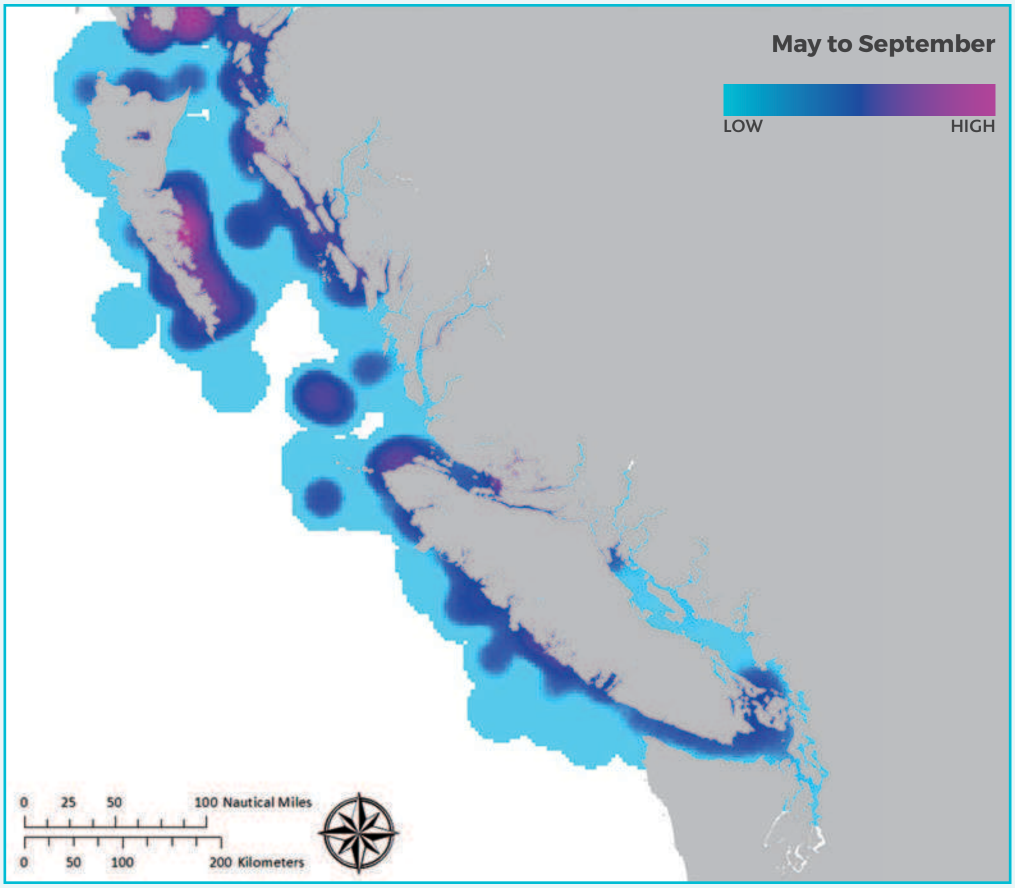
Vulnerability of the Species

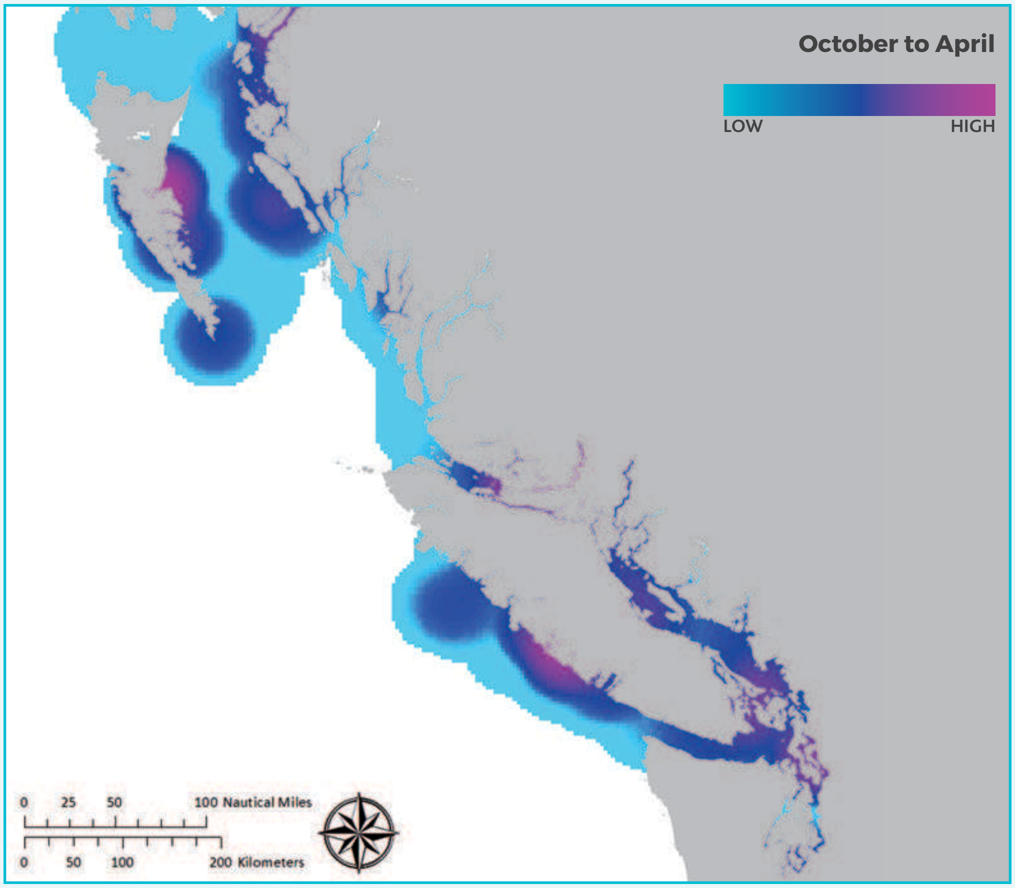
Harbour porpoise habitat in B.C. includes narrow, coastal waterways and areas close to urban centres exposing them to close contact with vessels. As the smallest cetacean in B.C., they are easy to miss, particularly in choppy seas.

Vessels may acoustically disturb harbour porpoise, which may interfere with foraging, navigating or social communication, and cause them to leave or not enter an area[12].

Further threats include entanglement, habitat degradation, toxic spills, contaminants and reduction in prey[12].

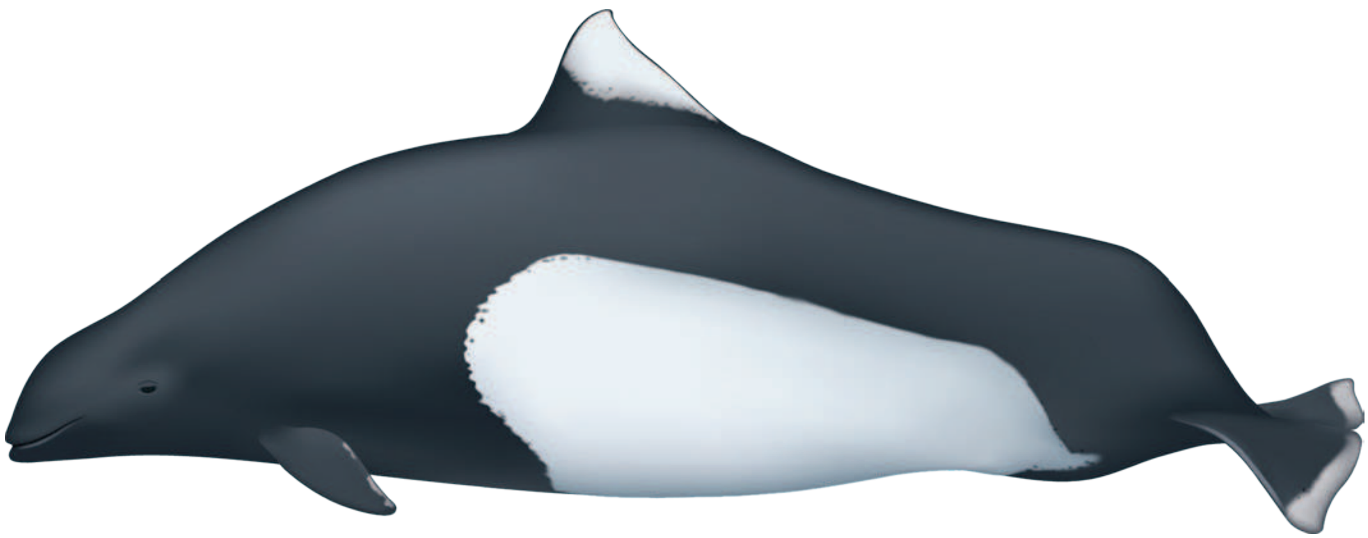
Relative Abundance of Harbour Porpoise in B.C. Waters





DALL'S PORPOISE

Phocoenoides dalli



Average Adult Length: 2 m / 6.5 ft

COSEWIC Status 1989

Not at Risk	Special Concern	Threatened	Endangered	Extirpated
NR	SC	TH	EN	EX

Dorsal Fin
Small, triangular, black with a white tip.

Appearance
Black back with prominent white flanks. Body is chunky with a small head and flippers. Small hump on tailstock before the flukes is evident when surfacing slowly.

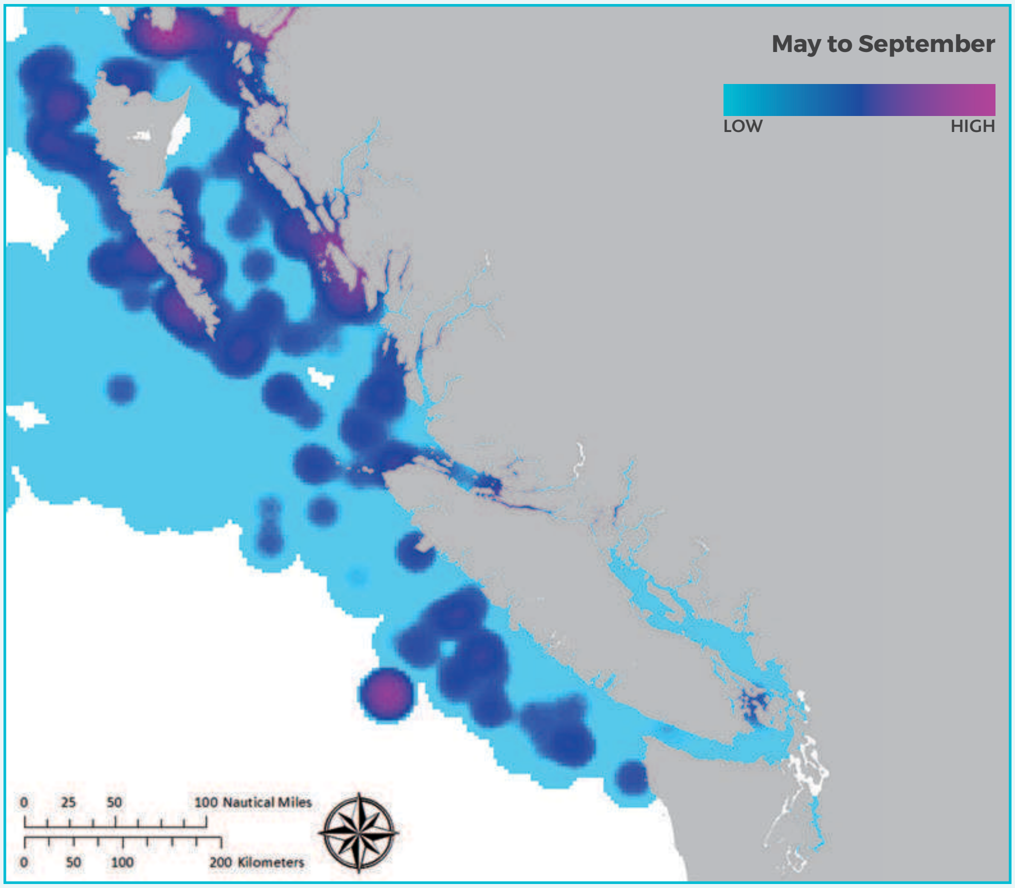
Behaviour
Usually travel in groups of 2-10 animals. Create "rooster-tail" of spray when swimming quickly. Often approach vessels to bow-ride.

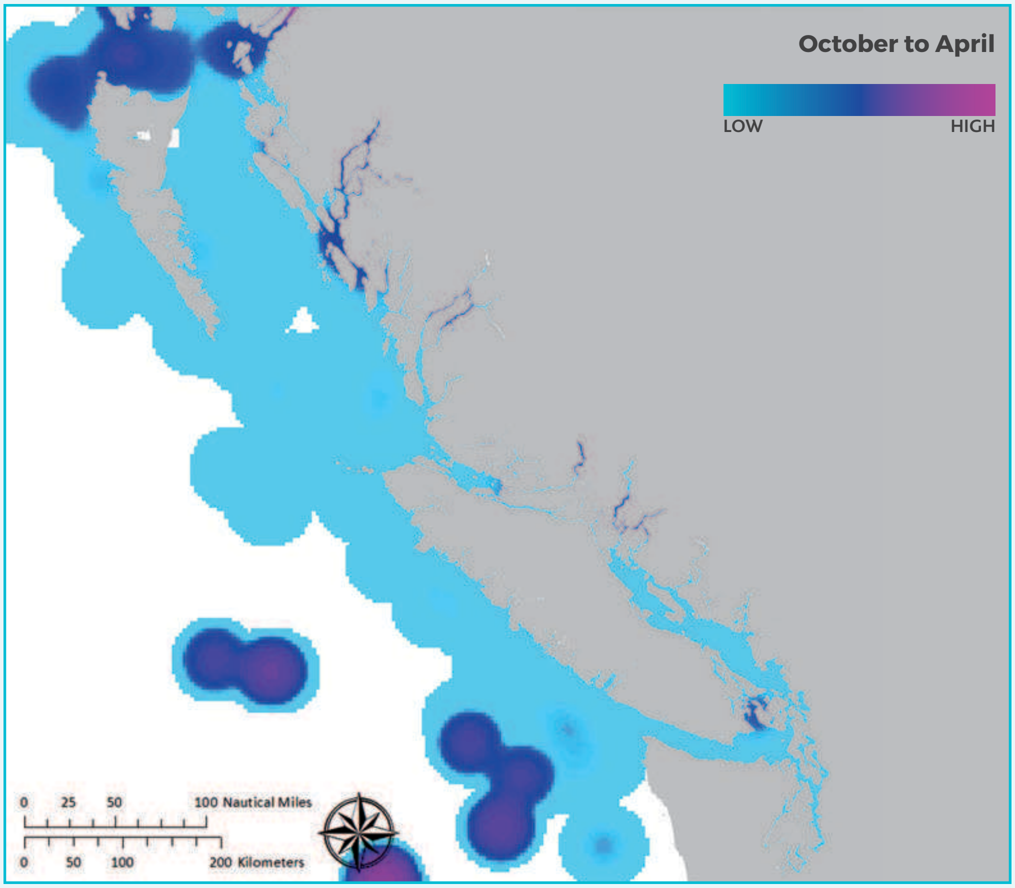
Distribution
Endemic to North Pacific Ocean and adjacent Bering, Okhotsk, and Japan Sea. Widely distributed year-round in B.C.

Vulnerability of the Species
Dall's porpoise have a tendency to approach vessels and bow-ride, which may increase the risk of vessel strike.

An additional threat to Dall's porpoise in B.C. is entanglement in fishing gear[19].

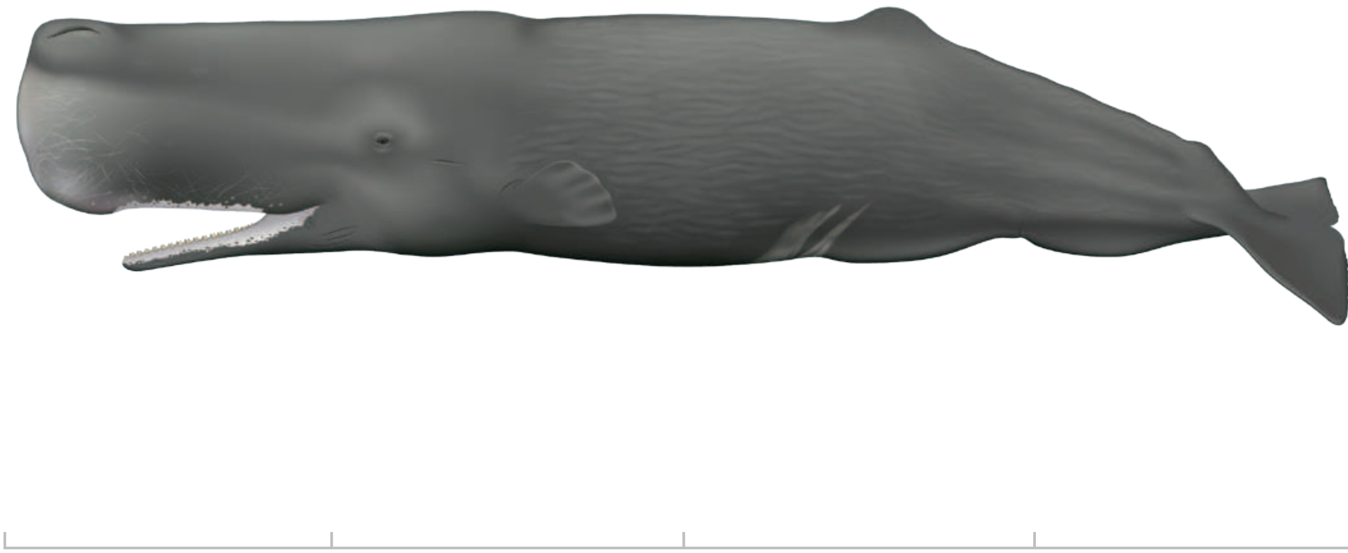
Relative Abundance of Dall's Porpoise in B.C. Waters





SPERM WHALE

Physeter macrocephalus



Average Adult Length: 11-13 m / 36-42 ft

COSEWIC Status 1996

Not at Risk	Special Concern	Threatened	Endangered	Extirpated
NR	SC	TH	EN	EX

Dorsal Fin

Triangular/rounded hump, followed by knuckles toward tail fluke.

Appearance

Dark brownish-grey in colour. Distinct, huge square-shaped head. Blowhole located very far forward on the head and on the left side (not centred). Skin appears wrinkled. Each half of tail fluke is the shape of a right triangle, with a distinctive "V" notch in the middle. Distinctive low, bushy blow from near the front of the head, angled to the left.

Behaviour

Lifts broad triangular trail flukes high in air before diving. Takes long dives, often 30-40 minutes in length.

Distribution

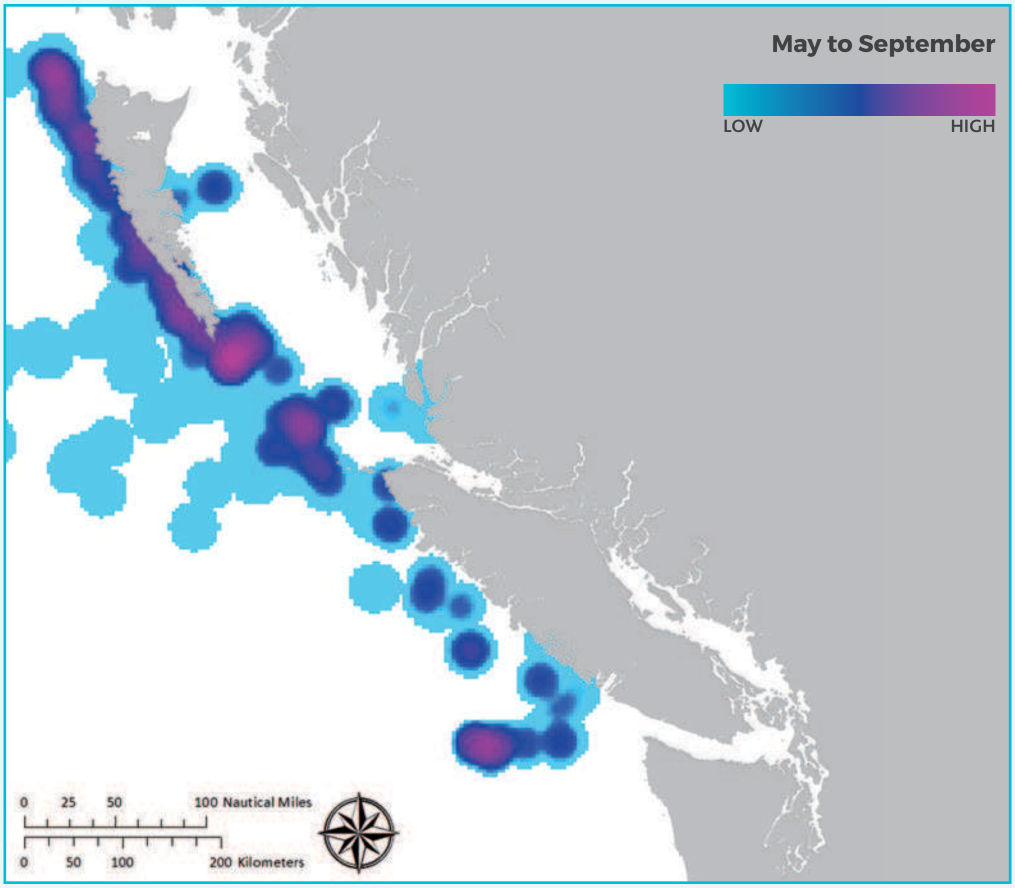
One of the most widespread cetaceans in the world. Found in productive coastal and deep waters surrounding oceanic islands. During the summer months, females and their young tend to be found further offshore than males. In B.C., primarily found along and off the continental shelf edge[19].

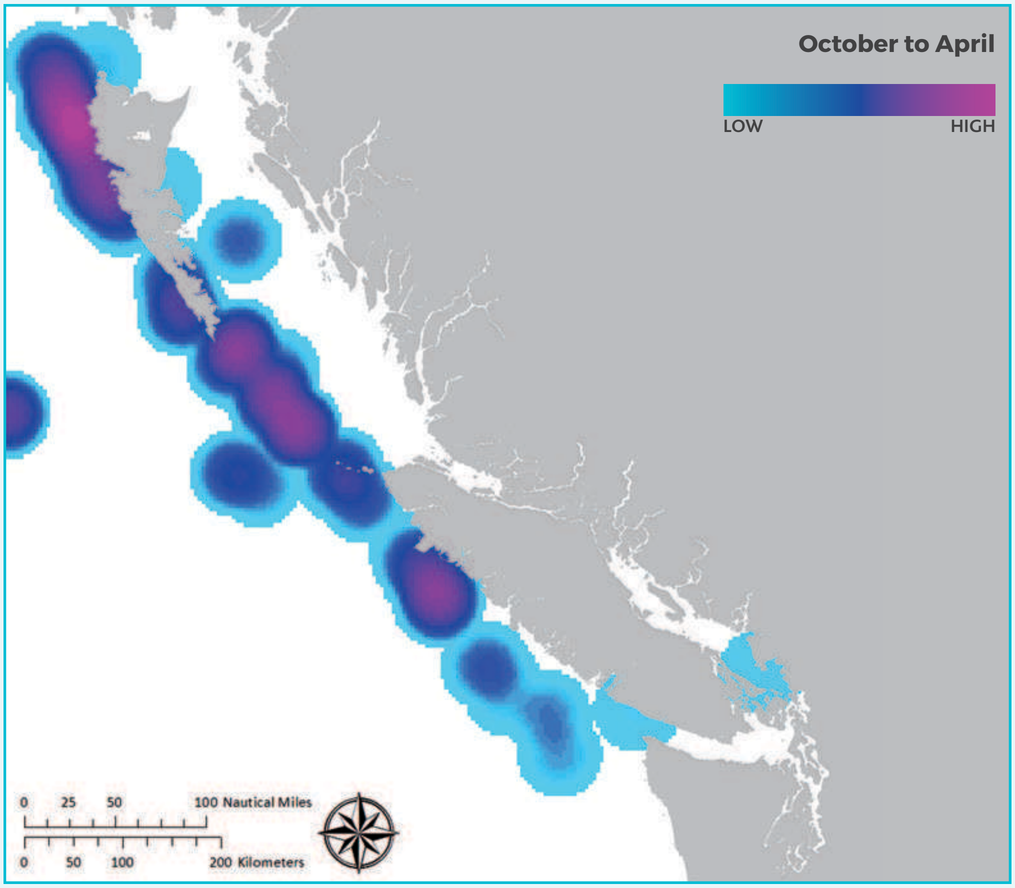
Vulnerability of the Species

Sperm whales are vulnerable to vessel strikes[29]. Strikes to this species may be underreported or observed due to their far offshore distribution, causing carcasses to sink before stranding (Spaven *et al*. 2013).

Further threats to sperm whales include depredation (whales taking fish off fishing lines) and ingestion of marine debris[19].

Relative Abundance of Sperm Whale in B.C. Waters





LESS COMMON TOOTHED WHALES

Northern Right Whale Dolphin

Lissodelphis borealis

Average Adult Length: 2-3 m / 7-10 ft

Description
Slender black body with white belly. Prominent beak with white tip. Only dolphin species in the North Pacific with no dorsal fin. Very small pectoral flippers often held close to the body.

Risso's Dolphin

Grampus griseus

Average Adult Length: 4 m / 13 ft

Description
Grey body, often with conspicuous lighter grey scratches all over. Heavily scarred individuals appear almost white. Dorsal fin is large. Dorsal fin and pectoral flippers are a darker grey than body. Head appears to be blunt with a prominent forehead. No beak visible. Forehead has distinctive furrow down the centre.

False Killer Whale

Pseudorca crassidens

Average Adult Length: 5-6 m / 16-20 ft

Description
Body is completely black with no white or grey markings. Dorsal fin is small and curved. Pectoral fins bulge along front edge. Rounded and prominent forehead.

Baird's Beaked Whale

Berardius bairdii

Average Adult Length: 10 m / 33 ft

Description
Brownish-grey back with irregular white patches on the belly. Adults may show linear scarring. Dorsal fin is slightly rounded and short, located 2/3 of the way down body. Adults have protruding teeth visible on the front of their lower jaw, which extends beyond the upper jaw. Long, prominent beak with a bulging forehead.

Cuvier's Beaked Whale

Ziphius cavirostris

Average Adult Length: 5-6 m / 16-20 ft

Description
Rusty brown to slate grey back with white head. Small white circular scars and heavy linear scarring may be evident. Dorsal fin is small, curved, and located 2/3 down body. Adult males may have visible protruding teeth on front of their lower jaw, which extends beyond upper jaw. Stubby head.

Other very rare species may occur off the coast of B.C. infrequently. If you feel that you have spotted one of these rare species, please take photos and alert the B.C. Cetacean Sightings Network as soon as possible at sightings@vanaqua.org or 1.866.I.SAW.ONE (1.866.472.9663).

RARE SPECIES

LONG-BEAKED COMMON DOLPHIN

Delphinus capensis

Average Adult Length: 2 m / 6.5 ft

SHORT-BEAKED COMMON DOLPHIN

Delphinus delphi

Average Adult Length: 2 m / 6.5 ft

STEJNEGER'S BEAKED WHALE

Mesoplodon stejnegeri

Average Adult Length: 5.5 m / 18 ft

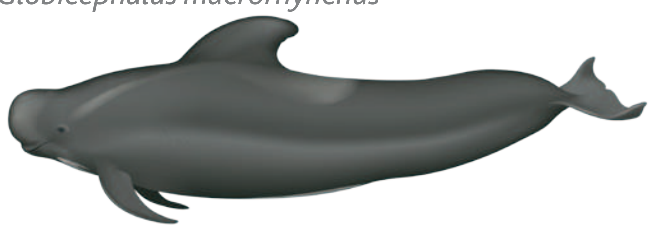
HUBB'S BEAKED WHALE

Mesoplodon carlhubbsi

Average Adult Length: 5 m / 16 ft

SHORT-FINNED PILOT WHALE

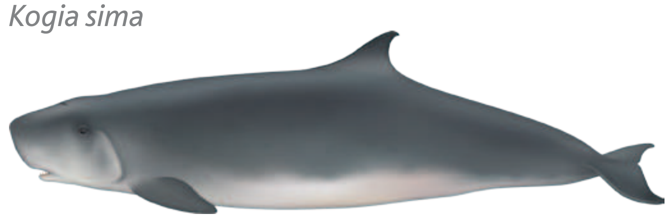
Globicephalus macrorhynchus



Average Adult Length: 5.5-7 m / 18-23 ft

DWARF SPERM WHALE

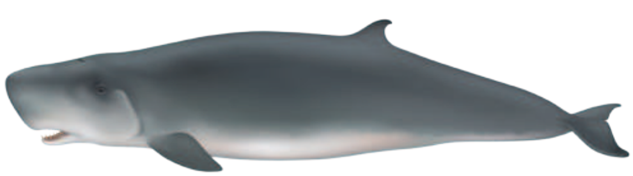
Kogia sima



Average Adult Length: 2.5 m / 8 ft

PYGMY SPERM WHALE

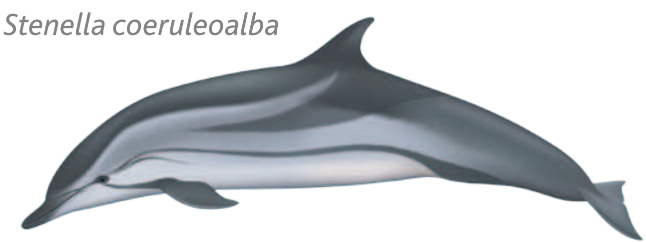
Kogia breviceps



Average Adult Length: 3.5 m / 11 ft

STRIPED DOLPHIN

Stenella coeruleoalba



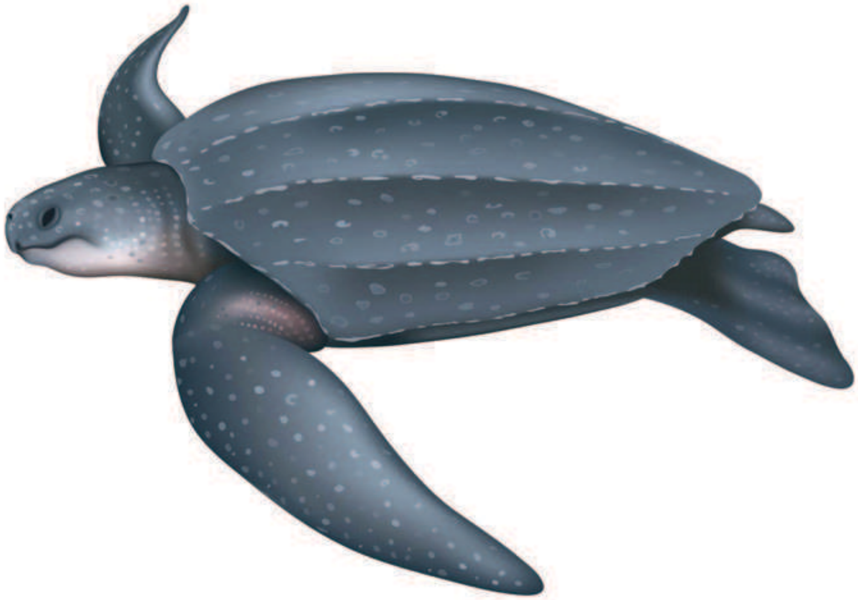
Average Adult Length: 2.5 m / 8 ft

Turtles

Scott Eckert

LEATHERBACK SEA TURTLE

Dermochelys coriacea



Average Adult Length: 3 m / 9 ft

SARA Status 2012

Not at Risk	Special Concern	Threatened	Endangered	Extirpated
NR	SC	TH	**EN**	EX

Appearance

Body is dark grey to black and may be covered with many white spots. No hard shell is present, instead shell is leathery. Prominent ridges run down the back (looks similar to the underside of a boat). Body is tear-shaped and tapers to a point at the rear. A pink-orange spot may be visible on the back of the head. Often only the head and front 1/3 of the back are seen when surfacing.

Behaviour

Solitary. Surfaces to breathe for a few minutes after undertaking a long dive. Holds head above the water, then slowly sinks back down.

Distribution

Make extensive feeding migrations to the waters off B.C. from nesting beaches in tropical regions in Southeast Asia and the South Pacific. Most frequently seen off B.C.'s coast in offshore and coastal waters between July and September, but may be spotted year-round. Often observed in the same areas where *Mola mola* (sunfish), sharks, or large numbers of jellies are seen.

Vulnerability of the Species

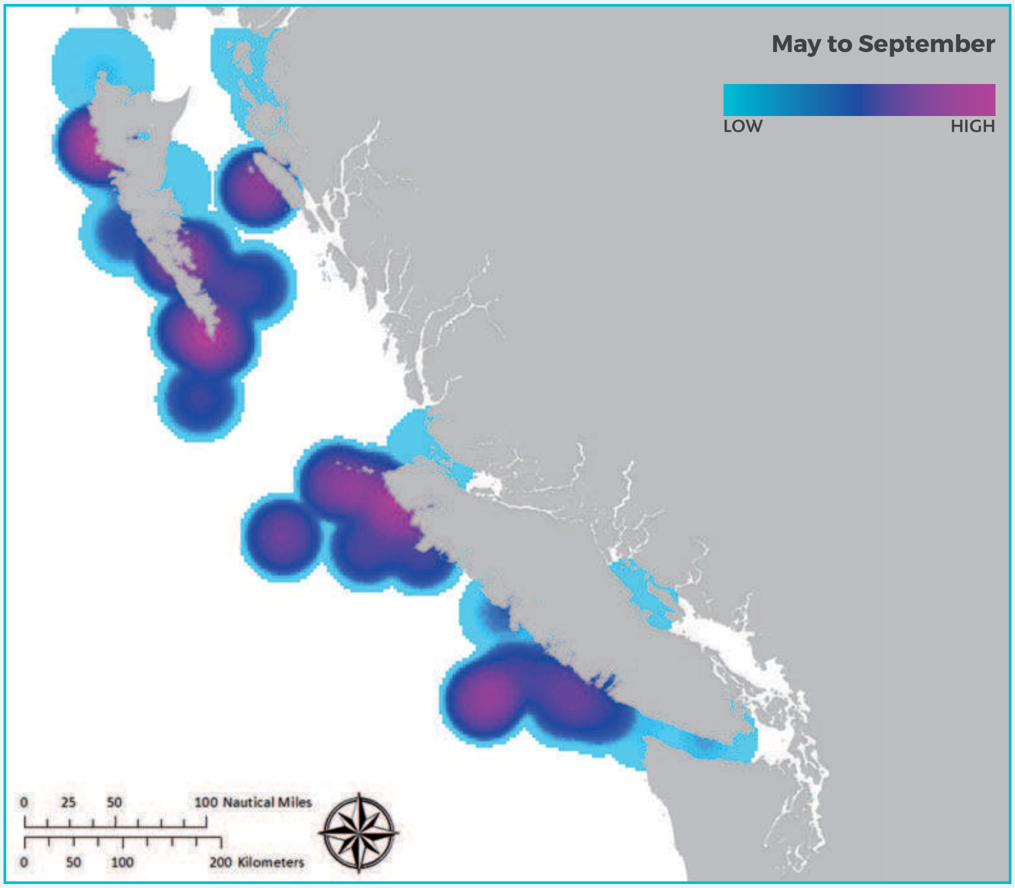
The endangered status of leatherback sea turtles make vessel strikes a particular concern, as mortality of even a few individuals can have a significant impact on their population status.

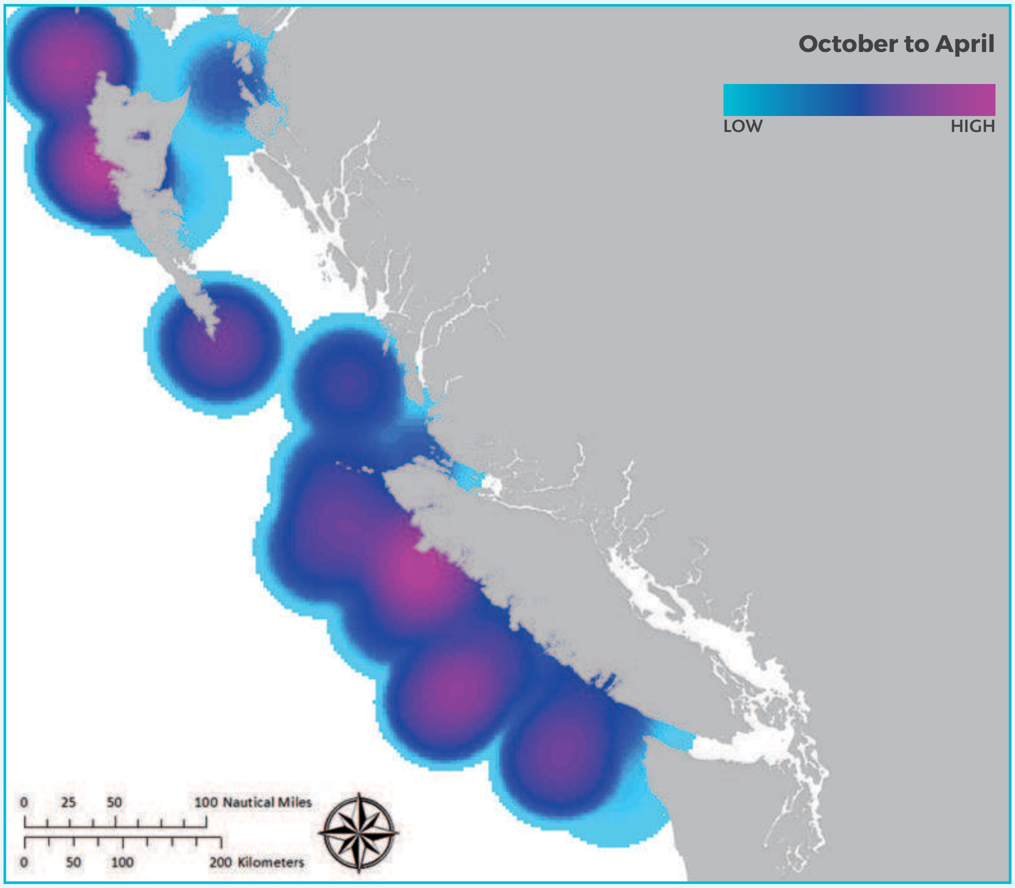
Leatherback sea turtles are a slow moving species, and spend a significant amount of time at or just below the surface when feeding and travelling, making them particularly vulnerable to vessel strikes[7].

Further threats to leatherback sea turtles include accidental capture, entanglement, ingestion of debris, diseases and parasites, predation, oil exploration and extraction, contamination, and aquaculture.

NOTE: While not a cetacean, leatherback sea turtles are included in this guide as they are a species found off the coast of B.C. that is vulnerable to vessel impacts. Any sightings of leatherback sea turtles (alive or dead) are very valuable to scientists, and should be reported immediately (see page 16).

Relative Abundance of Leatherback Sea Turtles in B.C. Waters

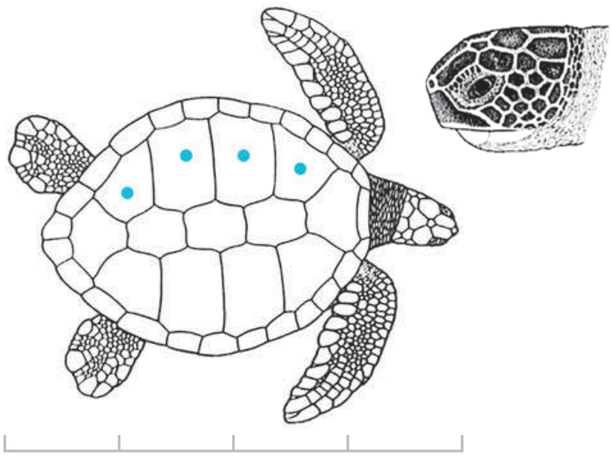




RARE SEA TURTLE SPECIES

GREEN SEA TURTLE

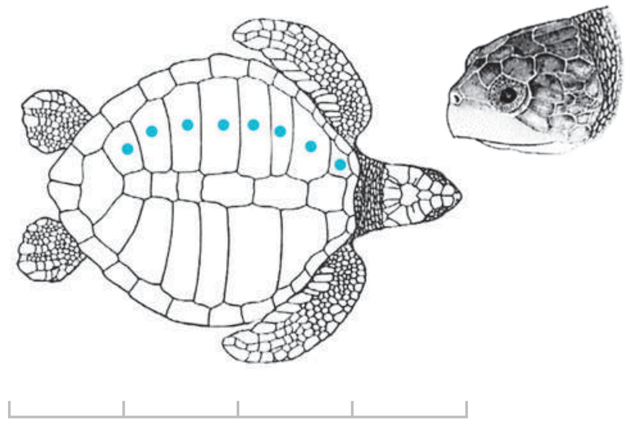
Chelonia mydas



Average Adult Length: 1.5 m / 5 ft

OLIVE RIDLEY SEA TURTLE

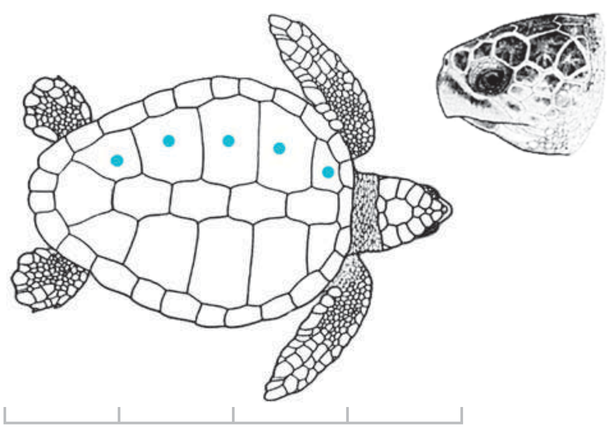
Lepidochelys olivacea



Average Adult Length: 1 m / 3 ft

LOGGERHEAD SEA TURTLE

Caretta caretta



Average Adult Length: 1.2 m / 4 ft

Bibliography

1. Berman-Kowalewski, M., Gulland, F.M.D., Wilkin, S., Calambokidis, J., Mate, B., Cardara, J., ... Dover, S. (2010). Associations between blue whales (*Balaenoptera musculus*) mortality and vessel strikes along the California Coast . *Aquatic Mammals Journal, 36,* 59-66.
2. Calambokidis, J., Schorr, G.S., Steiger, G.H., Francis, J., Bakhtiari, M., Marshall, G., ... Robertson, K. (2008). Insights into the underwater diving, feeding and calling behavior of blue whales from a suction-cup-attached video-imaging tag (Crittercam). *Marine Technology Society Journal, 41,* 19-29.
3. Carstensen, J., Henriksen, O.D., & Teilmann, J. (2006). Impacts of offshore wind farm construction on Harbour Porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs). *Marine Ecology Progress Series, 321,* 295-308.
4. Conn, P. & Silber, G. (2013). Vessel speed restrictions reduce risk of collision-related mortality for North Atlantic right whales. *Ecosphere, 4,* 43.
5. Culik, B.M., Koschinski, S., Tregenza , N., & Ellis, G.M. (2001). Reactions of harbor porpoises *Phocoena phocoena* and herring *Clupea harengus* to acoustic alarms. *Marine Ecology Progress Series, 211,* 255–260.
6. Douglas, A.B., Calambokidis, J., Raverty, S., Jeffries, S.J., Lambourn D.M., & Norman., S.A. (2008). Incidence of ship strikes of large whales in Washington State. *Journal of the Marine Biological Association of the United Kingdom, 88(6),* 1121-1132.
7. Eckert, S.A. (2002). Swim speed and movement patterns of gravid leatherback sea turtles (*Dermochelys coriacea*) at St. Croix, U.S. Virgin Islands. *Journal of Experimental Biology , 205,* 3689-3697.
8. Erbe, C. (2002). Underwater noise of whale-watching boats and potential effects on killer whales (*Orcinus orca*), based on an acoustic impact model. *Marine Mammal Science, 18,* 394-418.
9. Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K., & Dooling, R. (2016). Communication masking in marine mammals: A review and research strategy. *Marine Pollution Bulletin, 103*(1-2), 15-38.
10. Fisheries and Oceans Canada (2007). Recovery Strategy for the Transient Killer Whale (*Orcinus orca*) in Canada. *Species at Risk Act Recovery Strategy.* Vancouver: Fisheries and Oceans Canada. vi + 46 pp.
11. Fisheries and Oceans Canada (2009a). Management Plan for the Offshore Killer Whale (*Orcinus orca*) in Canada. *Species at Risk Act Management Plan Series.b.* Nanaimo: Fisheries and Oceans Canada. v + 49 pp.
12. Fisheries and Oceans Canada (2009b). Management Plan for the Pacific Harbour Porpoise (*Phocoena phocoena*) in Canada [FINAL]. *Species at Risk Act Management Plan Series.* Ottawa: Fisheries and Oceans Canada. v + 49 pp.
13. Fisheries and Oceans Canada (2010). Management Plan for the Grey Whale (*Eschrichtius robustus*) in Canada [Final]. *Species at Risk Act Management Plan Series.* Ottawa: Fisheries and Oceans Canada. v + 60pp.
14. Fisheries and Oceans Canada (2011a). Recovery Strategy for the North Pacific Right Whale (*Eubalaena japonica*) in Pacific Canadian Waters [Proposed]. *Species at Risk Act Recovery Strategy Series.* Ottawa: Fisheries and Oceans Canada. vii + 51 pp.
15. Fisheries and Oceans Canada (2011b). Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada. *Species at Risk Act Recovery Strategy Series.* Ottawa: Fisheries & Oceans Canada. ix + 80 pp.
16. Fisheries and Oceans Canada (2013). Recovery Strategy for the North Pacific Humpback Whale (*Megaptera novaeangliae*) in Canada. *Species at Risk Act Recovery Strategy Series.* Ottawa: Fisheries and Oceans Canada. x + 67 pp.
17. Fisheries and Oceans Canada (2016). [Proposed] Partial Action Plan for Blue, Fin, Sei and North Pacific Right Whales (*Balaenoptera musculus, B. physalus, B. borealis,* and *Eubalaena japonica*) in Canadian Pacific Waters. *Species at Risk Act Action Plan Series.* Ottawa: Fisheries and Oceans Canada. iv + 25 pp.
18. Ford, J.K.B., Durban, J.W., Ellis, G.M., Towers, J.R., Pilkington, J.R., Barrett-Lennard, L.G., & R.D. Andrews. (2013). New insights into the northward migration route of gray whales between Vancouver Island, British Columbia, and southeastern Alaska. *Marine Mammal Science, 29*(2), 325-337.
19. Ford, John. K. (2014). *Marine Mammals of British Columbia.* Victoria, B.C.: Royal B.C. Museum.
20. Gregr, E.J., Calambokidis, J., Convey, L. , Ford, J.K.B., Perry, R.I., Spaven, L., & Zacharias, M. (2006). Recovery Strategy for Blue, Fin, and Sei Whales (*Balaenoptera musculus, B. physalus,* and *B. borealis*) in Pacific Canadian Waters. *Species at Risk Act Recovery Strategy Series.* Vancouver: Fisheries and Oceans Canada. vii + 53 pp.
21. Heise, K., Personal Communication, April 2011 p.c (2011).
22. Hildebrand, J. (2009). Anthropogenic and natural sources of ambient noise in the ocean. *Marine Ecological Progress Series, 395,* 5-20.
23. Hildering, J., Personal Communication, July 5th, 2016 p.c. (2016).
24. Holt, M.M, Noren, D.P., Viers, V., Emmons, C.K., & Veirs, S. (2008). Speaking up: Killer whales (*Orcinus orca*). Increase their call amplitude in responce to vessel noise. *Journal of Acoustic Society of America, 125*, 27-32.
25. International Maritime Organization (2014). *Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life,* MEPC.1/Circ.833. London, U.K: IMO Publishing. 8pp.

25b. International Maritime Organization (2010). *Information on North American Emissions Control Area (ECA) Under Marpol Annex VI*, MEPC.1/Circ.723. London, U.K: IMO Publishing. 9pp.

26. Jensen, A.S. and G.K. Silber. 2003. Large Whale Ship Strike Database. *U.S. Department of Commerce, NOAA Technical Memorandum,* NMFS-OPR, 37 pp.
27. Koschinski, S., Culik, B. M., Henriksen, O.D., Tregenza, N.,Ellis, G., Jansen, C., & Kathe, G. (2003). Behavioural reactions of free-ranging porpoises and seals to the noise of a simulated 2 MW windpower generator. *Marine Ecology Progress Series, 265*, 263-273.
28. Lachmuth, C., Barrett-Lennard, L.G., Steyn, D.Q., & Milsom, W.K. (2010). Estimation of southern resident killer whale exposure to exhaust emissions from whalewatching vessels and potential adverse health effects and toxicity thresholds. *Marine Pollution Bulletin, 62*, 792-805.
29. Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., & Podesta, M. (2001). Collisions between ships and whales. *Marine Mammal Science 17*(1), 35-75.

30. Lammers, M.O., Pack, A.A., Lymans, E.G., & Expiritu, L. (2013). Trends in collisions between vessels and North Pacific humpback whales (*Megaptera novaeangliae*) in Hawaiian waters (1975-2011). *Journal of Cetacean Resource Management, 13*(1), 73-80.

31. Lusseau, D., & Bejder, L. (2007). The long-term consequences of short-term responses to disturbance experiences from whale watching impact assessment. *International Journal of Comparative Psychology, 20*, 228-236.

32. Lusseau, D., Bain, D.E., Williams, R., & Smith, J.C. (2009). Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*. *Endangered Species Research, 6*, 211–221.

33. McKenna, M. F., Calambokidis, J., Oleson, E. M., & Goldbogen, J. A. (2015). Simultaneous tracking of blue whales and large ships demonstrated limited behavioural responses for avoiding collision. *Endangered Species Research, 27*, 219-232.

34. Moore, M.J., McLellan, W.A., Daoust, P.Y., Bonde, R.K., & Knowlton, A.R. (2007). Right whale mortality: a message from the dead to the living. In S. D. Kraus and R. M. Rolland (Eds.), *The urban whale: North Atlantic right whales at the crossroads* (358-379). Cambridge, MA: Harvard University Press.

35. Neilson, J.L., Gabriele, C.M., Jensen A.S., Jackson, K., & Straley, J.M. (2012). Summary of Reported Whale-Vessel Collisions in Alaskan Waters. *Journal of Marine Biology, 2012*, 18.

36. NOAA/Fisheries and Oceans Canada (2011). "Be Whale Wise: Stay 100 Yards Away." Be Whale Wise. Retrieved from http://www.bewhalewise.org/new-regulations/

37. Noren D. P., Johnson A. H., Rehder D., & Larson, A. (2009). Close approaches by vessels elicit surface active behaviours by southern resident killer whales. *Endangered Species Research, 8*, 179-192.

38. Nowacek, D.P., Thorne, L.H., Johnston, D.W. & Tyack, P.L. (2007). Responses of cetaceans to anthropogenic noise. *Mammalian Review, 37*(2),81-115.

39. O'Hara, P.D. & Morgan, K.H. (2006). Do low rates of oiled carcass recovery in beached bird surveys indicate low rates of ship-source oil spills. *Marine Ornithology, 34*, 133-40.

40. Olesiuk, P. F., Nichol, L. M., Sowden, M. J., & Ford, J. K. B. (2002). Effect of the sound generated by an acoustic harassment device on the relative abundance and distribution of harbour porpoises (*Phocoena phocoena*) in Retreat Passage, British Columbia. *Marine Mammal Science, 18*, 843-862.

41. Pabst, D. A., Read, A.J., & Rolland, R.M. (2005). North Atlantic Right Whales in Crisis. *Science, 309*, 561-562.

42. Panigada, S., Pesante, G., Zanardelli, M., Capoulade, F., Gannier, A., & Weinrich, M. (2006). Mediterranean fin whales at risk from fatal ship strikes. *Marine Pollution Bulletin, 52*, 1287-1298.

42b. Province of British Columbia (2016). "Marine Emissions". B.C. Air Quality. Retrieved from: http://www.bcairquality.ca/topics/marine-emissions.html)

43. Rechsteiner, E.U., Birdsall, C.F.C., Sandilands, D., Smith, I.U., Phillips, A.V., & Barrett-Lennard, L.G. (2013). Quantifying observer effort for opportunistically-collected wildlife sightings. *BC Cetacean Sightings Network: Technical Report*. Vancouver, B.C.: Vancouver Aquarium Marine Science Centre. 43 pp.

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

45. Ritter, F. (2012). Collisions of sailing vessels with cetaceans worldwide: First insights into a seemingly growing problem. *Journal of Cetacean Research and Management, 12*(2), 119-127.

46. Rolland, R. M., Parks, S. E., Hunt, K. E., Castellote M., Corkeron P.J., Nowacek D. P., … Kraus, S.D. (2012). Evidence that ship noise increases stress in right whales. *Proceedings of the Royal Society B, 279* (1737), 2363-2368.

47. Silber, GK., Slutsky, J., & Bettridge, S. (2010). Hydrodynamics of a ship/whale collision. *Journal of Experimental Marine Biology and Ecology, 391*, 10-19.

48. Spaven, L., Ford, J., Hargreaves, M., Cottrell, P., Raverty, S., Aberethy, R., & Stredulinsky, E. (2013). Occurrences of vessel strikes in Canadian Pacific waters from 2004-2011. *Manuscript submitted for publication*.

49. Species at Risk Act (2002, c. 29). Retrieved from the Justice Laws website : http://laws-lois.justice.gc.ca/eng/acts/S-15.3/page-1.html#h-1

50. Waring, G.T., Palka, D.L., Clapham, P.J., Swartz, S., Rossman, M.C., Cole, T.V.N., Bisack, K.D. & Hansen, L.J. (1999). US Atlantic marine mammal stock assessments - 1998. *NOAA Technical Memorandum NMFS-NE, 116*, 151-9.

51. Watkins, W. (1986). Whale Reactions to human behaviours in Cape Cod waters. *Marine Mammal Science. 2* (4) 251-262.

52. Weinrich, M. (2005). A review of collisions between whales and whale watch boats. Scientific Committee at the 57th Meeting of the International Whaling Commission.

53. Williams,R., Bain, E.D., Ford, J.K.B., & Trites, A.W. (2002). Behavioural response of male killer whales to a 'leapfrogging' vessel. *Journal of Cetacean Research and Management. 4*(3), 305–310.

54. Williams, R., Lusseau, D., & Hammond, P. (2006). Estimating relative energetic costs of human disturbance to killer whales (*Orcinus orca*). *Biological Conservation, 133*(3), 301-311.

55. Williams, R., & O'Hara, P. (2010). Modelling ship strike risk to fin, humpback and killer whales in British Columbia, Canada. *Journal of Cetacean Research and Management 11*(1), 1-8.

56. Williams, R., Thomas, L. (2007). Distribution and abundance of marine mammals in the coastal waters of British Columbia, Canada. *Journal of Cetacean Research and Management 9*(1), 15-28.

PROJECT ADVISORS

BCFerries

CHAMBER of SHIPPING

BRITISH COLUMBIA COAST PILOTS

PPA

Fisheries and Oceans Canada Science | Pêches et Océans Canada Sciences

ROMM
RÉSEAU D'OBSERVATION DE MAMMIFÈRES MARINS

THIS PROJECT WAS UNDERTAKEN WITH THE FINANCIAL SUPPORT FROM:

PORT OF PRINCE RUPERT

PORT of vancouver

COASTAL OCEAN RESEARCH INSTITUTE

vancouver aquarium™