COSEWIC
Assessment and Update Status Report

on the

Killer Whale
Orcinus orca

Southern Resident population
Northern Resident population
West Coast Transient population
Offshore population
Northwest Atlantic / Eastern Arctic population

in Canada

Southern Resident population – ENDANGERED
Northern Resident population – THREATENED
West Coast Transient population – THREATENED
Offshore population – THREATENED
Northwest Atlantic / Eastern Arctic population – SPECIAL CONCERN
2008

COSEWIC
Committee on the Status of Endangered Wildlife in Canada

COSEPAC
Comité sur la situation des espèces en péril au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Previous reports:

COSEWIC. 2001. COSEWIC assessment and update status report on the Killer Whale *Orcinus orca* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 47 pp. (www.sararegistry.gc.ca/status/status_e.cfm)

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For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-953-3215
Fax: 819-994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

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Killer Whale — Illustration by A. Denbigh, courtesy of Fisheries and Oceans Canada.

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COSEWIC
Assessment Summary

Assessment Summary – November 2008

Common name
Killer Whale - Southern Resident population

Scientific name
Orcinus orca

Status
Endangered

Reason for designation
The population is small and declining, and the decline is expected to continue. Southern residents are limited by the availability of their principal prey, Chinook Salmon. There are forecasts of continued low abundance of Chinook Salmon. Southern residents are also threatened by increasing physical and acoustical disturbance, oil spills and contaminants.

Occurrence
Pacific Ocean

Status history
The “North Pacific resident populations” were given a single designation of Threatened in April 1999. Split into three populations in November 2001. The Southern Resident population was designated Endangered in November 2001. Status re-examined and confirmed in November 2008. Last assessment based on an update status report.

Assessment Summary – November 2008

Common name
Killer Whale - Northern Resident population

Scientific name
Orcinus orca

Status
Threatened

Reason for designation
The population is small, and is limited by the availability of its principal prey, Chinook Salmon. It is also at risk from physical and acoustical disturbance, oil spills and contaminants. However, this population has been increasing slowly but steadily since monitoring began in 1975.

Occurrence
Pacific Ocean

Status history
The “North Pacific resident populations” were given a single designation of Threatened in April 1999. Split into three populations in November 2001. The Northern Resident population was designated Threatened in November 2001. Status re-examined and confirmed in November 2008. Last assessment based on an update status report.

Assessment Summary – November 2008

Common name
Killer Whale - West Coast Transient population

Scientific name
Orcinus orca

Status
Threatened

Reason for designation
This population has a very small number of mature individuals (~122). It is subject to threats from high levels of contaminants, acoustical and physical disturbance, and potential oil spills. However, the population has been increasing since the mid-1970s when monitoring began, and its prey base of pinnipeds and cetaceans is likely stable or increasing.

Occurrence
Pacific Ocean

Status history
Designated Special Concern in April 1999. Status re-examined and designated Threatened in November 2001 and in November 2008. Last assessment based on an update status report.

Assessment Summary – November 2008

Common name
Killer Whale - Offshore population

Scientific name
Orcinus orca

Status
Threatened

Reason for designation
This population has a very small number of mature individuals (~120). It is subject to threats from high levels of contaminants, acoustical and physical disturbance, and potential oil spills. However, the population is monitored and appears to be stable.

Occurrence
Pacific Ocean

Status history
The “North Pacific resident populations” were given a single designation of Threatened in April 1999. Split into three populations in November 2001. The Offshore population was designated Special Concern in November 2001. Status re-examined and designated Threatened in November 2008. Last assessment based on an update status report.

Assessment Summary – November 2008

Common name
Killer Whale - Northwest Atlantic / Eastern Arctic population

Scientific name
Orcinus orca

Status
Special Concern

Reason for designation
Threats to this population include hunting in Greenland, acoustical and physical disturbance, which will become greater as shipping traffic increases in the Arctic, and contaminants. This population's small size (fewer than 1000 mature individuals and likely less than 250) and the species' life history and social attributes justify designation as Special Concern.

Occurrence
Arctic Ocean, Atlantic Ocean

Status history
Species considered in April 1999 and in November 2001, and placed in the Data Deficient category. Re-examined in November 2008 and designated Special Concern. Last assessment based on an update status report.

COSEWIC
Executive Summary

Killer Whale
Orcinus orca

Southern Resident population
Northern Resident population
West Coast Transient population
Offshore population
Northwest Atlantic / Eastern Arctic population

Species information

Killer Whales, or Orcas *Orcinus* orca, are easily identified by their tall, triangular dorsal fin and their distinctive black and white colouration. Only one species is recognized, but the taxonomy of *Orcinus* is a subject of ongoing debate.

Designatable units

Five designatable units are recognized — one in eastern and northern Canada (1. Northwestern Atlantic and Eastern Arctic population), and four in the coastal and offshore waters of British Columbia (2. Northern Resident population, 3. Southern Resident population, 4. West Coast Transient population, and 5. Offshore population). Resident, Transient and Offshore Killer Whales differ morphologically, genetically and behaviourally (social, acoustic and foraging); and the four populations in British Columbia do not associate with each other. In the absence of detailed information, Killer Whales in the northwestern Atlantic and the eastern Canadian Arctic are considered to constitute a single population.

Distribution

Killer Whales occur in all of the world's oceans. In Canada, several designatable units are recognized. The West Coast Transient population occurs throughout the coastal waters of British Columbia (BC); the Southern Resident population is generally found around southern Vancouver Island in summer and fall, although the animals may range widely at other times of year; and the Northern Resident population occurs from central Vancouver Island north to southeastern Alaska in summer and fall. The ranges of the Southern and Northern Resident populations at other times of the year are not well known. Offshore Killer Whales are seen less frequently but are known to travel

widely in coastal waters. The distribution of Killer Whales in the northwestern Atlantic and eastern Arctic is not well documented, but they are widespread and sightings are reported most commonly in the coastal waters of Newfoundland, likely due in part to the relatively concentrated sighting effort there.

Habitat

Killer Whales can tolerate wide ranges of salinity, temperature and turbidity, and their distribution appears to be determined mainly by the distribution and accessibility of their prey. Receding sea ice appears to be making new habitat (and prey resources) available to Killer Whales in the Arctic.

Biology

Killer Whales are long-lived, upper trophic-level predators. Individuals can be distinguished by scars and variations in pigmentation and dorsal fin shape. Life history parameters for the Resident populations in British Columbia have been estimated based on more than 30 years of photo-identification studies. It is not known how well these apply to other populations. Longevity is 80 years for females and 40-50 years for males respectively. Females give birth to their first calf between 12-17 years of age and produce a single calf every 5 years. The generation time is 26-29 years. Females more than 40 years old have an extended period of reproductive senescence. Resident Killer Whales are exceptional among marine mammals in that there is no dispersal of individuals of either sex from the natal group. This does not appear to be true for Transient Killer Whales.

Although they are known to feed on a large number of prey species, the Resident and Transient populations have remarkably different diets. Resident Killer Whales feed on fish, particularly Chinook and Chum Salmon, whereas Transient Killer Whales feed on marine mammals. The diet of Offshore Killer Whales is not as well understood. Killer Whales in the northwestern Atlantic and eastern Canadian Arctic have been observed feeding on marine mammals and fish.

Population sizes and trends

There were 70 Southern Residents in 1974 and 132 Northern Residents in 1975, and in 2006 there were 85 and 244, respectively. The population of Northern Residents has continued to increase fairly steadily since monitoring began in the mid-1970s, whereas that of Southern Residents, while it also increased fairly steadily through the mid-1990s, has been mostly declining since then. Both populations have shown annual increases or declines of up to ~3% for several years in a row. The West Coast Transient population has been increasing in recent years and consisted of an estimated 243 whales in 2006. The Offshore population is estimated at more than 288 whales, although Offshore Killer Whales have not been encountered frequently enough to provide trend data. The number of Killer Whales in the Northwestern Atlantic / Eastern Arctic is unknown.

Limiting factors and threats

The carcasses of Killer Whales are rarely recovered, and much of what is known about the threats they face is inferred using a weight-of-evidence approach. Pacific coast Killer Whales live in small, discrete populations that are inherently vulnerable to increases in mortality or decreases in reproduction. Exchange and interbreeding among these populations appears to be extremely rare, and this limits or prevents any genetic and/or demographic rescue effect. As a result of their fixed dietary specializations, Residents and Transients are vulnerable to decreases in the quantity or quality of prey. It is not known if the Offshore or Northwestern Atlantic / Eastern Arctic populations specialize in similar ways.

The principal anthropogenic threats to northeastern Pacific populations of Killer Whales are disturbance (physical and acoustic), prey depletion, and contaminants. These threats may act synergistically. Oil spills, collisions with vessels, interactions with commercial fisheries and climate change also may affect Killer Whales. A number of these threats likely apply to Killer Whales in the Northwestern Atlantic and Arctic. Killer Whales, likely from the Northwestern Atlantic / Eastern Arctic population, are hunted in western Greenland.

Special significance of the species

Killer Whales have iconic status with both Aboriginal people and the Canadian public. They are the focus of tourism, particularly on the Pacific coast of Canada, and are displayed in aquaria around the world. Although the total number of Killer Whales off the BC coast exceeds 500 individuals, they are distributed among 4 discrete populations that do not interact, and as a result the species requires complex conservation strategies. Many traits of Killer Whales, such as the lack of dispersal in Residents, an extended period of reproductive senescence, and extremely strong cultural traditions, are unusual in marine mammals.

Existing protection or other status designations

In Canada, Killer Whales are protected under the Marine Mammal Regulations of the *Fisheries Act*. The status of the five Killer Whale populations in Canada was evaluated in 2001, and four were listed under the *Species At Risk Act*. The Southern Resident population was listed as *Endangered*, the Northern Resident population and the West Coast Transient population as *Threatened* and the Offshore population as *Special Concern*. The Northwestern Atlantic / Eastern Arctic population was considered *Data Deficient*.

COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2008)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.

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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

Update
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Killer Whale
Orcinus orca

Southern Resident population
Northern Resident population
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Offshore population
Northwest Atlantic / Eastern Arctic population

in Canada

2008

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SPECIES INFORMATION

Name and classification

Killer Whales, or Orcas *Orcinus orca*, are members of the dolphin family Delphinidae (suborder Odontoceti, order Cetacea). In the past, other English names for the Killer Whale included grampus, swordfish, thrasher, and blackfish. French names for the Killer Whale include 'orque' and 'épaulard'. In Inuktitut, the Killer Whale is known as 'aarluk'.

Off the Pacific coast, three sympatric, morphologically and genetically distinct assemblages[1] of Killer Whales are recognized. These are known as 'Resident', 'Transient' and 'Offshore', and they differ in their dietary preferences, genetics, and social, acoustic and foraging behaviour. At present, only one population of Killer Whale is recognized in eastern Canadian Arctic and Atlantic waters.

Morphology

The size, striking black and white colouration and tall dorsal fin make the Killer Whale one of the most recognizable cetaceans (Figure 1). Killer Whales are sexually dimorphic, and the maximum recorded body lengths of males and females are 9.0 m and 7.7 m respectively (Dahlheim and Heyning 1999). The maximum recorded masses are 6,600 kg for a 7.65 m male and 4,700 kg for a 6.58 m female from Japanese waters (Yamada *et al.* 2007). In the eastern North Pacific, the dorsal fin of males can reach a height of approximately 1.8 m, whereas those of females and juveniles reach 0.9 m or less. The flippers and tail flukes are also longer in males than in females (Bigg *et al.* 1987). At the base of the dorsal fin is a grey-white area known as the saddle patch. Each Killer Whale is individually recognizable based on its uniquely shaped dorsal fin and saddle patch, as well as naturally acquired nicks and scars on its dorsal fin and saddle (Ford *et al.* 2000).

Figure 1. Male Killer Whale. Illustration by A. Denbigh, courtesy of Fisheries and Oceans Canada.

[1] A population assemblage is a set of populations belonging to a common genetic lineage.

There appear to be slight differences in the morphology of Killer Whales from different populations. In the Pacific, Resident, Transient and Offshore Killer Whales differ slightly in their dorsal fin shape and saddle patch pigmentation (Ford *et al.* 2000). The dorsal fins of Transients tend to be pointed and their saddle patches are large and uniformly grey. In contrast, the dorsal fins of Residents tend to be rounded at the leading edge and have a fairly abrupt angle at the trailing edge. Their saddle patches are more variable than those of Transients and may be uniformly grey or contain a black region. The dorsal fins of Pacific Offshore Killer Whales are similar to those of residents, but are more rounded at the trailing edge of the tip. Offshore Killer Whales also appear to be smaller than Resident and Transient Killer Whales.

Genetic description

Globally, Killer Whales have low diversity at nuclear and mitochondrial loci, and genetic linkages between ecologically similar populations from different ocean basins have not been found (Barrett-Lennard and Ellis 2001; Hoelzel *et al.* 1998, 2002, 2007). Known patterns of genetic diversity in Killer Whales are consistent with both a species that recently began an extensive adaptive radiation into a variety of new areas (possibly following a bottleneck, Hoelzel *et al.* 2002) and a species with a strong propensity to live in reproductively and socially isolated populations of at most a few hundred individuals (Barrett-Lennard 2000). The two views are not mutually exclusive but they support different conclusions regarding whether to split the species or leave it lumped. The subject of Killer Whale taxonomy is under review and multiple species or subspecies could be recognized in the near future. The present consensus is that *Orcinus orca* is best described as a species complex[2] (Reeves *et al.* 2004).

Designatable units

Five Designatable Units (DUs) of Killer Whales are recognized in Canadian waters based on morphology, genetics, range, distribution, movements, acoustic behaviour, and feeding ecology. The five DUs are the 1) Northern Resident 2) Southern Resident 3) West Coast Transient 4) Offshore and 5) Northwestern Atlantic and Eastern Arctic populations (as per Baird 2001). Killer Whales seen in the western Canadian Arctic are considered extralimital; they come from a population centred in the Chukchi or Bering Sea.

The two Resident populations (Northern and Southern) in British Columbia (BC) do not associate although their ranges overlap. A third Resident population known as the 'Southern Alaska Residents' inhabits the waters from southeastern Alaska to the northern Gulf of Alaska. The known range of this population overlaps the northern extreme of the range of Northern Residents, but since it rarely if ever enters Canadian waters it is not considered a Canadian DU.

[2]A species complex is a cluster of closely related population assemblages that meet criteria defining them as separate species, such as reproductive isolation and ecological distinctiveness.

In the northeastern Pacific Ocean three populations of Transient Killer Whales have been described. West Coast Transients range from Washington State to southeastern Alaska, AT1 Transients have been sighted only in and near Prince William Sound and Kenai Fjords, Alaska, and Gulf of Alaska Transients are usually sighted in the central and western portion of the Gulf of Alaska (Ford and Ellis 1999; Barrett-Lennard and Heise 2006). Unlike the Resident populations, members of different Transient populations have been seen swimming in close proximity on several occasions. The three populations are distinguished by: 1) patterns of social association (members associate much more frequently with each other than with members of other populations), 2) differences in call repertoires, 3) genetic differences (nuclear and mitochondrial) and 4) differences in central range.

Sequences of the mitochondrial D-loop region (950 nucleotides) of the eastern North Pacific Killer Whale populations analysed by Barrett-Lennard and Ellis (2001) revealed a maximum of 1 nucleotide difference (0.1 % sequence divergence) between haplotypes within populations and a maximum of 11 nucleotide differences (1.2% sequence divergence) between haplotypes from different populations. These low levels of mitochondrial DNA diversity are similar to those reported for other odontocete species with matrilineal social organization (Whitehead 1998). Barrett-Lennard and Ellis found no mitochondrial haplotypes shared by Residents and Transients, consistent with findings by Stevens *et al.* (1989) and Hoelzel *et al.* (1998, 2007). The Southern and Northern Resident populations are each fixed for single, different haplotypes, both of which are also present in the Southern Alaska Resident population. West Coast Transients and AT1s are also fixed for single, different mitochondrial haplotypes, neither of which is shared with the Gulf of Alaska Transients, which have at least two haplotypes (Barrett-Lennard 2000; Barrett-Lennard and Ellis 2001). Transients in the eastern Aleutian Islands that likely belong to one or more additional populations have both the Gulf of Alaska and AT1 haplotypes (Barrett-Lennard unpublished data). A single haplotype has been found in the Offshore population (Barrett-Lennard and Ellis 2001).

The mitochondrial D-loop sequences described above define two well-separated clades, one containing Transient populations and the other Resident populations (Figure 2). This suggests that the Resident and Transient assemblages have existed as distinct entities with virtually no movement of females between them long enough for mutations to occur and become fixed within each – likely thousands of years. It is also consistent with contemporary observations of their apparently complete ecological and social segregation. Figure 2 shows that the Offshores and four Killer Whales from the Atlantic sequenced by Barrett-Lennard and Ellis (2001) are in the same mitochondrial clade as residents, and subsequent work by Hoelzel et al (2002) revealed that most Killer Whales sampled in other ocean basins cluster more closely with residents than transients. Transients therefore may have been isolated from other populations longer and/or more completely than Residents.

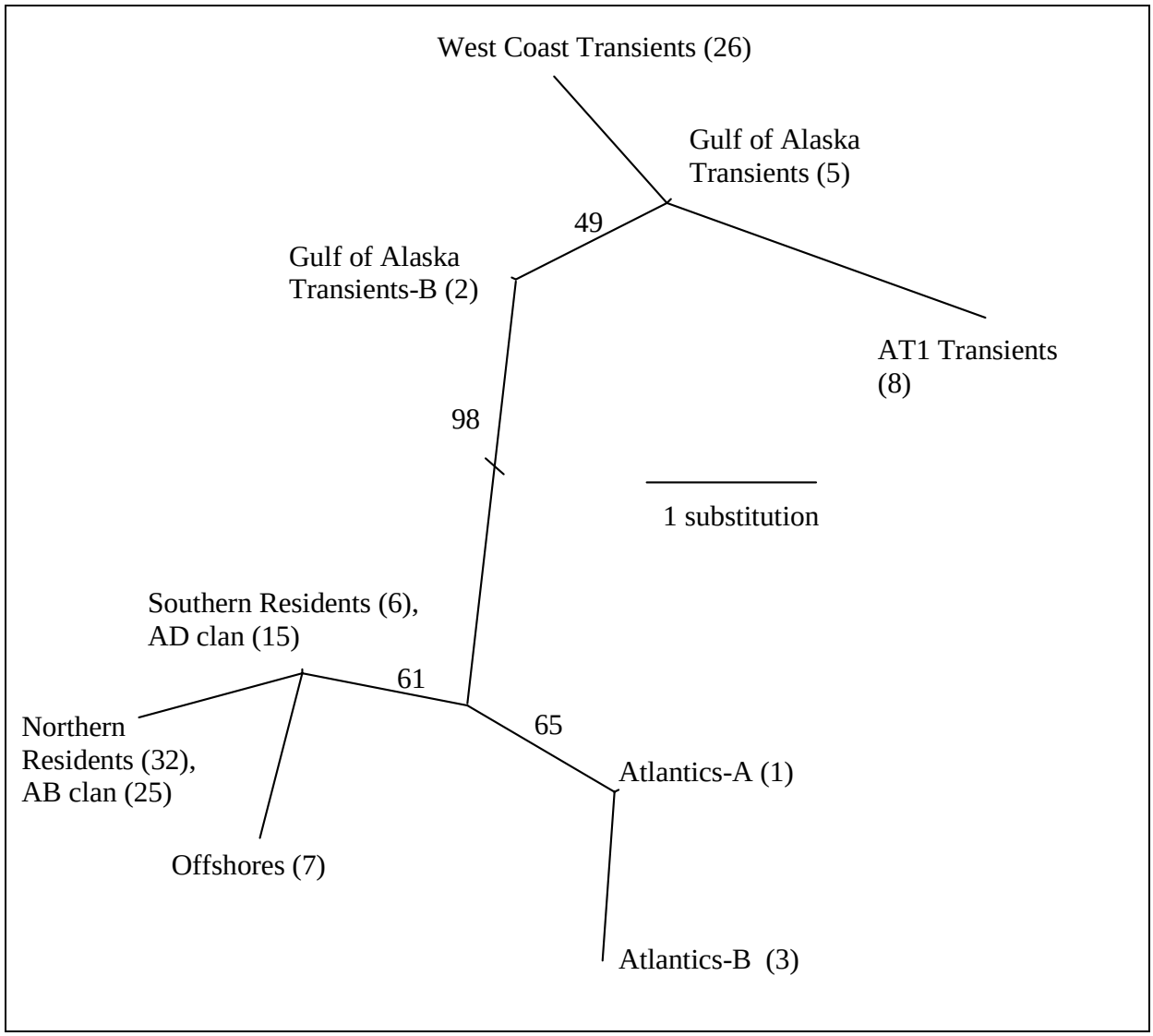

Figure 2. Maximum likelihood phylogram based on seven Pacific and two Atlantic Killer Whale mitochondrial D-loop haplotypes. The numbers on branches indicate percentage bootstrap support. The number of whales sequenced with each haplotype is shown in brackets. AB and AD refer to two acoustic clans of Alaska Residents. The suffixes A and B indicate two different haplotypes from the same subpopulation or, in the case of the Atlantics, the same ocean. The length of the longest branch was reduced by half in this drawing (Source: Barrett-Lennard and Ellis 2001).

Analysis of microsatellite markers presents a picture similar to that provided by mitochondrial DNA, and indicates that nuclear gene flow, including that mediated by males, has been extremely rare between resident and transient assemblages for many generations. Furthermore, it shows that divergence between the populations within each assemblage is more recent or less complete than the divergence between assemblages, providing strong evidence that Residents and Transients are monophyletic assemblages with their divergence traceable to a single event (Figure 3, Barrett-Lennard 2000; Barrett-Lennard and Ellis 2001).

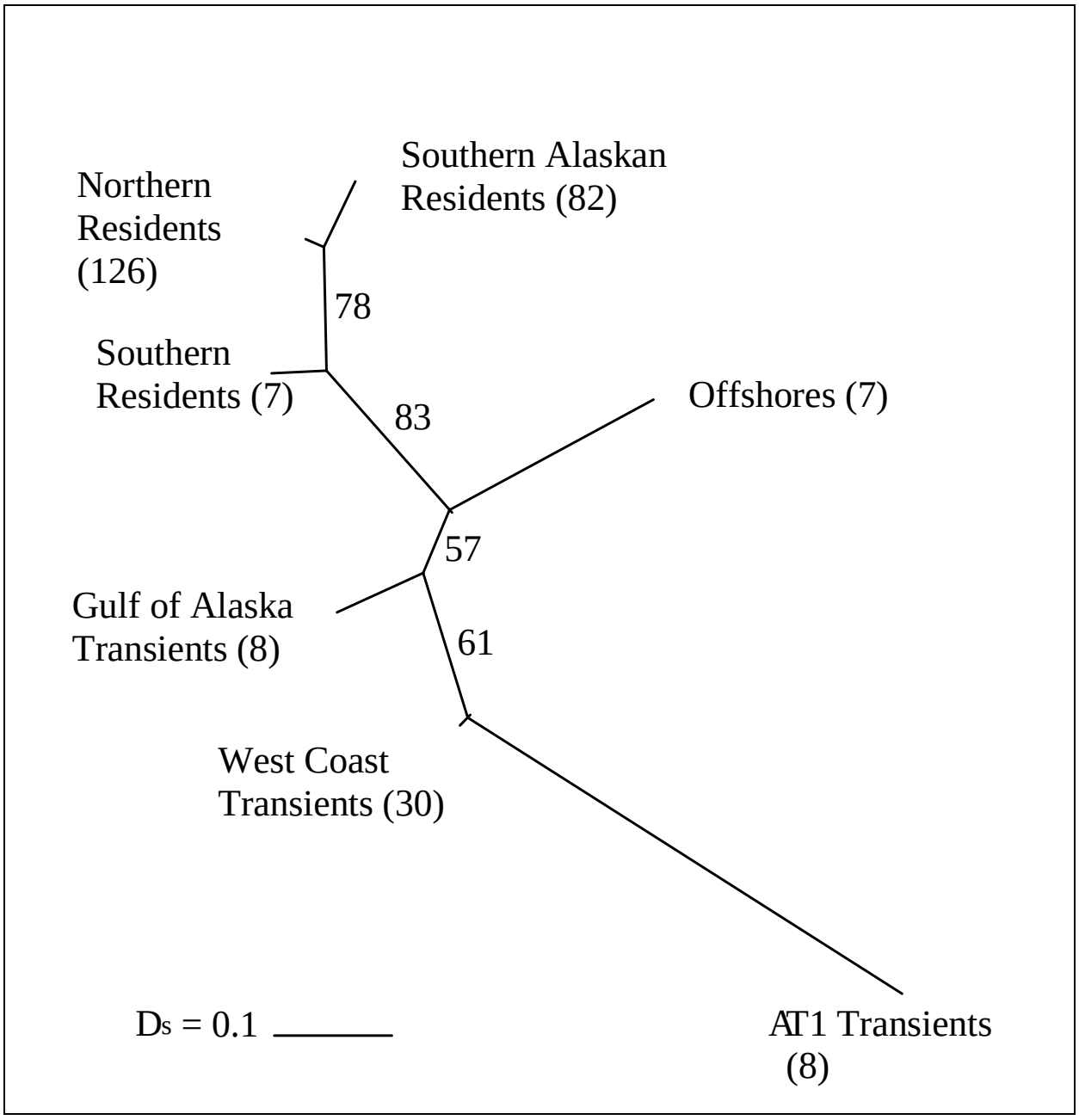

Figure 3. Unrooted neighbour-joining phylogram for Alaskan and British Columbian Killer Whales based on 11 microsatellite loci, using Nei's standard genetic distances. The numbers on the branches give percentage bootstrap support. When the Offshore population was removed, support for the Resident / Transient separation was 97% (Source: Barrett-Lennard and Ellis 2001). Sample sizes are in brackets.

Offshore Killer Whales are the least known of the three assemblages of Killer Whales in BC waters. They have not been observed interacting with Transients or Residents. The single haplotype shared by the relatively small number of Offshores sampled to date indicates that Offshore and Resident Killer Whales share more recent maternal ancestors with each other than they do with Transients (Figure 2) (Barrett-Lennard and Ellis 2001). However, nuclear DNA indicates a somewhat closer contemporary relationship with Transients than with Residents, and does not rule out the possibility of occasional intermatings (Figure 3) (Barrett-Lennard 2000, Barrett-Lennard and Ellis 2001).

Paternity tests indicate that Northern Residents effectively avoid mating with close kin, even though both males and females remain within their natal groups for life (Barrett-Lennard 2000). Most matings are between individuals that have few to no calls in common (i.e. they are said to be from different acoustic clans), and apparently occur during short periods when Resident Killer Whales from different clans associate (Barrett-Lennard 2000). Since call similarity and genetic relatedness are positively correlated, this mating system effectively minimizes inbreeding and allows small populations to persist without genetic exchange (Barrett-Lennard 2000). The mating patterns of Transient Killer Whales are unknown, but their relatively high levels of genetic diversity suggest that, like Northern Residents, matings between closely related individuals are rare, and Transient populations are just as genetically viable as Resident populations (Barrett-Lennard and Ellis 2001).

Other than records of sightings and a small number of strandings and kills, there is relatively little information on Killer Whales in the northwestern Atlantic and eastern Canadian Arctic, and they are considered a single DU for the purposes of this report. It is likely, judging by experience in other regions, that some form of structure or differentiation exists, but data presently available are insufficient to determine this. Mitochondrial DNA from a single whale from Newfoundland was similar to the Southern (BC) Resident mitochondrial haplotype (Hoelzel *et al.* 2002).

DISTRIBUTION

Global range

Killer Whales occur in all oceans, although they are most common in highly productive areas[3] (Forney and Wade 2006). In the northern hemisphere, concentrations have been found along the western coast of North America, around Iceland and the Faroe Islands, and along the northern coast of Norway. This probably reflects, at least to some extent, concentrations of Killer Whale researchers. For example, recent survey effort has documented much larger numbers of Killer Whales in other parts of the North Pacific, such as along the Aleutian Island chain (Matkin *et al.* 2007; Zerbini *et al.* 2007), in the Bering Sea (Waite *et al.* 2002), in Russian waters (Burdin *et al.* 2006) and in Newfoundland and Labrador (Lawson *et al.* 2007). In the southern hemisphere, they are commonly observed off the coasts of New Zealand, Tasmania, Argentina and southern Brazil. They are abundant in the Antarctic, particularly along the pack ice edge.

Canadian range

Killer Whales are present in all three of the oceans bordering Canada, as well as in Hudson Bay. The range in the Pacific is fairly well understood, particularly from spring through fall. Resident Killer Whales typically travel 1,500-2,000 km throughout their range (Ford 2006). The greatest recorded distance between sightings of an individual Transient Killer Whale is more than 2,600 km (Goley and Straley 1994). Members of a Killer Whale population may be spread over hundreds of kilometres at any given time. Relatively little is known about the range and distribution of northwestern Atlantic / Eastern Arctic Killer Whales, and information on winter ranges is lacking for all populations.

The Southern Resident population is known to range from the Queen Charlotte Islands (Haida Gwaii) in northern BC to Monterey Bay in California (Figure 4, Ford *et al.* 2000, Black *et al.* 2001, Cetacean Research Program, Fisheries and Oceans Canada, Nanaimo [hereafter CRP-DFO] unpublished data). The EO in Canadian waters is 220,000 km^2 and the AO is 99,549 km² (EO is calculated using a 2 km x 2 km grid, clipped within the Extent of Occurrence and Canada's Extent of Jurisdiction). The Northern Resident population is known to range from Glacier Bay, Alaska, to Grays Harbor, Washington (Figure 5, Ford *et al.* 2000, CRP-DFO unpublished data). Its EO in Canadian waters is estimated to be 290,000 km^2 and the AO is 144,357 km².

[3] Because Killer Whales are found in all of the world's oceans, a global distribution map was not included in this report.

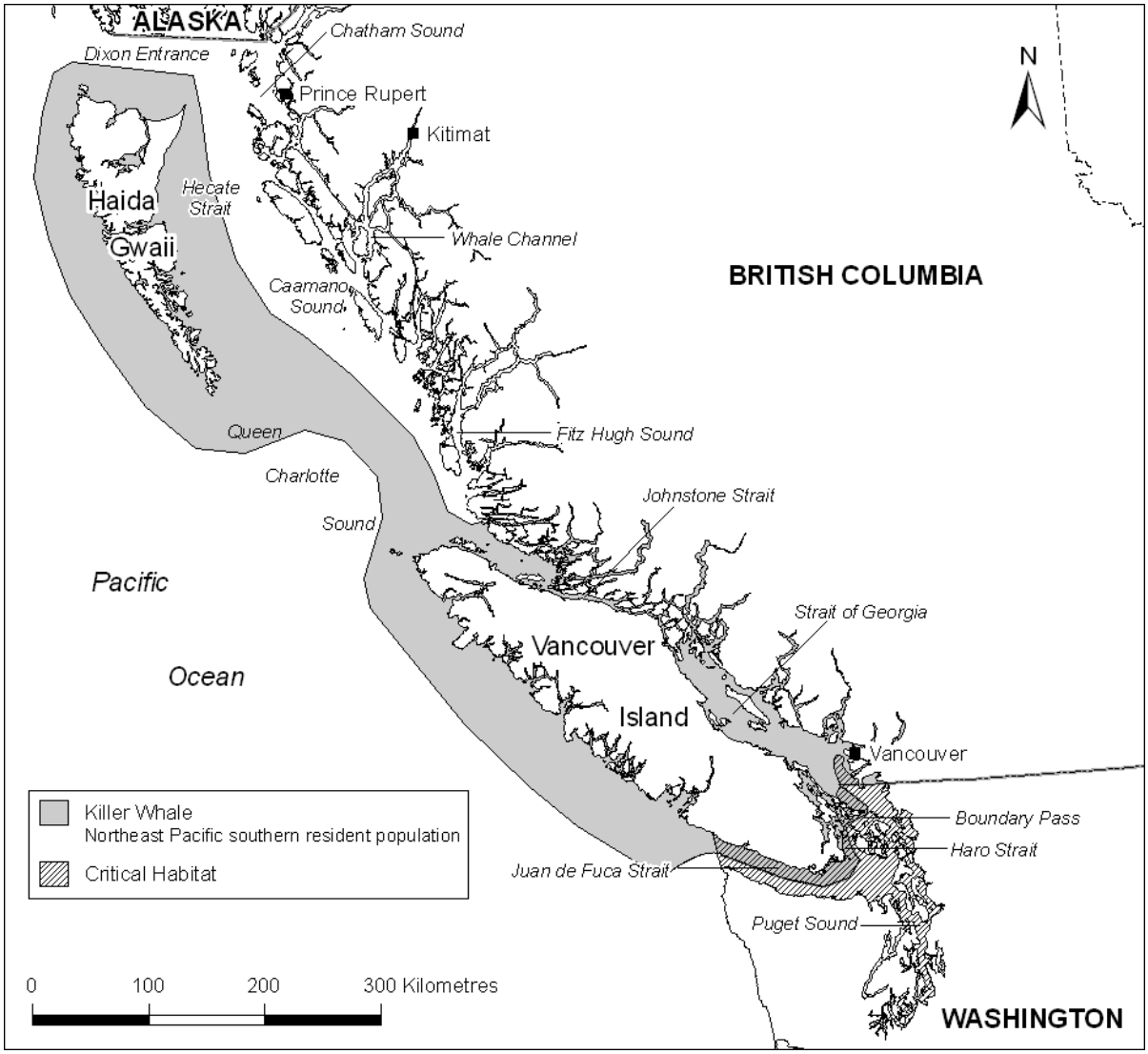

Figure 4. The range of Southern Resident Killer Whales in Canadian waters. In summer and fall Southern Resident Killer Whales are most frequently seen in the area designated as Critical Habitat, shown by diagonal lines (Fisheries and Oceans Canada 2008). In winter and spring, Southern Resident Killer Whales range widely, from Haida Gwaii (Queen Charlotte Islands) in the north to Monterey Bay, California, in the south. (Sources: Ford *et al.* 2000, Black *et al.* 2001, CRP-DFO unpublished data).

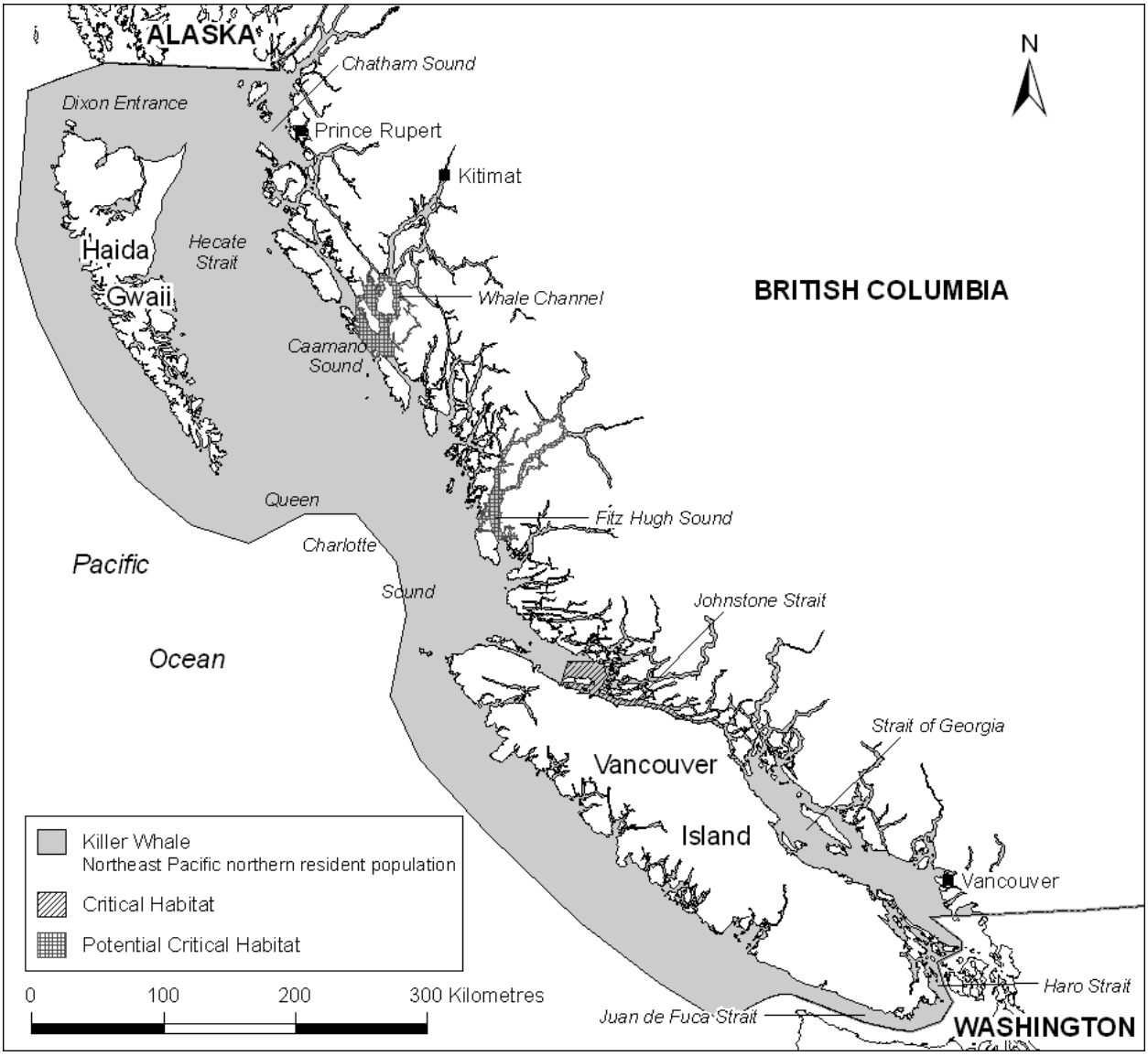

Figure 5. The range of the Northern Resident Killer Whale population in Canadian waters. From spring through mid-summer, members of this population are frequently found in Chatham Sound, Caamaño Sound and Fitz Hugh Sound, areas that have been identified as potential Critical Habitat (Ford 2006). In summer and fall, Northern Resident Killer Whales are often found in the Johnstone Strait area, and this area has been designated as Critical Habitat (Fisheries and Oceans Canada 2008). In winter and spring, Northern Resident Killer Whales are known to range widely, from Glacier Bay, Alaska, to Gray's Harbour, Washington, and up to 50 km from shore. (Sources: Ford *et al.* 2000, CRP-DFO unpublished data).

The West Coast Transient population ranges from Washington to southeastern Alaska (Figure 6, CRP-DFO unpublished data). Its EO is estimated to be 290,000 km^2 and the AO is 154,986 km².

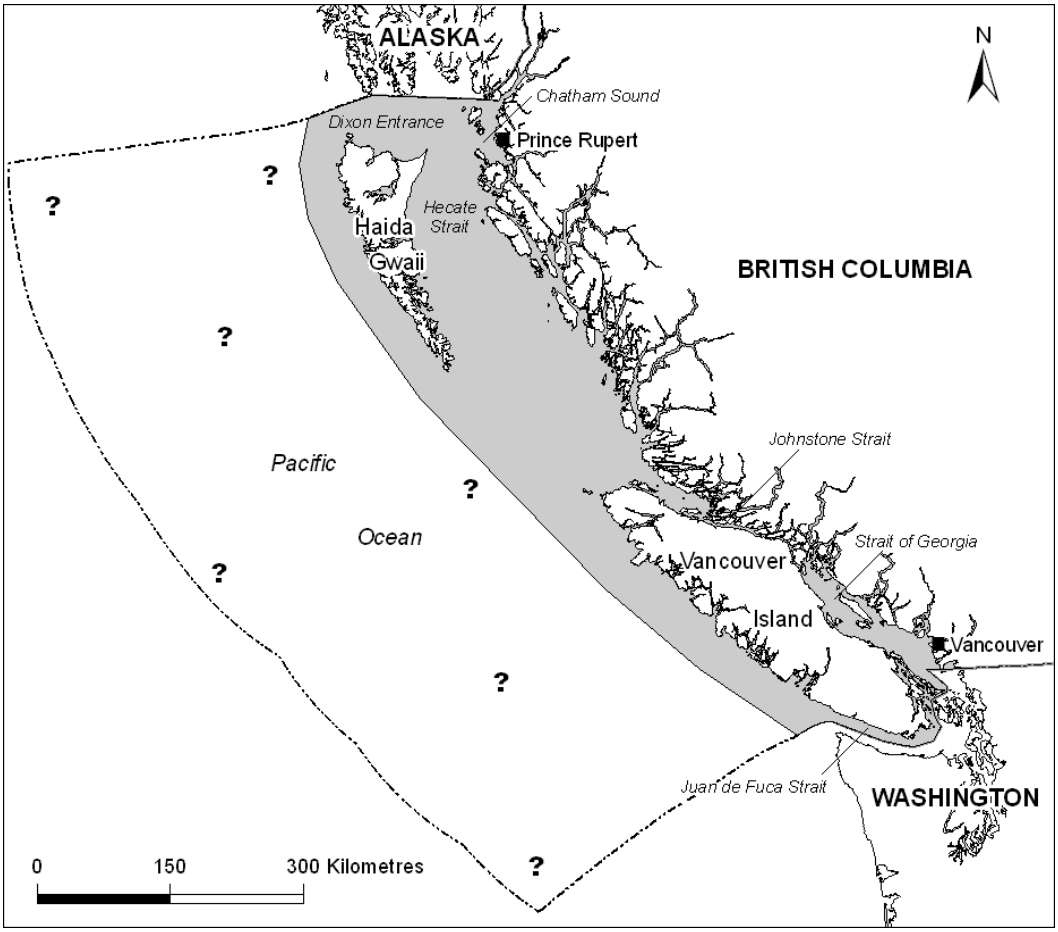

Figure 6. The range of the West Coast Transient Killer Whale population in Canadian Pacific waters. The whales can be found from Washington to southeastern Alaska. It is not known how far offshore they occur, thus uncertainty regarding the western limit of their range is shown by '?'. This area is not included in the estimates of EO and AO. (Source: CRP-DFO unpublished data).

Offshore Killer Whales are observed most frequently off the outer coast but occasionally travel in inside waters (Figure 7, Ford *et al.* 2000). They have been observed in the eastern Aleutian Islands (Krahn *et al.* 2007) and as far south as the Channel Islands near Los Angeles (CFP-DFO unpublished data). The extent to which their range extends westward into the Pacific is unknown. The EO is estimated to be 300,000 km^2 in Canadian waters and the AO is 170,490 km².

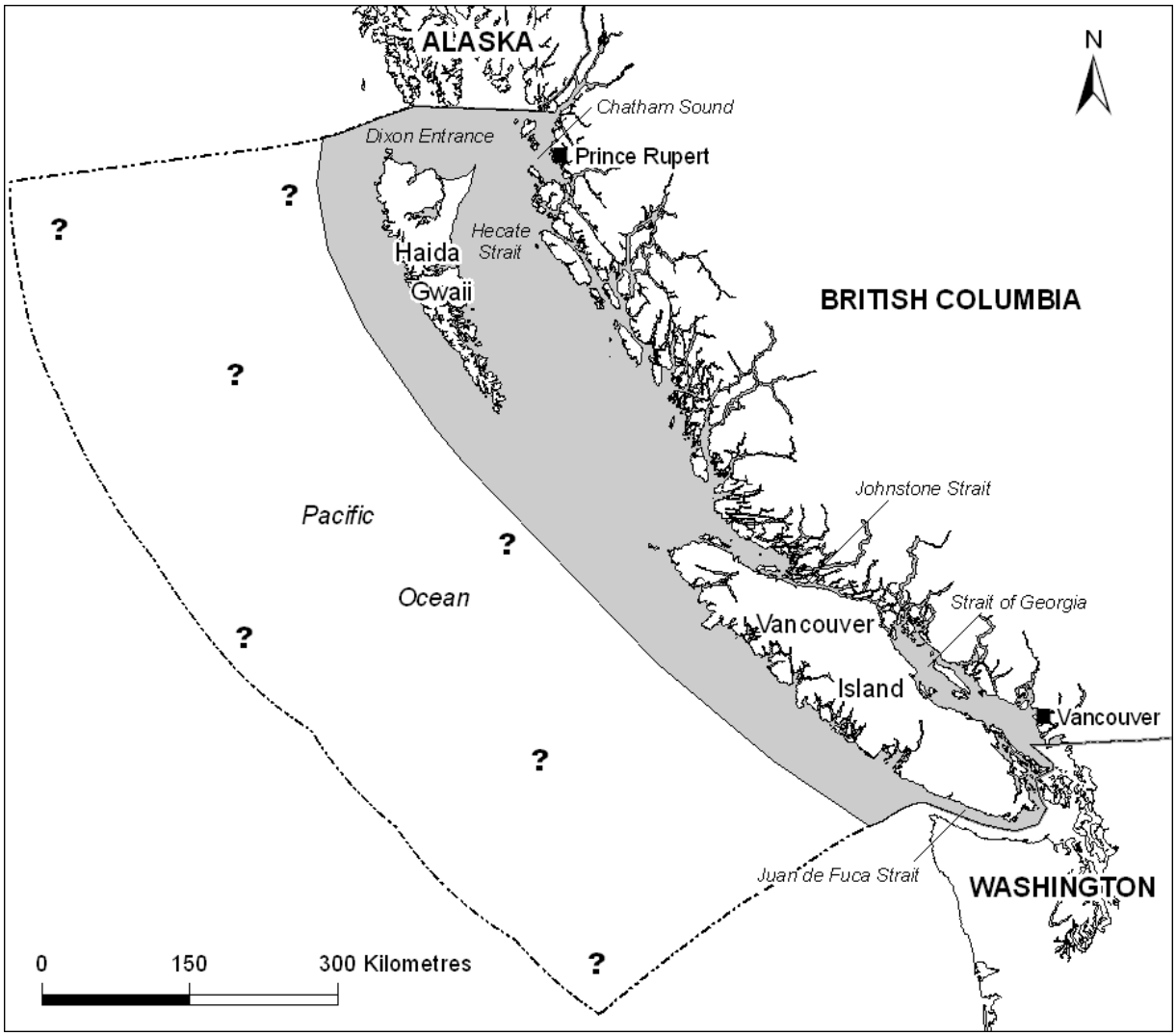

Figure 7. The range of the Offshore population of Killer Whales in Canadian Pacific waters. Members of this assemblage are not seen as frequently as Residents and Transients, but they are known to travel large distances. They are known to range from the eastern Aleutian Islands, Alaska, to the Channel Islands near Los Angeles. Uncertainty regarding the western limit of their range is shown by '?'. This area is not included in the estimates of EO and AO. (Sources: Krahn *et al.* 2007, CRP-DFO unpublished data).

Killer Whales in the northwestern Atlantic and eastern Canadian Arctic have an estimated EO of 6,600,000 km^2 and an AO of 3,329,551 km² (Figure 8). The range extends south into US coastal waters. Whales from this DU likely also travel to western Greenland (Higdon 2007). Historically, Killer Whales were considered common in the Gulf of St. Lawrence and St. Lawrence estuary, but are now sighted there only occasionally (Lesage *et al.* 2007). They are seen in nearshore waters of Newfoundland, particularly in the Strait of Belle Isle (Lawson *et al.* 2007).

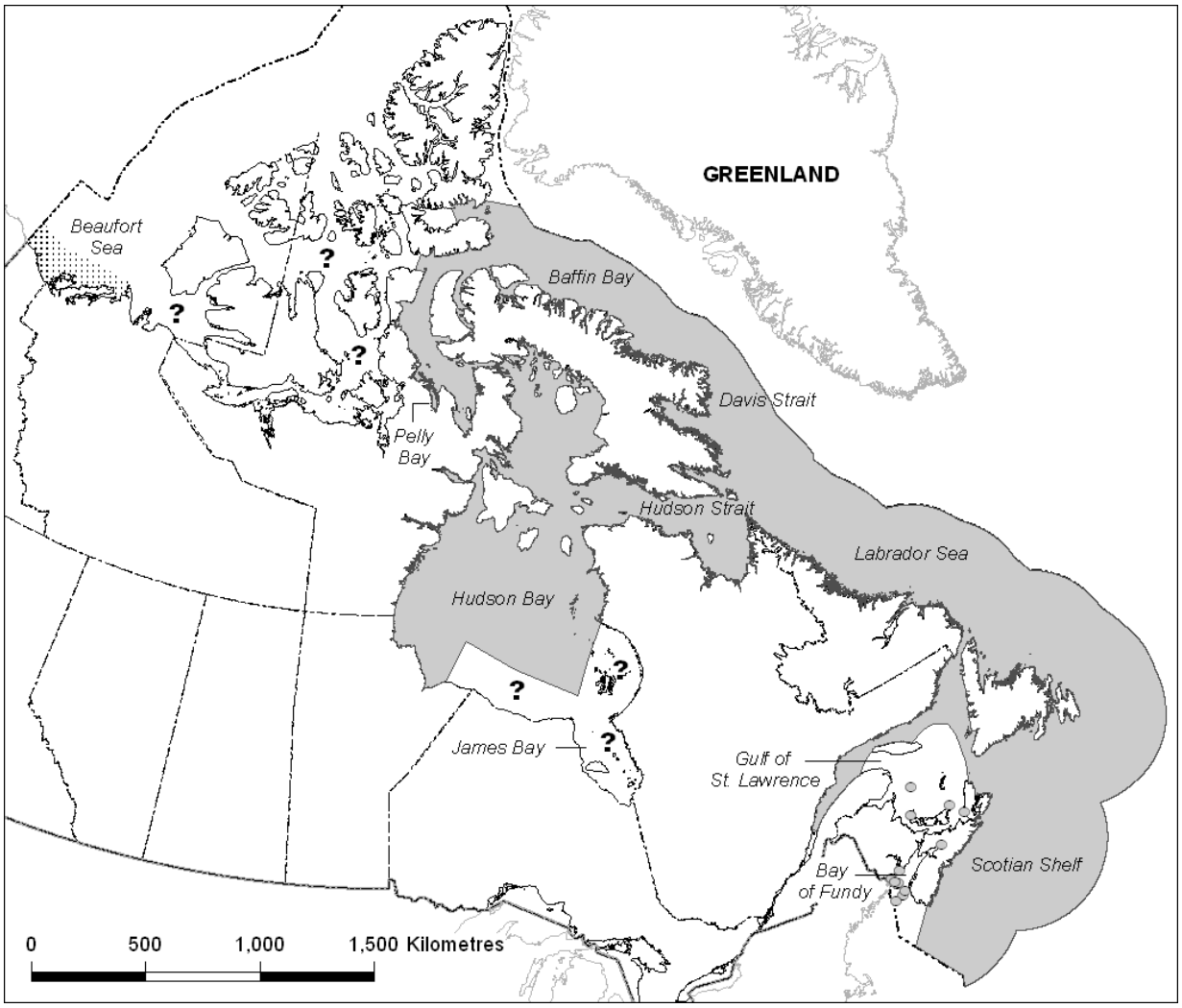

Figure 8. The range of Killer Whales in Canadian waters in the northwestern Atlantic and eastern Canadian Arctic. Killer Whales in this area are considered to represent one designatable unit (DU). Killer Whales are rarely sighted in the western Canadian Arctic and are considered extralimital (area of occurrence of these "stragglers" indicated by stippling). Individual sightings in other areas where Killer Whales are rarely encountered (despite substantial survey effort) are indicated by circles. (Sources: Published and unpublished data, DFO Quebec and Newfoundland, and Orcas in the Canadian Arctic project.)

Declining summer sea ice appears to be allowing Killer Whales to expand their range in the Arctic. They have been observed with increasing frequency in Hudson Bay (Higdon *et al.* 2006, Higdon and Ferguson 2007) and further northwest in Pelly Bay (NAMMCO 2005). There have been only a few sightings of Killer Whales in the central Canadian Arctic (Higdon 2007). This may be due partly to a lack of observer effort, although the area generally has lower numbers of marine mammals and multi-year sea ice is present.

Killer Whales are rarely seen in the western Canadian Arctic (Higdon 2007). Local people there reported that they had been seen 2-3 times per decade from the 1940s to the 1980s (Byers and Roberts 1995, in Higdon 2007). The most recent sightings were of a single individual observed several times in July 2006 (Higdon 2007). The Killer Whales occasionally present in the western Canadian Arctic are considered extralimital.

HABITAT

Habitat requirements

Killer Whale movement does not appear to be limited by features of their environment other than ice in high latitudes. They inhabit a wide range of nearshore and pelagic habitats worldwide and tolerate broad temperature, salinity and turbidity levels. Their basic requirements include 1) sufficient quantity and quality of prey, 2) an acoustic environment that does not inhibit communication and foraging or result in hearing loss, and 3) safe passage conditions that allow for seasonal movements, resting and foraging (NOAA 2004; 2006).

During the summer and fall, the distribution of both Northern and Southern Resident Killer Whales is closely linked to that of Chinook Salmon (*Oncorhynchus tshawytscha)*, their preferred prey (Heimlich-Boran 1988; Felleman *et al.* 1991; Osborne 1999; Nichol and Shackleton 1996; Ford *et al.* 1998; Ford and Ellis 2006). Changes in the relative strength of major salmon runs results in corresponding shifts in the areas where Killer Whales are found (Ford and Ellis 2006). For the rest of the year less information is available on habitat use.

Within the Johnstone Strait area of BC (Figure 5), Northern Resident Killer Whales also engage in beach rubbing, and they are very sensitive to disturbance while doing so. Whales repeatedly rub on small smooth pebbles on very specific patches of beach in shallow water (Ford *et al.* 2000). This behaviour has not been observed in Southern Residents, Transients or Offshores. Whether access to beach-rubbing habitat is a “requirement” for Killer Whales is uncertain.

The habitat requirements of Transient Killer Whales are not well understood. They rely on marine mammals as prey, and their specialized hunting techniques involving stealth imply that their habitat must be sufficiently quiet for them to detect and localize their prey primarily through passive listening (Barrett-Lennard *et al.* 1996). This would apply equally to mammal-eating Killer Whales in the Atlantic and Arctic. Beyond that, however, the specific habitat requirements of Offshore and Northwestern Atlantic / Eastern Canadian Arctic Killer Whales are not known.

Habitat trends

Although there has been no documented change in the quantity of Killer Whale habitat, there are concerns that the quality of their habitat is declining due to increasing physical and acoustic disturbance (NRC 2003; IWC 2004) and contaminants such as PBDEs (see later under Anthropogenic Threats) (Hooper and McDonald 2000; Ross 2006).

Reduction of sea ice in the Arctic may create dramatically different conditions for Killer Whales and their prey. Receding ice is affecting ocean circulation, with potentially large-scale effects (Schiermeier 2007). Historically, Killer Whales in the Arctic were not often reported near ice (they do occur near ice in the Antarctic and off Newfoundland), but ice-free areas are now lasting longer over larger geographic expanses and Killer Whales are increasingly sighted in high latitudes (Higdon 2007). Declining sea ice may be opening up larger foraging areas for Killer Whales, although it is not known how such changes will affect the distribution or abundance of their prey.

Habitat protection/ownership

In Canadian waters, Killer Whale habitat is protected under the *Fisheries Act* and the *Oceans Act*. Responsibility for enforcing the *Oceans Act* rests with the Department of Fisheries and Oceans (DFO). Portions of the *Fisheries Act* are also enforced by the Department of the Environment, the Department of Indian Affairs and Northern Development, and in British Columbia, the provincial Ministry of the Environment. In 1982, the BC Ministry of the Environment established the Robson Bight (Michael Bigg) Ecological Reserve in Johnstone Strait to protect Northern Resident Killer Whales using the rubbing beaches from human disturbance (Ford *et al.* 2000). A Special Management Zone was later identified to include this area as well as most of southeastern Queen Charlotte Strait and western Johnstone Strait (Ford 2006). The Special Management Zone was never formally implemented in practice but it is now included in the legally described Critical Habitat (Fisheries and Oceans Canada 2008).

In 2008, Critical Habitat for Resident Killer Whales was designated for two areas in British Columbia under the Canadian *Species at Risk Act* (SARA) (Figures 4 and 5) (Fisheries and Oceans Canada 2008). For Southern Residents this area includes Juan de Fuca and Haro Straits, Boundary Pass, the waters surrounding the southern Gulf Islands, and a part of southern Georgia Strait off the mouth of the Fraser River (Figure 4). This is adjacent to an area in Washington State designated by the National Marine Fisheries Service as Critical Habitat under the *Endangered Species Act* (NOAA 2006). The Johnstone Strait area has been identified as Critical Habitat for Northern Residents (Figure 5).

There has been no attempt to identify Critical Habitat or enact legislation related to the Northwestern Atlantic/Eastern Arctic DU.

BIOLOGY

Much of what is known concerning the biology of Killer Whales is based on long-term field studies in the northeastern Pacific, and from studies in captivity. Field studies have been conducted mainly in sheltered waters during the months of May to October, and Killer Whale behaviour and ecology in other seasons and in other areas are poorly understood (Ford *et al.* 1998, 2000). It is not known if the life history parameters presented here are typical for Killer Whales from other populations.

Life history

The life history and population parameters presented below are taken primarily from Olesiuk *et al.* (2005). Estimates are based on studies of the Northern Resident population, but the population parameters for Southern Residents and Southern Alaska residents appear to fall within similar ranges. The Olesiuk *et al.* study spanned two periods, one of population growth from 1973-1996 and one of no net growth from 1996-2004. Parameters that differed between these two time periods are summarized in Table 1.

Table 1. Life history parameters for Northern Resident Killer Whales during periods of population growth (1973-1996) and no growth (1996-2004). Adapted from Olesiuk *et al.* (2005).

	Study Period	
	1973-1996	**1996-2004**
	Females	
Mean age at first birth	14.1 yr	15.4 yr
Average calving interval	4.9 yr	5.5 yr
Mean onset of reproductive senescence	38 yr	41 yr
Average reproductive lifespan	24 yr	27 yr
Reproductive potential	4.7 calves	4.5 calves
Percent females surviving to age 40 yr	93%	68%
	Males	
Life expectancy	31 yr	19 yr
Maximum longevity	60-70 yr	40-50 yr
	Juveniles	
Mean annual mortality	1.6%	3.4%
Percent surviving to age 15 yr	80%	61%
	Population Composition	
Juveniles	46%	47%
Reproductive females	21%	24%
Post-reproductive females	10%	11%
Adult males	22%	18%

Survival and longevity

Survival rates varied with age, and mortality rates were highest for neonates. From birth to 6 months of age, mortality ranged from 37-50% (Olesiuk *et al.* 1990) although these estimates are crude and may be high. During the period of population growth (1973-1996) the average life expectancy for animals that survived their first 6 months was estimated as 46 yr for females and 31 yr for males. However, during the period of no net growth (1996-2004), this estimate fell to 30 yr and 19.3 yr for females and males respectively. Longevity was approximately 80 yr for females and 40-50 yr for males.

During both study periods, Killer Whale mortality rates followed the U-shaped curve typical of mammals. However, the curve shifted upwards during the period of no population growth, indicating that all sex and age classes experienced a higher rate of loss. From 1996-2004 there were 2.3 times as many juvenile deaths as would have occurred were the population increasing, 1.7 times as many adult female deaths, and 2.5 times as many adult male deaths (Olesiuk *et al.* 2005). This reduced survival largely explains the lack of growth by the Northern Resident population from 1996 to 2004. Reasons for this are discussed in the Trends section below. Krahn *et al.* (2004) suggested that the Southern Resident population has experienced a decrease in fecundity.

Reproductive parameters

Male Killer Whales reach sexual maturity at 12.8 yr (mean). During the period of population growth, females gave birth to their first viable calf at 14.1 yr. This increased slightly (but significantly) to 15.4 yr during the period of no net growth. The typical age range for first-time mothers was 12-17 yrs (77%) but some were as young as 9 yr and as old as 22 yr (Olesiuk *et al.* 2005). The gestation period is 16-17 months (Walker *et al.* 1998; Duffield *et al.* 1995).

From 1973-1996 female Northern Resident Killer Whales produced a single calf every 4.7 yr over an average 24 yr reproductive period. This changed to one calf every 5.5 yr over a 27 yr reproductive period, resulting in a slight decline in the reproductive potential of females from 4.7 calves to 4.5 calves. The calving interval is highly variable and can range from 2 to 11 yr. Calving occurs year-round but is diffusely seasonal, peaking from fall through spring (Olesiuk *et al.* 2005). Calves are 2.2-2.5 m long at birth (Olesiuk *et al.* 1990; CRP-DFO unpublished data).

The generation time for Northern Resident Killer Whales (average age of parents) ranges from 26-29 yr. Female Killer Whales produce their last calf at approximately 40 yr but live on average another 10 yr and often much longer (Olesiuk *et al.* 2005). This prolonged period of reproductive senescence is rare in animals. It is possible that the presence of older females in a group increases the survival of offspring even if such individuals no longer contribute directly to population growth.

Mating behaviour between male and female Killer Whales has rarely been observed in the wild. Testosterone levels in captive adult male Killer Whales were highest from March through June (Robeck and Monfort 2006). This, and a peak in calving from fall through spring, suggests that breeding is most frequent in the spring and early summer.

Diet

Globally, Killer Whales are known to feed on a wide range of prey species, yet within the eastern North Pacific different assemblages specialize on fundamentally different species and use different foraging strategies. Based on behavioural observations, prey fragment sampling and stomach content analyses, Resident Killer Whales feed primarily on fish, and Transient Killer Whales feed on marine mammals (Bigg *et al.* 1987; Baird and Dill 1996; Barrett-Lennard *et al.* 1996; Ford *et al.* 1998; Ford and Ellis 2006). In Alaska, Resident and Transient populations show a similar difference in dietary preferences. These conclusions are further supported by differences in fatty acid profiles, stable isotope analysis and PCB contaminant levels (Herman *et al.* 2005; Krahn *et al.* 2007).

Resident Killer Whales travel in acoustically active groups (i.e., groups that are producing sounds and not just listening) and are generally predictable in their movements while foraging (Morton 1990; Ford *et al.* 2000). Both Northern and Southern Resident Killer Whales forage selectively for specific salmon species (Ford and Ellis 2006). Their predominant prey is Chinook Salmon from May through September, despite the low abundance of this species relative to other salmonids such as Pink (*O. gorbuscha*), and Sockeye Salmon (*O. nerka*). During October, Chum Salmon (*O. keta)* are abundant and dominate the diet of Residents, although Chinook are taken as well. From November through April, the diet is not well known. Chinook Salmon appear to be preferred by Resident Killer Whales due to their large size, high fat content, and year-round availability in coastal waters (Ford *et al.* 1998; Ford and Ellis 2006). Chum Salmon are second to Chinook in body size.

Transient Killer Whales in BC consume a variety of marine mammals. Harbour Seals (*Phoca vitulina*) are the most frequently recorded prey, followed by Harbour Porpoises (*Phocoena phocoena*), Dall's Porpoises (*Phocoenoides dalli*) and Steller Sea Lions (*Eumetopias jubatus*). They also consume California Sea Lions (*Zalophus californianus*), Pacific White-sided Dolphins (*Lagenorhynchus obliquidens*), Grey Whales (*Eschrichtius robustus*), Common Minke Whales (*Balaenoptera acutorostrata*) and, less commonly, River Otters (*Lontra canadensis*), Northern Elephant Seals (*Mirounga angustirostris*) and seabirds (Baird and Dill 1996; Ford *et al.* 1998, 2005a).

Transient Killer Whales typically forage in small, acoustically quiet groups (i.e., groups primarily listening and not producing sounds of their own), with long dives and often erratic movements (Morton 1990; Baird and Dill 1996; Ford and Ellis 1999). Their use of stealth likely helps them capture acoustically sensitive prey, and they typically do not vocalize until after a kill (Deecke *et al.* 2005). Kills of harbour seals and porpoises may take place very quickly, but attacks on other species such as sea lions and minke whales can be prolonged and chases can occur over several kilometres (Ford *et al.* 1998; Heise *et al.* 2003; Ford *et al.* 2005a, Ford and Reeves 2008).

The diet of Offshore Killer Whales is not well understood because they are not often encountered. They travel in large acoustically active groups, so their behaviour is consistent with a predator that does not feed on marine mammals. They have been reported to feed on fish (Heise *et al.* 2003; Jones 2006) and this is supported by fatty acid profiles (Herman *et al.* 2005). Their PCB contaminant levels resemble those found in Transients, suggesting that Offshore Killer Whales prey on heavily contaminated, long-lived, high trophic-level predators such as elasmobranchs (Herman *et al.* 2005; Krahn *et al.* 2007).

In the northwestern Atlantic, Killer Whales have been observed preying on Harp Seals (*Pagophilus groenlandica*), White-beaked Dolphins (*Lagenorhynchus albirostris*), Common Minke Whales, Belugas (*Delphinapterus leucas*), and Humpback Whales (*Megaptera novaeangliae*), Razor-billed Auks (*Alca torda*), Bluefin Tuna (*Thunnus thynnus*) and Herring (*Clupea harengus*) (Lien *et al.* 1988; Lawson *et al.* 2007). They have also been observed feeding on discarded fish near vessels fishing for Greenland Halibut (Lawson *et al.* 2007). In the eastern Canadian Arctic, Killer Whales prey on Bowhead Whales (*Balaena mysticetus*), Belugas, Narwhals (*Monodon monoceros*), Long-finned Pilot Whales (*Globicephala melas*), Fin Whales (*Balaenoptera physalus*), Common Minke Whales, Humpback Whales, and Seals (Higdon 2007).

Social structure

Northern and Southern Residents are the only Killer Whale populations for which there is detailed knowledge of social structure. The fundamental social unit of Residents is the ‘matriline’, which consists of up to four generations of whales that are closely related by matrilineal descent. Dispersal of individuals from matrilines is extremely rare, although orphaned calves have been known to join closely related matrilines. Groups of related matrilines that spend most of their time traveling together are known as ‘pods’, and different pods from the same population frequently travel together. The composition of some pods in the Northern Resident population has been remarkably stable, although other pods have been observed in recent years to split between sister matrilines (Ford *et al.* 2000; Ford and Ellis 2002). Matrilines of the Northern Resident population fall into three distinct acoustic groups, or ‘clans’, and the relatively small Southern Resident population has a single acoustic clan consisting of three pods – known as J, K, and L (Ford 1991). Members of the Northern Resident clans frequently associate with one another, but Northern Resident clans remain isolated from Southern Resident clans.

The social groupings of Transients are more fluid than those of Residents, and they do not necessarily remain in their natal matrilines for life. Individuals that disperse may mix widely within the population (Ford and Ellis 1999) although there can be strong long-term associations (Baird and Whitehead 2000). The social structure of Offshore Killer Whales is unclear, and it is not known if they disperse from their natal groups.

Dispersal, distribution and movements

In the Pacific, Killer Whales do not migrate to specific breeding or calving areas that are separate from their feeding grounds. Rather, they appear to shift their distribution to take advantage of aggregations of prey, such as salmon returning to freshwater rivers to spawn.

Most sightings of Killer Whales in the northwestern Atlantic and eastern Canadian Arctic are in summer (Higdon 2007, Lawson *et al.* 2007). This is probably at least partly a reflection of observer effort. There is no evidence of large-scale north-south migration, and Killer Whales are observed over a range of latitudes in summer throughout the area (Higdon 2007).

Adaptability

Dietary preferences and acoustic behaviour are extremely fixed in the Resident and Transient Killer Whale populations of the northeastern Pacific. However, both Resident populations have adapted to, or at least tolerate the increasing presence of, whale-watching vessels and continue to use their traditional foraging areas. The Southern Resident population is exposed to intense whale-watching in Haro Strait, where on average 19-22 boats follow whales from 9 am to 9 pm throughout the summer (Osborne *et al.* 2003).

Recently, culture, defined as a body of information and behaviour transmitted within and between generations by social learning, has been described for Northern and Southern Residents, as well as Southern Alaska Residents (Ford 1991; Ford *et al.* 1998; Barrett-Lennard *et al.* 2001; Yurk *et al.* 2002). Culture may help Killer Whales respond to changes in their environment, as they learn behaviour from each other, as well as from experience. In Alaska, Resident Killer Whales learned to depredate longline fishing gear, and this behaviour spread very rapidly (Matkin and Saulitis 1994). Depredation on Chinook Salmon in troll fisheries by Resident Killer Whales appears to be spreading in BC (CRP-DFO unpublished data). Killer Whales in the Atlantic take discarded fish from longline operations, and whales have also been reported to remove tuna from fishing lines (Lawson *et al.* 2007).

POPULATION SIZES AND TRENDS

Search effort

Killer Whales from the western coast of Canada have been photo-identified since the early 1970s. The number of Resident Killer Whales is well known since most individuals within each population (northern and southern) are photographed each year. An annual estimate of the Southern Resident population is made by the Center for Whale Research in Friday Harbor, Washington (CWR). Estimates of the Northern Resident, West Coast Transient and Offshore populations are made by the CRP-DFO, Nanaimo. The entire Southern Resident population is photographed annually, and the count is considered accurate. Not all members of the Northern Resident population are seen in some years, so the count is less accurate. Individuals from the West Coast Transient population are not seen reliably each year, and there is some dispersal from natal groups. The estimate for Offshore Killer Whales is based on photographs taken during relatively few encounters.

Most of what is known about Arctic Killer Whales comes from scattered records, although in September 2005, DFO initiated the Orcas in the Canadian Arctic (OCA) project, which focuses on Killer Whales in the eastern Canadian Arctic and includes a GIS database, a community monitoring network, acoustic monitoring, photo-identification and the collection of skin and blubber samples for genetic and other analyses. This project is also compiling *Inuit Quajimajatuqangit* (IQ, Inuit Traditional Ecological Knowledge).

Monitoring of Killer Whales in Newfoundland and Labrador began in 1979 (Lawson *et al.* 2007). Since the 1980s photo-identification data have been collected by observers from DFO, Memorial University, NGOs and others, and nearshore Killer Whale photographs have been compiled by David Snow (Wildland Tours, St. John's, Newfoundland. www.atlanticwhales.com/orcas). In 2006 DFO began large-scale surveys and a cataloguing program. DFO in Quebec and in Newfoundland and Labrador maintains regional sightings databases that include all reports of cetaceans in the regions.

The Atlantic Canada Conservation Data Centre also maintains a database containing more than 35,500 cetacean records, of which only four are sightings of Killer Whales in the Bay of Fundy (Marx and Kenney 2001). Considering that the Bay of Fundy is surveyed intensively every year for Right Whales, Killer Whales apparently are rare in this area. Also, the Scotian Shelf does not appear to be used frequently by Killer Whales. Systematic surveys by the US National Marine Fisheries Service in the western Shelf have not yielded enough sightings of Killer Whales to support an abundance estimate (NMFS 2000). Similarly, summer surveys for cetaceans on the Scotian Shelf, averaging about 1 month per year since 1986, have yielded thousands of sightings of other cetacean species, but not a single sighting of Killer Whales (Hal Whitehead pers. comm. 2007).

Abundance

In 2006 there were 87 individuals in the Southern Resident Killer Whale population (CWR unpublished data, analyzed by G. Ellis, CRP-DFO Nanaimo[4]), 244 whales in the Northern Resident population and an estimated 243 whales in the West Coast Transient population (Ford *et al.* 2007). Table 2 shows the breakdown of Resident and Transient populations into age and sex categories.

Table 2. Population composition of the Northern, Southern Resident and West Coast Transient Killer Whale populations in 2006 (CWR, CRP-DFO, unpublished data).

	Population		
	Northern Residents	**Southern Residents**	**Transients**
Total population identified in 2006	244	87	198[@]
Calves	16 (6.5%)	0 (0%)	13 (6.6%)
Juveniles	102 (42%)	39 (45%)	74 (37%)
Sexually mature males[#]	13 (5%)	9 (10%)	12 (6%)
Mature males	33 (14%)	7 (8%)	27 (14%)
Mature females	71 (29%)	20 (23%)	72 (36%)
Post-reproductive females	9 (4%)	12 (14%)	?*

[#] A sexually mature but physically immature male is a whale whose dorsal fin is beginning to sprout but has not reached its full height.
[@] Only 198 transients were photo-identified in 2006, although the population consisted of an estimated 243 animals at that time (Ford *et al.* 2007).
* Possible post-reproductive females are counted as mature females for this population

Encounters with Offshore Killer Whales are relatively rare compared to encounters with Residents and Transients. Photo-identifications made during 86 encounters with Offshore Killer Whales in BC waters from 1988 to mid-2008 yielded a total of 288 unique individuals (CRP-DFO unpublished data). Because this total only includes animals with distinctive markings, 288 can be considered a conservative estimate of abundance of the Offshore population.

There are no estimates of the number of Killer Whales in the northwestern Atlantic and eastern Canadian Arctic. At least 63 individuals have been photo-identified around Newfoundland and Labrador (Lawson *et al.* 2007). In a review of all available records in the Nunavut region from 1756 to 2006, Higdon (2007) accounted for at least 15 sightings of large groups comprising more than 40 Killer Whales.

[4] This count is based on a different census date of the Southern Resident Population than that used by the Center for Whale Research.

Trends

Between 1964 and1973 at least 14 whales, including 12 from one pod, were removed from the Northern Resident population for captivity (Bigg *et al.* 1990). In 1975 the population contained approximately 132 whales and had increased to 220 by 1997 (average rate of increase of 2.9%/yr) (Figure 9). From 1997 to 2001 the population declined to 201 whales (overall decline of 8.6%, or 2.11%/yr) due primarily to mortality (Olesiuk *et al.* 2005). The population had increased to 244 whales by 2006. Overall, from 1997 to 2006 the Northern Resident population increased by 24 whales, i.e. by 11% (1.1%/yr). This was due largely to juvenile recruitment, however, and the number of mature individuals increased by only 7 animals (6%) (Figure 9).

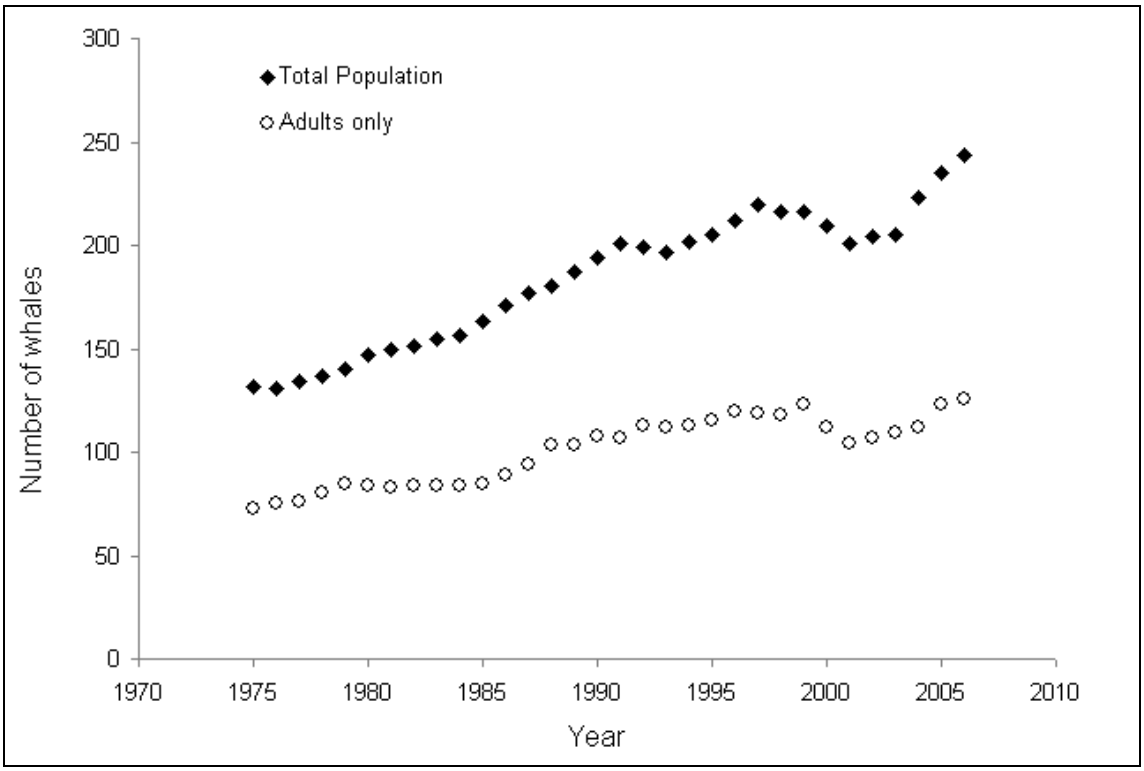

Figure 9. Size of the Northern Resident population from 1974 to 2006. Open circles indicate number of adults (Source: CRP-DFO unpublished data).

The Southern Resident population declined in the late 1960s and early 1970s because about 47 individuals were captured for display in aquaria (Bigg and Wolman 1975; Bigg 1990). Live captures ended in 1973 when approximately 70 Southern Residents remained. By 1980 the population had increased to 83 whales (Figure 10), an increase of 18.6% (average 2.88%/yr), although the rate of increase varied by pod. From 1981 to 1984 the population declined by 12% (average -3.1%/yr) to 73 due to low birth rates and high mortality in adult females and juveniles (Taylor and Plater 2001). The low birth rate is thought to have been a legacy of the live-capture fishery that reduced the number of mature animals, especially males (Olesiuk *et al.* 1990).

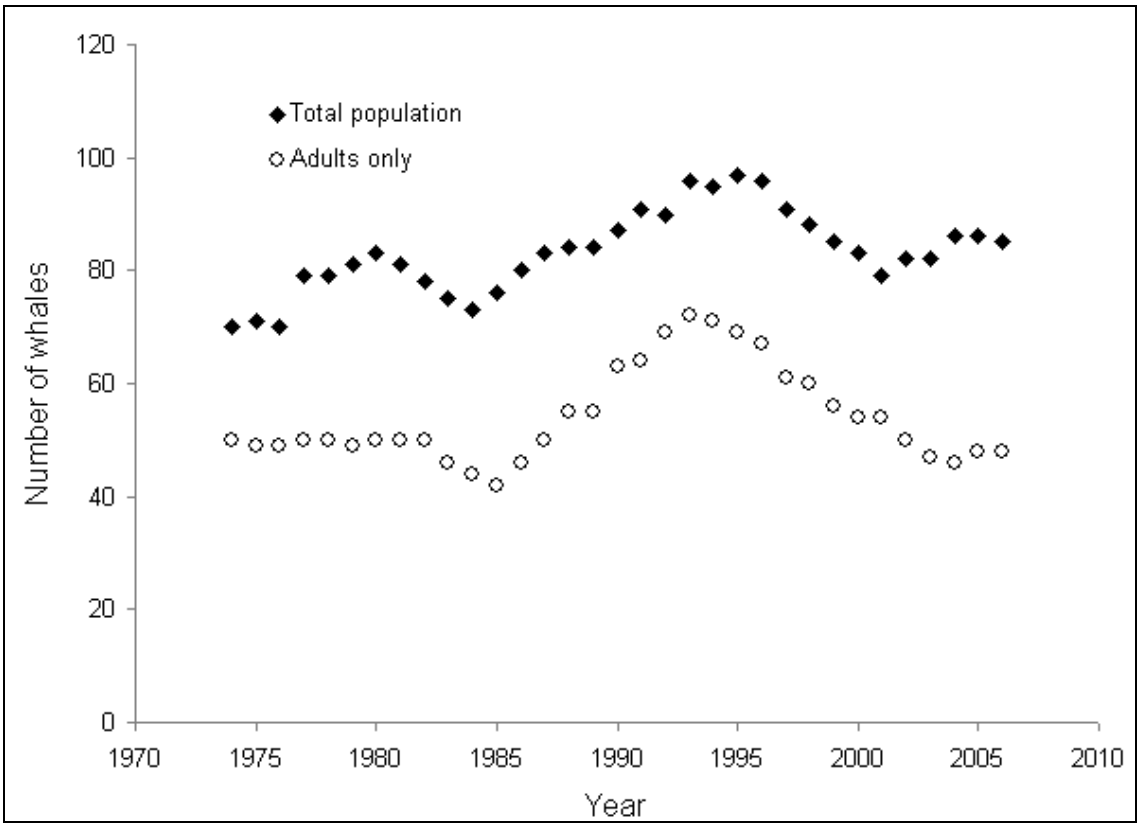

Figure 10. Size of the Southern Resident Killer Whale population from 1974 to 2006. Open circles indicate number of adults (Source: CWR unpublished data).

The Southern Resident population had increased to 96 whales by 1996 (average 2.3%/yr) as the number of mature animals rose (Figure 10), birth rates increased and mortality fell. In 1996 the population entered a period of decline with poor survival and a low birth rate (Taylor and Plater 2001, Krahn *et al.* 2004). By 2001 the population had declined to 79 whales (17.7% overall, or -3.8%/yr). Since 2001 the number of Southern Residents has fluctuated, increasing to 87 by 2006 (CWR unpublished data). Overall, the Southern Resident population declined by 4 animals between 1997 and 2006, i.e. a decline of 4.4% (-0.4%/yr). However, the number of mature individuals declined by 13 individuals (21%) over this same period (Figure 10).

The risk of extinction for Southern Resident Killer Whales has been estimated from population viability analyses (Taylor and Plater 2001; Krahn *et al.* 2002, 2004), but the results provide little insight on the population's future. It is predicted that if the mortality and reproductive rates of the 1990s persist, there is a 6-100% probability that the population will be extinct within 100 years, and a 68-100% risk that it will be extinct within 300 years (10-12 generations). However, when the mortality and reproductive rates of the entire 1974-2000 period are used, the risk that the population will go extinct declines to 0-55% over 100 years and 2-100% over 300 years.

The success of Northern Residents relative to Southern Residents between 1974 and the mid 1990s is likely due to its larger size initially, which would have buffered it from changes in birth and death rates. Also, fewer Northern Residents were removed by the live-capture fishery (Olesiuk *et al.* 1990). Finally, Northern Residents are exposed to less disturbance and less environmental contamination than Southern Residents. However, both populations declined during the late 1990s, concurrent with declines in their principal prey, Chinook Salmon (Ford *et al.* 2005b, see section on Prey Limitation).

From the mid-1970s to mid-1990s the West Coast Transient population grew rapidly (average 6%/yr) coinciding with dramatic increases in the abundance of Harbour Seals and Steller Sea Lions in BC coastal waters. This rapid growth (which exceeds the estimated r_{max} of 3-4% for toothed whales) suggests that the early increase was due, at least in part, to movement of adults into nearshore areas (Ford *et al.* 2007). Growth in the population since 1990 (average 2%/yr) has been due to recruitment (Ford *et al.* 2007).

No information is available on trends in population size for the Offshore or Northwestern Atlantic / Eastern Arctic Killer Whale populations. Animals from the Offshore population in the Pacific are infrequently observed but they are monitored. Based on the available information, the population appears to be stable. Local knowledge suggests that sightings are increasing in the eastern Canadian Arctic (NAMMCO 2005; Higdon 2007), but it is not clear whether this represents a change in sighting effort, a change in whale distribution (possibly due to increased extent of ice-free habitat), or an increase in overall population size.

Rescue effect

The rescue effect is unlikely to apply to any of the Pacific populations of Killer Whales. Each population is genetically and culturally unique, with very little evidence of mixing.

LIMITING FACTORS AND THREATS

Natural mortality

Carcasses of Killer Whales are rarely recovered and relatively little is known about natural sources of mortality. Potential sources include disease, accidental beaching (stranding), parasites, biotoxins and starvation (Baird 2001). A number of pathogens have been identified in Killer Whales, some of which cause abortions, reduced fecundity and/or increased mortality (Gaydos *et al.* 2004, Raverty pers. comm. 2007).

Killer Whales occasionally strand or become entrapped by ice or shallow water, and this can be fatal (Mitchell and Reeves 1988). Temporary entrapment was reported twice for groups of Southern Residents in the 1990s (Shore 1995, 1998) but there have been few recent live strandings in the Pacific. The most recent strandings in the Atlantic were of two whales in January 1998 in Fortune Bay, Newfoundland (Baird 2001) and a single animal on Sable Island, Nova Scotia (Lucas and Hooker 2000). In the Arctic there are occasional reports of single stranded Killer Whales but there are also several reports of animals that have become entrapped that were then killed by local hunters, including two reports involving groups of more than 10 whales (Higdon 2007).

Biological limiting factors

Although Killer Whales are long-lived animals with no natural predators, information on both Northern and Southern Residents suggests that populations are vulnerable because of their small size, their low reproductive rate, and the absence of inter-population mating. Other biological factors that may affect the ability of Killer Whale populations to recover are discussed below.

Fixed dietary preferences and changes in prey supply

The feeding specializations of Resident and Transient Killer Whales in BC are strongly entrenched, and there is no evidence to suggest that they switch between marine mammals and fish. The outcome of the capture of three transient Killer Whales in 1970 illustrates the strength of this dietary preference. One whale died after 75 days in captivity, having refused to eat fish. On the 79th day the remaining two whales began to eat fish. These whales were later returned to the wild where they resumed their diet of marine mammals (Ford and Ellis 1999). Such strong and consistent foraging specializations mean that the Resident and Transient populations are more vulnerable to the depletion of their preferred prey than if they were generalist feeders. It is not known if other populations of Killer Whales have such strong prey specializations.

There is evidence that Resident Killer Whale abundance may be limited by availability of their primary prey, Chinook Salmon (Ford *et al.* 2005b). If so, it is likely that these whales were more numerous historically than they are today. Many Chinook stocks are at only a small percentage of their historical abundance level, and more than 50 stocks within the range of Resident Killer Whales are now extinct (Heard *et al.* 2007). For example, Chinook Salmon production in the Fraser River system experienced a 5-fold decline between the late 1800s and the 1980s (Northcote and Burwash 1991). There have also been significant long-term reductions in the average size and age of Chinook Salmon (Ricker 1980; Heard *et al.* 2007), indicating that this prey resource has declined in both quantity and quality.

A substantial decline in Chinook Salmon abundance during the late 1990s was associated with a sharp increase in mortality rates of both Northern and Southern Residents which resulted in declines in these populations (Ford *et al.* 2005b). Chinook abundance began to improve in 2001 and levels of salmon abundance were relatively high during 2004-2006 (PSC 2008). This period coincided with recent increases in abundance of Resident Killer Whales, particularly in the Northern Resident population. However, Chinook salmon abundance declined in 2007 and projections for 2008 indicate that a further decline in abundance is likely (PSC 2008). This may result in decreased survival of Resident Killer Whales as seen in the period of low Chinook abundance in the late 1990s.

Mating behaviour

The propensity of Residents to mate outside their matriline (and clan in the case of Northern Residents) but within their population minimizes the possibility of inbreeding but it restricts options for mating should the population become very small (Barrett-Lennard 2000; Barrett-Lennard and Ellis 2001). Genetic studies indicate Transient, Resident and Offshore populations are largely closed to immigration, and that successful mating between members of these three different assemblages, if it occurs, is extremely rare (Barrett-Lennard 2000).

Small population size

Killer Whale populations are at risk by virtue of their low numbers. In animals with highly matrilineal societies a breakdown in social structure may occur if the population becomes too small (Williams and Lusseau 2006; Matkin *et al.* 2008). The Southern Resident population in particular has few mature males (Table 2). Even if factors that have caused the decline of a Killer Whale population are reduced or eliminated, the time required for recovery will be long, because on average, females produce a calf only every 5 years.

Culture

The best evidence of culture in Killer Whales (and birds) is the use of dialects. A calf learns its dialect from its mother and other closely related adults, uses it for life, and passes it on to the next generation with few changes (Ford 1991; Deecke *et al.* 2000; Miller and Bain 2000). Culturally transmitted dialects play an important role in inbreeding avoidance, since whales mate preferentially with individuals whose dialects are different from their own (Barrett-Lennard 2000; Yurk *et al.* 2002).

Culture also plays a role in foraging, as dietary preferences, foraging techniques and knowledge of geographic and seasonal patterns of prey abundance appear to be learned socially (Ford *et al.* 1998). In Killer Whales, culture may select for longevity by providing a mechanism for older animals to increase the fitness of their offspring and relatives by transferring knowledge to them (Barrett-Lennard *et al.* 2001). However, fixed cultural attributes may also limit the ability of killer whales to adapt to rapidly changing environmental conditions.

Anthropogenic threats

The principal recognized anthropogenic threats to northeastern Pacific populations of Killer Whales are reduced prey availability, physical and acoustic disturbance, and chemical contaminants (Fisheries and Oceans Canada 2007, 2008). Oil spills, collisions with vessels ("ship strikes") and interactions with commercial fisheries may also affect Killer Whale populations. Furthermore, multiple, co-occurring stressors can have synergistic or cumulative effects (e.g. Sih *et al.* 2004). Some or all of those threats likely apply to Killer Whales in the northwestern Atlantic and eastern Canadian Arctic. In the Arctic, and especially off western Greenland, Killer Whales are hunted (see section on Direct Killing).

Reduction in prey availability

The reliance of resident Killer Whales on healthy populations of Chinook Salmon makes them particularly vulnerable to over-fishing or activities that reduce or degrade salmon spawning habitat. Chinook Salmon are their principal prey species from May through September, and they likely rely heavily on Chinook year-round (Ford and Ellis 2006). Fluctuations in Chinook Salmon abundance over the past 25 years appear to have played an important role in Killer Whale population dynamics (Ford *et al.* 2005b). In the 1980s Chinook abundance was variable across different areas of the coast but was generally higher than the long-term average. Between 1996 and 2000 coastwide Chinook abundance was 24-40% below the long-term average (Ford *et al.* 2005b). During this period, mortality rates of both Northern and Southern Resident populations were 2-3 times higher than expected based on pre-1996 mortality rates. Mortality was distributed broadly among different pods as well as age and sex classes. From 2000 to 2003 Chinook abundance increased above the long-term average in all areas (except the Strait of Georgia) and mortality rates of Resident Killer Whales declined to levels close to expected. Overall, there was a striking inverse correlation between mortality rates of Resident Killer Whales and abundance of Chinook Salmon during 1979-2004 (R^2=0.763, $p < 0.001$; Ford *et al.* 2005b). There was also a significant positive correlation with birth rates during the same period (R^2=0.227, $p < 0.05$; Ford *et al.* 2005b).

The mechanism by which reduced Chinook Salmon abundance may have resulted in increased mortality of Resident Killer Whales during the late 1990s is uncertain. Animals may have died from starvation but it is possible that reduced feeding success led to nutritional stress that in turn increased the animals' susceptibility to disease or parasitism. This effect could have been amplified by the potentially immunosuppressive effects of contaminants such as PCBs, which are found at high levels in these whales (Ross *et al.* 1990; Ford *et al.* 2005b).

Changes in prey abundance also are correlated with changes in the size of the West Coast Transient Killer Whale population (Ford *et al.* 2007). In the 1970s, relatively few Transients were observed in inshore waters. At this time pinniped populations had been significantly depleted by culls and commercial hunts. This reduction likely affected the environmental carrying capacity for Transient Killer Whales, resulting in reduced survival and/or emigration. Since the 1970s pinniped populations have increased substantially as has the size of the Transient Killer Whale population. The increase in Transients may be due to recruitment, at least in part, but it also likely reflects inshore movement of Transients not previously available for photo-identification (see Population Trends section). The population size of Harbour Seals, the primary prey of Transient Killer Whales, stabilized in the mid-1990s in BC at a very high level of abundance (Olesiuk 1999) and growth in the Transient Killer Whale population has continued since then (Ford *et al.* 2007).

The food habits of Offshore Killer Whales are too poorly known to judge whether changes in prey availability are likely to affect them in the foreseeable future.

Similarly, not enough is known about Killer Whales around Newfoundland and Labrador to predict how they might be affected by changes in prey populations. It is also not possible to predict with confidence how prey populations in the Arctic, and in turn Killer Whales there, will be affected by reductions in sea ice associated with climate change. Reduced sea ice has been associated with an increased frequency of observations of Killer Whales in the Arctic where they are able to exploit prey that were previously unavailable (Higdon *et al.* 2006; Higdon and Ferguson 2007). Declines in the extent and coverage of sea ice are expected to continue for many years (Schiermeier 2007) and the ramifications for both Killer Whales and their prey are difficult to predict.

Chemically contaminated prey

In the northern hemisphere, persistent bioaccumulating toxins (PBTs) present the greatest toxic challenge to long-lived, upper trophic-level organisms such as Killer Whales that feed on chemically contaminated prey. Assessing the effects of contaminants is particularly complex, however, since they are widespread in the environment and interact synergistically to produce toxic effects (Braune *et al.* 2005).

Killer Whales carry the highest concentrations of organochlorine contaminants known in marine mammals (Ross *et al.* 2000). Adult males tend to carry higher levels than reproducing females because PBTs are transferred to offspring during gestation and lactation (Ross *et al.* 2000, 2002; Rayne *et al.* 2004; Ross 2006). West Coast Transient Killer Whales are more contaminated than Resident Killer Whales due to their diet, which includes other mammals already contaminated with PBTs (Ross *et al.* 2000).

Although some PBTs, such as PCBs (polychlorinated biphenyls) and DDT (dichloro-diphenyl trichloroethane), are no longer widely used in industrialized countries, many of these 'legacy contaminants' continue to enter the environment from terrestrial runoff and atmospheric transport (Hartwell 2004; Stern *et al.* 2005; Muir *et al.* 2005). Ringed Seals show elevated levels of DDT and other contaminants (Braune *et al.* 2005), and as Killer Whales in the Arctic have been observed feeding on seals, Belugas, and Narwhals (Higdon 2007), it is likely that they also have elevated contaminant levels.

West Coast Transient Killer Whales have tissue levels of PCBs 2 to 4 times higher than the threatened St. Lawrence River population of Belugas (Martineau *et al.* 1987; Béland *et al.* 1993; Ross *et al.* 2000). This depleted population of Belugas has not increased in over 20 years, possibly at least partly due to high levels of contaminants (De Guise *et al.* 1995). The West Coast Transient population, however, has grown about 2%/yr despite the high concentrations of PBTs.

Contaminant levels in Killer Whales are considerably higher than those known to cause PCB-associated reproductive impairment, skeletal abnormalities, endocrine disruption, and immunotoxicity in other mammals such as pinnipeds (Ross 2000; Ross *et al.* 2004). Although PCB levels are declining, models suggest that it will take decades before levels in Killer Whales go below the thresholds for potentially adverse effects (Hickie *et al.* 2007).

'Emerging contaminants', with properties similar to those of legacy PBTs, include polybrominated diphenyl ethers (PBDEs), which are used as flame retardants. Levels of PBDEs in the environment have been increasing exponentially (Hooper and McDonald 2000). Although the toxicity of PBDEs is not well understood, these chemicals have been associated with endocrine disruption in laboratory mammals (Darnerud 2003) and immunotoxicity in Grey Seals (*Halichoerus grypus*) (Hall *et al.* 2003). Transient Killer Whales carry higher levels of PBDEs than fish-eating Southern Resident Killer Whales, likely because they feed on contaminated, high trophic-level marine mammals (Ross 2006).

Acoustic disturbance

Awareness that underwater noise may be a significant threat to Killer Whales and other marine life has increased since COSEWIC last assessed Killer Whales (NRC 2003; Southall *et al.* 2007). Underwater noise can interfere with the ability of marine mammals to detect prey, communicate, and acquire information about their environment. It can also disrupt natural behaviour such as foraging (e.g., by displacing prey), impair hearing, and even cause physiological damage (NRC 2003). Measuring responses to acoustic disturbance is a challenge because reactions may be subtle or difficult to interpret, and animals may not show an obvious behavioural response yet still be affected (e.g. Todd *et al.* 1996).

Vessel traffic is the primary source of chronic noise for Killer Whales. Vessel noise covers a broad band of frequencies and is the dominant source of ambient noise in the 0-200 Hz range (NRC 2003). The consequences of chronic noise for Killer Whales have not been assessed. As the focus of commercial whale-watching activities, Resident Killer Whales are exposed to vessel noise more than Transient or Offshore Killer Whales. In the Southern Resident population, increasing vessel noise caused the whales to increase the duration of their calls (Foote *et al.* 2004).

Vessel noise may be more of a concern for Transient Killer Whales. They vocalize less frequently than Residents (Deecke *et al.* 2005) and chronic noise may mask cryptic calls used to communicate. Transients primarily detect their prey by listening for sounds produced by prey animals as they swim or vocalize, and increased noise likely reduces Transient foraging efficiency by masking such sounds (Barrett-Lennard *et al.* 1996).

Acute sources of anthropogenic sound in the ocean include military and other sonars, military exercises, seismic surveys, underwater explosions, pile driving and other construction activities. The overall level of underwater noise has increased significantly in the North Pacific and North Atlantic over the last few decades. Commercial shipping, offshore oil and gas exploration and drilling, and naval and other uses of sonar are most responsible for this increase (Hildebrand 2005). High-energy impulsive sounds, such as those produced during seismic exploration, can travel long distances underwater (>10-100+ km). Such noise may have significant effects on cetaceans, e.g. causing behavioural changes, hearing threshold shifts, production of stress hormones, and tissue damage (Ketten *et al.* 1993; Crum and Mao 1986; Evans and England 2001; Morton and Symonds 2002; Finneran 2003; Jepson *et al.* 2003; Fernandez *et al.* 2004). At-sea operating protocols applied to activities that produce high-energy sounds may not adequately protect cetaceans from exposure to harmful levels of sound (NRC 2007; Weir and Dolman 2007). Systematic surveys of cetaceans during seismic surveys in UK waters suggested a degree of avoidance behaviour by Killer Whales and other cetaceans (Stone and Tasker 2006). Unusual behaviour was observed in May 2003 when intense mid-frequency military sonar was used near Southern Resident Killer Whales (Balcomb 2007). The whales gathered into a tight group, swam close to shore, changed directions several times, and finally split apart and left the area traveling quickly in opposite directions. High-energy sound from

acoustic harassment devices ("seal scarers") was associated with the displacement of Northern Resident Killer Whales (Morton and Symonds 2002).

Physical disturbance

Killer Whales can be disturbed by vessels that approach closely, especially when the whales are feeding or beach rubbing (Williams 1999). Killer Whales are targeted by whale-watching in both BC and Newfoundland. In BC the whale- watching industry grew from a few boats carrying less than 1,000 passengers per year in the late 1970s and early 1980s to 80 boats carrying half a million passengers per year in 1998 (Osborne 1999; Baird 2002; Osborne *et al.* 2003). In addition, people in privately owned vessels often whale-watch.

Short-term behavioural changes have been linked to boat activity near Resident Killer Whales (Kruse 1991; Smith and Bain 2002; Williams *et al.* 2002, 2006). Whales may swim faster, travel in less predictable paths, change their dive times, move into more open water and reduce their foraging time in response to the presence of vessels. The long-term effects of whale-watching on Killer Whale populations are not known (Trites *et al.* 2002). In Canada, DFO has established voluntary guidelines for whale watching, which are currently being re-evaluated. Guidelines have also been established by the Whale Watch Operators Association Northwest for observing both Southern Resident and Transient Killer Whales (WWOAN 2007).

Oil spills

Killer Whales show little or no tendency to avoid oil spills, as demonstrated by a diesel fuel spill in August 2007 in an area designated as Critical Habitat in Johnstone Strait (CBC 2007) and by the *Exxon Valdez* crude oil spill in Prince William Sound, Alaska, in 1989 (Matkin *et al.* 2008). During the *Exxon Valdez* spill the Resident 'AB' pod was seen swimming in oil slicks immediately following the spill. This group experienced significant and unprecedented mortality (up to 18 times expected) in the months following oil exposure. Deaths were most likely due to the inhalation of petroleum vapours (Matkin *et al.* 2008). Mortality continued in the following year because mothers died leaving orphaned calves that subsequently died. Mortality in Transients in the AT1 population, which inhabits Prince William Sound, did not occur immediately, but 9 of the 22 whales in that population disappeared the following winter. They may have died from the protracted effects of inhaling toxic vapours or from feeding on heavily oiled Harbour Seals. Neither group ('AB' pod nor the AT1 population) has recovered since the 1989 spill (Matkin *et al.* 2008)

Tankers frequently cross the confined inland waters occupied by Resident and Transient Killer Whales (Baird 2001; Grant and Ross 2002; Fisheries and Oceans Canada 2008). Furthermore, the proposed 400,000 barrel/day pipeline to Kitimat, on the northern coast of BC (Enbridge 2007), will increase the tanker-associated risk of an oil spill significantly. On the Atlantic coast, Killer Whales also may be at risk from oil spills given the presence of a large offshore oil and gas industry (e.g., the Terra Nova spill in November 2004; CBC 2004). As the Northwest Passage opens up to oil tanker and container traffic with the reduction of sea ice (Schiermeier 2007), Killer Whales in the Arctic also will become more at risk from oil spills.

Ship strikes

At least eight Killer Whales are known or suspected to have been struck by vessels off the Canadian west coast, judging by observed incidents, scarring or recovery of carcasses. Six of these strikes have occurred since 2002. The types of vessels involved range from small high-speed skiffs (6-8 m length) to 20m tug boats (CRP-DFO unpublished data). The risk of collisions may be increasing for Killer Whales with the increase in vessel traffic in areas frequented by them.

Interactions with fisheries

It is not clear to what extent commercial or recreational fisheries threaten Killer Whales. Based on anecdotal accounts and the absence of net marks in identification photographs, it can be inferred that Pacific Killer Whales are rarely entangled in commercial fishing gear. In the Atlantic, at least two Killer Whales are known to have been entangled in gillnets (Lawson *et al.* 2007).

In BC, Resident Killer Whales may compete with commercial and recreational fisheries for fish (see earlier section) and in doing so may ingest fishing gear. Killer Whales with hooks and fishing lures caught in their mouths are observed from time to time (CRP unpublished data). Ford *et al.* (1998) reported that out of eight carcasses of Resident Killer Whales (with stomach contents), two had hooks or lures designed to catch salmon and two contained hooks used to catch Pacific Halibut (Ford et al 1998). These hooks and lures may be acquired when whales consume fish that escaped from fishing gear. Although steel hooks corrode in time, stainless steel hooks do not and may persist in the digestive system long after they are ingested. A juvenile Resident Killer whale necropsied in southeastern Alaska had lures for salmon stuck in its mouth, but was likely killed by a halibut hook that had pierced its esophagus (CRP unpublished data). This may be a long-term problem; a Southern Resident necropsied in 1986 had a stainless steel hook in its intestinal tract.

Direct killing

Historically, Resident Killer Whales that raided the gear of both commercial and recreational fishers were likely to be shot at by fishers and this may have been a significant cause of mortality (Olesiuk *et al.* 1990). Incidents of depredation on fishing gear by Killer Whales appear to be increasing off the northern BC coast (CRP-DFO unpublished data). Such behaviour, once started, is difficult to prevent or mitigate (Barrett-Lennard 2007; VAMSC 2007) and may lead to Killer Whales being shot at once again. In Prince William Sound, Alaska, depredation became widespread, and Killer Whales were often shot at until operational changes were made in the fishery (Matkin 2007).

Killer Whales are hunted or killed opportunistically in parts of the Arctic (Higdon 2007). Inuit in Canada have killed Killer Whales trapped in ice or saltwater lakes, and historically commercial whalers harpooned or shot them as pests or competitors. At least 21 (confirmed) and up to 37 (unconfirmed) Killer Whales were killed in the eastern Canadian Arctic between the 1950s and 2008 (Higdon 2007).

Hunters in West Greenland shoot Killer Whales opportunistically. Official statistics (Piniarneq 2006) indicate that 153 Killer Whales were taken between 1996 and 2004. Efforts to validate those data suggest that this was an overestimate and that although 130-150 were taken in the 1950s, only 55-70 were taken between 1996 and 2006 (Higdon 2007). However, the revised data are likely negatively biased because of underreporting and because animals that were shot and lost were not reported (Heide-Jørgensen 1988; Higdon pers. comm. 2007). No data are available for the period 1987-1995.

SPECIAL SIGNIFICANCE OF THE SPECIES

Killer Whales are apex predators with a cosmopolitan distribution. They hold iconic status with some aboriginal people, particularly in BC. As charismatic animals, they are exceptionally popular with the general public and are displayed in aquaria around the world. Killer Whales have been studied intensively in BC for more than 30 years in one of the world's longest ongoing programs of research on a wild animal population. Within the last 25 years they have also become an important focus of tourism operations, particularly in BC.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Globally, the Killer Whale is designated by IUCN as *Data Deficient*, and it is in CITES Appendix II. Table 3 summarizes the current status of the five identified Killer Whale populations known to occur regularly in Canada. Southern Residents are listed as Endangered under the United States *Endangered Species Act*.

Table 3. Federal, provincial and US status designations and protection for Canadian Killer Whale populations.

Population	Federal	Provincial	United States
Northern Resident	*Threatened* (Nov. 2001) and Critical Habitat proposed (Ford 2006) Final Recovery Strategy posted on SARA Public Registry March 2008	*Red List*	
Southern Resident	*Endangered* (Nov. 2001) and Critical Habitat proposed (Ford 2006) Final Recovery Strategy posted on SARA Public Registry March 2008	*Red List*	*Endangered* under the *Endangered Species Act* (2005) *Depleted* under the *Marine Mammal Protection Act* (May 2003) *Endangered* by Washington State (2004) Critical Habitat designated (Nov. 2006) San Juan County Ordinance* (Sept. 2007)
West Coast Transient	*Threatened* (Nov. 2001) Draft Recovery Strategy posted March 2008 on DFO website	*Red List*	
Offshore	*Special Concern* (Nov. 2001) Proposed Management Plan posted in April 2008 on DFO website	*Blue List*	
Northwest Atlantic/ Eastern Arctic	*Data Deficient* (Nov. 2001)		

**'Ordinance Regulating the Operation of Vessels in Proximity to the Southern Resident Killer Whales, an Endangered Species, and Establishing Penalties for the Violation Thereof'* based on the current Be Whale Wise Guidelines for boaters.

Killer Whale populations in British Columbia were first protected in 1970 under the *Wildlife Act*. In 1982 Killer Whales throughout Canada were protected under Sections 5 and 7 of the Marine Mammal Regulations of the *Fisheries Act*. Section 5 states that "subject to Section 6 [which provides exemptions for food, social or ceremonial purposes], no person shall fish for marine mammals except under the authority of a licence issued under these Regulations or under the Aboriginal Communal Fishing Licences Regulations." Section 7 stipulates, "No person shall disturb a marine mammal except when fishing for marine mammals under the authority of these Regulations." Under Section 32 of SARA, Northern and Southern Resident Killer Whales are protected from being killed, harmed, harassed, or captured, and under SARA Section 33 their critical habitats are protected from damage or destruction. Recovery plans have been written for Resident Killer Whales in BC, and recovery activities, including the designation and protection of Critical Habitat (see habitat section), are underway. A draft recovery strategy for transient Killer Whales and a draft management plan for Offshore Killer Whales are in progress. Table 3 lists the status and protection afforded all Killer Whale populations in Canada.

TECHNICAL SUMMARY - Southern Resident Population

Orcinus orca
Killer Whale
Southern Resident population
Range of Occurrence in Canada: Pacific Ocean

Épaulard
Population résidente du sud

Demographic Information

Generation time (average age of parents in the population)	26-29 yrs
Observed percent reduction in total number of mature individuals over the last 3 generations. Decline in the total number of mature individuals from 1993, when the highest number was reached for the period over which this population has been monitored (starting in 1974), to 2006 is 33.3%.	Unknown
Projected percent reduction in total number of mature individuals over the next 3 generations.	Unknown
Observed percent reduction in total number of mature individuals over any 3-generations period, over a time period including both the past and the future. Decline expected given recent decline in Chinook salmon abundance.	Unknown
Are the causes of the decline clearly reversible?	No
Are the causes of the decline understood? Decline due to high mortality, which correlates strongly with low Chinook salmon abundance. Contaminants and poor nutrition may interact to increase mortality.	No
Have the causes of the decline ceased? Chinook abundance is projected to remain low.	No
Observed trend in number of populations. There is one population of Southern Residents.	Stable
Are there extreme fluctuations in number of mature individuals? From 1974-2006 the maximum number of mature individuals (1993) was 72, the minimum number (1985) was 42.	No
Are there extreme fluctuations in number of populations?	No

Number of mature individuals in each population

Population	N Mature Individuals
Southern Resident Population (2006)	48
Grand Total	48

Extent and Area Information

Estimated extent of occurrence (km²)	220,000 km²
Observed trend in extent of occurrence	Stable
Are there extreme fluctuations in extent of occurrence?	No
Estimated area of occupancy (km²) (2 km x 2 km grid, clipped within the Extent of Occurrence and Canada's Extent of Jurisdiction)	99,549 km²
Observed trend in area of occupancy	Unknown
Are there extreme fluctuations in area of occupancy?	No
Is the extent of occurrence or area of occupancy severely fragmented?	No

Number of current locations	N/A
Trend in number of locations N/A	Unknown
Are there extreme fluctuations in number of locations? N/A	No
Observed trend in quality of habitat Quality of habitat is declining due to increasing physical and acoustical disturbance and contaminants	Decline

Quantitative Analysis

Although quantitative analyses have been carried out (e.g. % probability of extinction in 50 years), they provide little insight on likely future of this population	N/A

Threats (actual or imminent, to populations or habitats)

Primary threats are (a) reduced abundance of Chinook salmon, the principal prey of this population, and (b) physical and acoustical disturbance, which reduces the ability of whales to capture prey. Additional concerns are chemical contaminants, oil spills and mortality from ship strikes.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: Northern residents - Threatened; Southern Alaska residents unassessed	
Is immigration known or possible? Immigration between populations is not known to occur.	No
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Endangered 2001, 2008 BC Provincial Assessement: Red List; USA *Endangered Species Act*: Endangered (2005); *Marine Mammal Protection Act*: Depleted (2003); Washington State: Endangered (2004); Critical Habitat designated (Fisheries and Oceans Canada (2008)

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Endangered	C2a(i,ii); D1
Reasons for designation: The population is small and declining, and the decline is expected to continue. Southern residents are limited by the availability of their principal prey, Chinook Salmon. There are forecasts of continued low abundance of Chinook Salmon. Southern residents are also threatened by increasing physical and acoustical disturbance, oil spills and contaminants.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): The population was already reduced by 1974 when monitoring began. After a period of increase through the mid 1990s, the number of mature individuals has declined to approximately the same level as in 1974. Data are insufficient to make a meaningful assessment against this criterion.
Criterion B (Small Distribution Range and Decline or Fluctuation): Extent of occurrence is greater than 20,000 km^2.
Criterion C (Small and Declining Number of Mature Individuals): Meets criterion C2 for Endangered because number of mature individuals is only 48 (C), the number of mature individuals has been declining over the last 10-15 years (observed) and is expected to continue to do so (projected) in the foreseeable future (C2). There is only one population and it contains fewer than 250 mature individuals so the DU meets subcriteria (i) and (ii).
Criterion D (Very Small Population or Restricted Distribution): Total number of mature individuals is only 48 so population is very small and meets D1 for Endangered.
Criterion E (Quantitative Analysis): Quantitative analyses are not informative.

TECHNICAL SUMMARY - Northern Resident Population

Orcinus Orca
Killer Whale
Northern Resident population
Range of Occurrence in Canada: Pacific Ocean

Épaulard
Population résidente du nord

Demographic Information

Generation time (average age of parents in the population)	26-29 yrs
Observed percent increase in total number of mature individuals over the last 3 generations. From 1975, when monitoring of this population began, to 2006 the number of mature individuals increased by 72.6% (from 73 to 126). This population was significantly depleted when monitoring began in 1975. Growth over the last 10 years has averaged 5.8%.	Unknown
Projected percent reduction in total number of mature individuals over the next 3 generations. Declines in Chinook Salmon abundance may result in increased mortality.	Unknown
Observed percent reduction in total number of mature individuals over any 3-generations period, over a time period including both the past and the future. A decline of 8% in number of mature individuals from 1992 (n=113) to 2001 (n=104) was strongly correlated with low Chinook Salmon abundance. Further future declines in Chinook Salmon availability therefore would be expected to affect this whale population's status negatively.	Unknown
Are the causes of the decline clearly reversible? N/A	Unknown
Are the causes of the decline understood? N/A	Unknown
Have the causes of the decline ceased? N/A	Unknown
Observed trend in number of populations There is one population of Northern Residents	Stable
Are there extreme fluctuations in number of mature individuals?	No
Are there extreme fluctuations in number of populations?	No

Number of mature individuals in each population

Population	N Mature Individuals
Northern Resident population	126
Grand Total	126

Extent and Area Information

Estimated extent of occurrence (km²)	290,000 km²
Observed trend in extent of occurrence	Stable
Are there extreme fluctuations in extent of occurrence?	No
Estimated area of occupancy (km²) (2 km x 2 km grid, clipped within the Extent of Occurrence and Canada's Extent of Jurisdiction)	144,357 km²
Observed trend in area of occupancy	Unknown

Are there extreme fluctuations in area of occupancy?	No
Is the extent of occurrence or area of occupancy severely fragmented?	No
Number of current locations N/A	
Trend in number of locations N/A	
Are there extreme fluctuations in number of locations? N/A	
Observed trend in quality of habitat Quality of habitat is likely declining due to increasing physical and acoustical disturbance and contaminants.	Decline

Quantitative Analysis

None Available	

Threats (actual or imminent, to populations or habitats)

Primary threats are (a) reduced abundance of Chinook Salmon and (b) physical and acoustical disturbance, which reduces the ability of whales to capture prey. Additional concerns are chemical contaminants, oil spills, and mortality from ship strikes.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: Southern Residents: Endangered; Southern Alaskan residents unassessed	
Is immigration known or possible? Immigration between populations is not known to occur.	No
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	No

Current Status

COSEWIC: Threatened 2001, 2008 BC Provincial Assessment: Red List; Critical Habitat designated (Fisheries and Oceans Canada 2008)

Status and Reasons for Designation

Status: Threatened	**Alpha-numeric code:** Met criterion for Endangered, D1, but designated Threatened, D1, because of the recent and apparently ongoing increase in mature individuals.
Reasons for designation: The population is small, and is limited by the availability of its principal prey, Chinook Salmon. It is also at risk from physical and acoustical disturbance, oils spills and contaminants. However, this population has been increasing slowly but steadily since monitoring began in 1975.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): The population has been increasing slowly but steadily since monitoring began in 1975.
Criterion B (Small Distribution Range and Decline or Fluctuation): Extent of occurrence is greater than 20,000 km^2.
Criterion C (Small and Declining Number of Mature Individuals): Although the population is small enough to qualify for Endangered under C (total mature individuals is 126, well below the threshold of 2,500), there is no continuing decline. Therefore, it does not qualify for any designation under this criterion.
Criterion D (Very Small Population or Restricted Distribution): Total number of mature individuals is only 126, so population is very small and meets D1 for Endangered.
Criterion E (Quantitative Analysis): No quantitative analyses have been conducted.

TECHNICAL SUMMARY - West Coast Transient Population

Orcinus orca
Killer Whale
West Coast Transient population
Range of Occurrence in Canada: Pacific Ocean

Épaulard
Population migratrice de la côte Ouest

Demographic Information

Generation time (average age of parents in the population)	26-29 yrs
Estimated percent increase in total number of mature individuals over the last 3 generations. The total population has increased due to intrinsic growth and immigration although it is not known whether or to what extent the number of mature individuals has increased over the period in which this population has been monitored (1974-present). Since 1990 population growth has slowed due to reduced immigration.	unknown
Projected percent reduction in total number of mature individuals over the next 3 generations.	Unknown
Estimated percent increase in total number of mature individuals over any 3-generations period, over a time period including both the past and the future. The total population (all ages) has increased at ~2% per year since 1990.	Unknown
Are the causes of the decline clearly reversible? N/A	
Are the causes of the decline understood? N/A	
Have the causes of the decline ceased? N/A	
Observed trend in number of populations There is only one population of West Coast Transients.	Stable
Are there extreme fluctuations in number of mature individuals?	No
Are there extreme fluctuations in number of populations?	No

Number of mature individuals in each population

Population	**N Mature Individuals**
West Coast Transient population	~122
(estimate based on proportion of individuals photo-identified in 2006)	
Grand Total	~122

Extent and Area Information

Estimated extent of occurrence (km²)	290,000 km²
Observed trend in extent of occurrence	Stable
Are there extreme fluctuations in extent of occurrence?	No
Estimated area of occupancy (km²) (2 km x 2 km grid, clipped within the Extent of Occurrence and Canada's Extent of Jurisdiction)	154,986 km²
Observed trend in area of occupancy	Stable
Are there extreme fluctuations in area of occupancy?	No
Is the extent of occurrence or area of occupancy severely fragmented?	No

Number of current locations	N/A
Trend in number of locations N/A	
Are there extreme fluctuations in number of locations? N/A	
Observed trend in quality of habitat Quality declining due to increasing acoustical and physical disturbance and contaminants, but increasing availability of marine mammal prey might be offsetting, at least to some extent.	Unknown

Quantitative Analysis

None	

Threats (actual or imminent, to populations or habitats)

The primary threats are (a) increasing acoustical and physical disturbance and (b) oil spills. Increasing underwater noise (both chronic and acute) interferes with the ability of West Coast Transient Killer Whales to detect their prey acoustically, thus potentially having a negative effect on foraging success.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: Gulf of Alaska and California populations of Transient Killer Whales have not been assessed. Sympatric populations of residents: Northern Residents - Threatened, Southern Residents - Endangered under US ESA and Depleted under the US Marine *Mammal Protection Act*.	
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely? The exact relationship between West Coast Transients and other Transient populations is not well understood.	Likely

Current Status

COSEWIC: Threatened 2001, 2008 BC Provincial Assessment; Red List

Status and Reasons for Designation

Status: Threatened	**Alpha-numeric code:** Met criterion for Endangered, D1, but designated Threatened, D1, because total abundance has increased since the 1970s.
Reasons for designation: This population has a very small number of mature individuals (~122). It is subject to threats from high levels of contaminants, acoustical and physical disturbance, and potential oil spills. However, the population has been increasing since the mid-1970s when monitoring began, and its prey base of pinnipeds and cetaceans is likely stable or increasing.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): No reduction in the total number of mature individuals has been observed since monitoring began in 1975.
Criterion B (Small Distribution Range and Decline or Fluctuation): Extent of occurrence is greater than 20,000 km^2 and area of occupancy is greater than 2000 km^2.
Criterion C (Small and Declining Number of Mature Individuals): Although the population is small enough to qualify for Endangered under C (total mature individuals is ~122, well below the threshold of 2,500), there is no continuing decline. Therefore it does not qualify for any designation under this criterion.
Criterion D (Very Small Population or Restricted Distribution): Total number of mature individuals is only ~122, so population is very small and meets D1 for Endangered.
Criterion E (Quantitative Analysis): No quantitative analyses have been conducted.

TECHNICAL SUMMARY - Offshore Population

Orcinus orcas
Killer Whale — Épaulard
Offshore population — Population océanique
Range of Occurrence in Canada: Pacific Ocean

Demographic Information

Generation time (average age of parents in the population)	26-29 yrs
Estimated percent reduction in total number of mature individuals over the last 3 generations. From available evidence population appears stable.	Unknown
Suspected percent reduction in total number of mature individuals over the next 3 generations.	Unknown
Estimated percent reduction in total number of mature individuals over any 3-generations period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible? N/A	
Are the causes of the decline understood? N/A	
Have the causes of the decline ceased? N/A	
Observed trend in number of populations. Only one known population.	Stable
Are there extreme fluctuations in number of mature individuals?	No
Are there extreme fluctuations in number of populations?	No

Number of mature individuals in each population

Population	N Mature Individuals
Offshore population (based on the total number of Offshore Killer Whales photo-identified and adjusted using proportion of mature individuals in the Northern Resident population)	121
Grand Total	121

Extent and Area Information

Estimated extent of occurrence (km²) Source Jenny Wu, Environment Canada	300,000 km²
Inferred trend in extent of occurrence	Unknown
Are there extreme fluctuations in extent of occurrence?	No
Estimated area of occupancy (km²) (2 km x 2 km grid, clipped within the Extent of Occurrence and Canada's Extent of Jurisdiction)	170,490 km²
Observed trend in area of occupancy	Unknown
Are there extreme fluctuations in area of occupancy?	No
Is the extent of occurrence or area of occupancy severely fragmented?	No
Number of current locations	N/A
Trend in number of locations	Unknown

Are there extreme fluctuations in number of locations?	No
Observed trend in quality of habitat	Unknown

Quantitative Analysis

None

Threats (actual or imminent, to populations or habitats)

Threats are not well understood but likely include acoustical and physical disturbance.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: Unknown	
Is immigration known or possible?	Unknown
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Unknown
Is rescue from outside populations likely?	Unknown

Current Status

COSEWIC: Special Concern 2001, Threatened 2008 BC Provincial Assessment: Red List

Status and Reasons for Designation

Status: Threatened	**Alpha-numeric code:** Met criterion for Endangered, D1, but designated Threatened, D1, because the population appears to be stable and threats do not appear to be currently severe enough to be negatively affecting the population.
Reasons for designation: This population has a very small number of mature individuals (~120). It is subject to threats from high levels of contaminants, acoustical and physical disturbance, and potential oil spills. However, the population is monitored and appears to be stable.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): No reduction in the total number of mature individuals has been observed.
Criterion B (Small Distribution Range and Decline or Fluctuation): Extent of occurrence is greater than 20,000 km² and area of occupancy is greater than 2000 km².
Criterion C (Small and Declining Number of Mature Individuals): Although the population is small enough to qualify for Endangered under C (total mature individuals is ~120, well below the threshold of 2,500), there is no evidence to suggest a continuing decline. Therefore, it does not qualify for any designation under this criterion.
Criterion D (Very Small Population or Restricted Distribution): Total number of mature individuals is only ~120, so population is very small and meets D1 for Endangered.
Criterion E (Quantitative Analysis): No quantitative analyses have been conducted.

TECHNICAL SUMMARY - Northwest Atlantic / Eastern Arctic Population

Orcinus orca
Killer Whale
Northwest Atlantic / Eastern Arctic population

Épaulard
Population de l'Atlantique Nord-Ouest et de l'est de l'Arctique

Range of Occurrence in Canada: Atlantic and Arctic Oceans

Demographic Information

Generation time (average age of parents in the population)	26-29 yrs
Observed percent reduction in total number of mature individuals over the last 3 generations.	Unknown
Projected percent reduction in total number of mature individuals over the next 3 generations.	Unknown
Observed percent reduction in total number of mature individuals over any 3-generations period, over a time period including both the past and the future.	Unknown
Are the causes of the decline clearly reversible? N/A	Unknown
Are the causes of the decline understood? N/A	Unknown
Have the causes of the decline ceased? N/A	Unknown
Observed trend in number of populations	Unknown
Are there extreme fluctuations in number of mature individuals?	No
Are there extreme fluctuations in number of populations?	No

Number of mature individuals in each population

Population	**N Mature Individuals**
Northwest Atlantic / Eastern Arctic (based on sighting effort and knowledge of Pacific Killer whale population abundance)	Likely < 1000
Grand Total	Likely < 1000

Extent and Area Information

Estimated extent of occurrence (km²)	6,600,000 km²
Inferred trend in extent of occurrence Reduction in sea ice may increase range.	Increase
Are there extreme fluctuations in extent of occurrence?	No
Estimated area of occupancy (km²) (2 km x 2 km grid, clipped within the Extent of Occurrence and Canada's Extent of Jurisdiction)	3,329,551 km²
Observed trend in area of occupancy	Unknown
Are there extreme fluctuations in area of occupancy?	No
Is the extent of occurrence or area of occupancy severely fragmented?	Unknown
Number of current locations	N/A
Trend in number of locations N/A	Unknown

Are there extreme fluctuations in number of locations? N/A	No
Inferred trend in extent and quality of habitat Extent of habitat may be increasing due to reduced sea ice (i.e. more open water). Increased acoustical and physical disturbance may be reducing habitat quality in some areas.	Unknown

Quantitative Analysis

None

Threats (actual or imminent, to populations or habitats)

Little known but threats that affect other Killer Whale populations, particularly acoustical and physical disturbance, likely affect this one as well. Increased shipping and other human activity in the Arctic as a result of reduced sea ice is likely to put these whales at greater risk. Also, whales from this population may enter Greenland coastal waters where they would be at risk of deliberate killing by hunters.

Rescue Effect (immigration from an outside source)

Status of outside population(s)? USA: Unknown	
Is immigration known or possible?	Unknown
Would immigrants be adapted to survive in Canada?	Likely
Is there sufficient habitat for immigrants in Canada?	Likely
Is rescue from outside populations likely?	Unknown

Current Status

COSEWIC: Data Deficient 2001, Special Concern 2008

Status and Reasons for Designation

Status:	**Alpha-numeric code:**
Special Concern	
Reasons for designation: Threats to this population include hunting in Greenland, acoustical and physical disturbance, which will become greater as shipping traffic increases in the Arctic, and contaminants. The population's small size (fewer than 1000 mature individuals and likely fewer than 250) and the species' life history and social attributes justify designation as Special Concern.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): No reduction in the total number of mature individuals has been documented.
Criterion B (Small Distribution Range and Decline or Fluctuation): Extent of occurrence is greater than 20,000 km^2 and area of occupancy is greater than 2000 km^2.
Criterion C (Small and Declining Number of Mature Individuals): Although the population is small enough to qualify for Endangered under C (total mature individuals is well below the threshold of 2500), there is no evidence of a continuing decline. Therefore, the DU does not qualify for any designation under this criterion.
Criterion D (Very Small Population or Restricted Distribution): Total number of mature individuals is <1000, so population meets D1 for Threatened; may be <250 and thus may qualify for Endangered under this criterion.
Criterion E (Quantitative Analysis): No quantitative analyses have been conducted.

ACKNOWLEDGEMENTS AND AUTHORITIES CONSULTED

Contact tracking sheet

Name of jurisdiction	Name of contact(s) and date(s)
Canadian Wildlife Service	NA
Department of Fisheries and Oceans (aquatic species only)	Steve Ferguson, Research Scientist, Arctic Region, DFO Winnipeg (May 30, 2007) Jeff Higdon, Biologist, Arctic Region, DFO Winnipeg (numerous e-mail communications since April 2, 2007) Jack Lawson, Research Scientist, Marine Mammals Section, DFO St. John's (August 23, October 25-26, 2007) Veronique Lesage, Research Scientist, Maurice Lamontagne Institute, DFO Quebec (October 3, 2007)
Parks Canada	NA
Provincial / territorial representative(s) corresponding to the range of the species	NA
Conservation Data Centre(s) or Natural Heritage Information Centre(s) corresponding to the range of the species	The Centres for BC, Manitoba, Ontario, Quebec, Atlantic Canada, were all contacted on August 30, 2007.
Wildlife Management Board(s) corresponding to the range of the species (British Columbia, Yukon, Northwest Territories, Nunavut or northern Quebec)	The following WMBs were contacted on August 22, 2007: FJMC, HFTCC, NWMB, WMAC-NS, NWC and NJFMC.
COSEWIC Secretariat a) for information on sources of Aboriginal Traditional Knowledge b) to discuss requirements and methods for preparing distribution maps and calculating the extent of occurrence and area of occupancy.	a) Gloria Goulet, Coordinator Aboriginal Traditional Knowledge (August 3, 20-22, 2007). b) Alain Filion, Scientific and Geomatics Project Officer, Species Assessment Section, Ottawa (August 3, 2007) and Jenny Wu, Species Assessment Section, Ottawa (ongoing communication since August 22, 2007).
Community Knowledge (CK) contacts provided by COSEWIC through its CK initiative that began in 2005.	NA
Recovery team	All authors are on the Resident Killer Whale Recovery Team, and have participated in technical workshops for Transient and Offshore Killer Whales.

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BIOGRAPHICAL SUMMARY OF REPORT WRITERS

Kathy Heise has been involved in research on Killer Whales since the mid-1980s when she first began volunteering to monitor Killer Whales while working as a lighthouse keeper at various locations on the BC coast. Since then she has worked as a consulting biologist on projects studying marine mammals and seabirds in British Columbia and Alaska. Her MSc research was on the behaviour and ecology of Pacific White-sided Dolphins in BC. She is a member of the Resident Killer Whale Recovery Team and has participated in technical workshops on other marine mammals run by Fisheries and Oceans Canada. She has co-authored over 20 scientific publications and reports.

Lance Barrett-Lennard has been an active collaborator in ongoing studies of the behaviour and population biology of Killer Whales in British Columbia and Alaska since 1984. He has also studied the species in Norway and the sub-Antarctic. His MSc research was on the use of echolocation by Killer Whales in the wild. His PhD was on the population structure and mating patterns of Killer Whales revealed from DNA analysis. He is interested in the conservation of small populations, and the mechanisms of speciation and cultural transmission in animals. He heads the Cetacean Research Laboratory at the Vancouver Aquarium, is an adjunct professor in the Zoology Department at the University of British Columbia, and co-chairs the Resident Killer Whale Recovery Team.

John Ford has been involved in a long-term collaborative study of the identification, social organization and life history of Killer Whales since the 1970s. His PhD research focused on the call traditions and vocal dialects of resident Killer Whales in BC. Much of his research has involved the function of underwater acoustic signals in social communication, and the historical social evolution of Killer Whale populations. Recently his studies have focused on the foraging specializations of resident Killer Whales. As head of the Cetacean Research Program at the Pacific Biological Station in Nanaimo, his research also includes assessing the conservation status of SARA-listed marine mammals and turtles, with a particular emphasis on humpback whales. Ford is an adjunct professor in the Zoology Department at the University of British Columbia.