Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
Pacific Region
Canadian Science Advisory Secretariat
Science Advisory Report 2013/025

INFORMATION IN SUPPORT OF THE IDENTIFICATION OF CRITICAL HABITAT FOR TRANSIENT KILLER WHALES (*ORCINUS ORCA*) OFF THE WEST COAST OF CANADA

G. Ellis

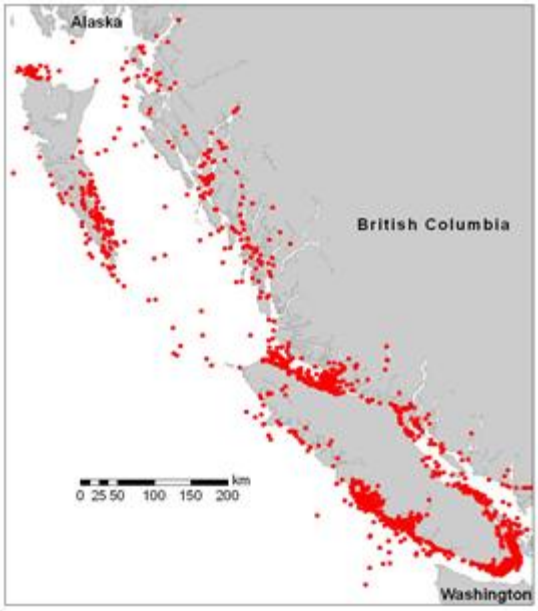

Figure 1. Locations of encounters with West Coast Transient killer whales in Canadian waters.

Context :

A population of mammal-hunting killer whales known as the 'West Coast Transient' population inhabits coastal waters of British Columbia. This population was designated by COSEWIC as Threatened in November 2001, and it became legally listed on Schedule 1 with the proclamation of the Species-at-Risk Act (SARA) in 2003. The Threatened status of this population was reaffirmed by COSEWIC in 2008.

A recovery strategy for transient killer whales in Canada was prepared by Fisheries and Oceans Canada (2007). The stated goal of the recovery strategy is: to attain long-term viability of the West Coast transient killer whale population by providing the conditions necessary to preserve the population's reproductive potential, genetic variation, and cultural continuity. Although the recovery strategy did not specify what constituted "viability" of this population, it outlined population and distribution objectives that were considered to be interim measures of recovery success over a five-year period following the strategy's completion. Key among these are that the population size, averaged over the next five years, will remain at or above the current (2007) level, that the transient killer whale population will continue to use its known range, that prey will be available within that range to allow for recovery, and that studies will be undertaken to determine how the range is utilized at a population and sub-population level.

As dictated in the SARA, recovery strategies are legally required to identify critical habitat, which is defined as the habitat that is necessary for the survival or recovery of a listed wildlife species that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species (SARA s.2 (1)). In cases where information is insufficient to identify critical habitat, the recovery strategy must include a schedule of studies to obtain such information. At the time the transient killer whale recovery strategy was

prepared, it was judged by the technical team involved in its drafting that existing information was inadequate to identify critical habitat and a schedule of studies was included in the document.

This document describes the extent of habitat that is considered to be required to meet the population and distribution recovery objectives for transient killer whales in British Columbia. This information is intended to assist in the identification and designation of critical habitat for West Coast Transient killer whales.

SUMMARY

- West Coast Transient (WCT) killer whales (*Orcinus orca*) are apex predators of marine mammals in coastal waters of British Columbia. This population has been studied annually since the early 1970s by means of photographic identification of individual whales using natural markings.
- A population of about 500 mammal-hunting WCT killer whales is known to use coastal waters of British Columbia. Two putative subpopulations occur in this area – "inner coast" WCT killer whales are commonly found in inshore, protected waters and in nearshore waters along the exposed west coasts of Vancouver Island and Haida Gwaii, and "outer coast" WCT killer whales are that rarely encountered, occurring mostly in deeper waters closer to the continental shelf break.
- A total of 304 individuals have been identified and assigned to the inner coast subpopulation based on frequency of encounters. An additional 217 rarely-seen individuals are considered to be members of the outer coast WCT subpopulation. The inner coast subpopulation appears to be increasing. The status of the outer coast subpopulation is unknown.
- WCT killer whales are highly mobile in Canadian nearshore waters. Most individuals have been recorded in multiple regions, from southern Vancouver Island to the Alaskan border. Despite this mobility, there is considerable site fidelity with many individuals returning repeatedly to particular regions, likely in order to benefit through familiarity with local habitats.
- Fine-scale movements of WCT killer whales can be characterized as constant, unpredictable and erratic. Feeding or travelling between foraging locations are their predominant activity states. WCT killer whales hunt most marine mammals found in nearshore waters, especially harbour seals, harbour porpoises, Steller sea lions and Dall's porpoises. Their hunting tactic is to use stealth to surprise and capture unsuspecting prey. They hunt opportunistically, with no evidence of specialization on particular prey species.
- The primary prey species of WCT killer whales are distributed widely in nearshore waters of the whales' habitat. WCT killer whales are likely vulnerable to local resource depression in foraging locations, whereby prey becomes alert to the whales' presence and less vulnerable to predation. For this reason, the whales tend to move continuously through their habitat and do not remain long in particular locations.
- Due to the high mobility of these whales and the large-scale movements of individuals throughout their coastal range, a substantial portion of their area of occupancy is essential habitat to ensure recovery. The widespread distribution of their prey, as well as the probable need for the whales to continually move between foraging locations to avoid the effects of local resource depression, similarly indicate that extensive habitat is required.
- Site fidelity of individuals to various regions within the population's overall range also highlights the importance of habitats distributed broadly throughout the area of occupancy.
- It is proposed that Pacific coast marine waters within 3 nautical miles (5.56 km) of the nearest shoreline be considered as the habitat necessary to meet the population and distribution recovery objectives for WCT killer whales. This area encompasses the locations

of 92% of all individual identifications of inner coast WCT killer whales and 64% of identifications of outer coast WCT killer whales made in BC waters between 1990 and 2011. Furthermore, this area also includes the locations of 90% of all predation events observed during the same period. This area comprises 40,358 square km, or about 8.9% of Canadian west coast waters.

- The biophysical functions, features and attributes of habitat considered necessary for recovery of WCT killer whales are described. These whales are year-round residents off Canada's west coast and thus this habitat must support all life processes necessary for the survival and recovery of the population.
- Feeding is a primary biophysical function, but other vital life processes include reproduction, socializing, and resting. No specific habitat area appears to serve particular functions other than feeding. The biophysical features and attributes to support the feeding function of this habitat are adequate year-round supplies of the whales' primary prey species that are distributed over a sufficient geographical area to allow exploitation of locally abundant prey resources that may vary seasonally, and to offset the probable effects of resource depression.
- Another important feature is the underwater acoustic environment, which must be of sufficient quality (i.e., low levels of anthropogenic ambient noise) that it enables the animals to utilize passive listening to detect prey and to communicate vocally.
- Activities or events that could destroy WCT killer whale habitat that is essential for recovery include the following:
    - any activity that would reduce prey abundance or accessibility, such as an oil spill resulting from a marine transportation accident or other incident, which has the potential to deplete prey;
    - developments in confined passages, such as the installation of tidal energy devices, which could present barriers to movements through the whales' foraging habitats or affect the distribution of their prey;
    - introduction of persistent bioaccumulating toxins (PBTs) into the habitat;
    - acoustic disturbance from anthropogenic noise; and,
    - physical disturbance from vessels or other marine activities.
- The degree of habitat destruction from anthropogenic activities would depend on the geographic extent, duration and intensity of the activity. In some cases, particularly those related to PBT contamination and anthropogenic noise, effects are poorly known. Further research is needed to establish thresholds that would constitute destruction under SARA.
- Additional research is needed to improve understanding of population structure of WCT killer whales in the region and to identify habitats that are essential to the putative outer coast WCT subpopulation.

BACKGROUND

The killer whale (*Orcinus orca*) is the largest member of the family Delphinidae and one of the most widely distributed mammals. It occurs in all the world's oceans and most seas, but is most commonly found in productive coastal waters in high latitude regions. There is an estimated total abundance of at least 50,000, but this is likely far short of the true global abundance. The killer whale is the apex marine predator, capable of feeding on a great diversity of prey, from the largest whales to small schooling fish. It has no natural predators. Despite being a generalist

predator as a species, different populations of killer whales often have highly specialized foraging strategies and diets.

Three distinct assemblages, or lineages, of killer whales have been described in coastal waters of the northeastern Pacific Ocean. These lineages, named *transient, resident* and *offshore*, differ in diet and foraging behaviour, acoustic behaviour, morphology, and genetic characteristics. Despite having overlapping ranges, these lineages do not mix and are thus socially and reproductively isolated from each other. Recent studies indicate that transient killer whales are the most genetically divergent of these lineages and warrant distinct species status. Transient killer whales – also known as Bigg's killer whales – specialize on marine mammal prey, although they occasionally kill and eat seabirds as well. There is no evidence from decades of field observations that they feed on fish. Resident killer whales prey mainly on fish, particularly salmon, and some squid. Offshore killer whales also feed on fish and may specialize on sharks. Neither residents nor offshores have been observed to prey on marine mammals. These foraging specializations appear to be fixed behavioural traits that are maintained by cultural transmission within populations.

Three putative populations of transient killer whales have been described from studies in nearshore waters of the northeastern Pacific. These are the so-called *West Coast transients*, distributed along the west coast of the mainland US and Canada, the *AT1 transients*, centered in Prince William Sound and Kenai Fjords, Alaska, and the *Gulf of Alaska transients,* most reliably seen between the central Gulf of Alaska and the central Aleutian Islands. The West Coast Transient (WCT) killer whale population is the only one known to frequent Canadian waters, and is the focus of this report. This population is distributed throughout coastal waters of British Columbia, with an overall coastal range from northern California to the northern extreme of southeastern Alaska. This represents a linear distance of over 2000 km along the coast.

Killer whales tend to live in long-term matrilineal groups. Transient killer whale society is considerably more dynamic than that of resident killer whales due to the regular dispersal of individuals, particularly females, from the natal matriline. As a result of dispersal, transient matrilines tend to be small – typical group sizes of transients are 3-6 individuals, though temporary associations of over 30 whales have been observed. Transients are acoustically quiet compared to residents, probably because their hunting strategy relies on stealthy approaches to unwary marine mammals.

ANALYSIS

Analyses were based on an archive of 15,904 positive individual identifications obtained from photographs collected during 3,582 encounters with WCT killer whales between 1958 and 2012. Encounters were distributed widely in coastal waters between northern California and southeastern Alaska. A total of 521 unique individuals were named during this period. Evidence suggests that these whales fall into two fairly discrete clusters that are spatially and socially heterogeneous. Although most animals in the population were encountered repeatedly in nearshore waters, a substantial proportion were identified only rarely (most seen in fewer than 10 encounters) and typically in outer coast waters. Many of these individuals appear to be members of adjacent populations found in waters to the south or north. Forty-six whales have been identified off central California and 14 are known from the southern Alaska coast (west of southeastern Alaska). These whales differ in vocal dialect from those commonly found in nearshore BC waters and those from Alaska differ in mitochondrial DNA haplotype. These uncommon individuals – referred to here as "outer coast" WCT killer whales – are found significantly more often in deeper waters closer to the continental shelf than the regularly sighted "inner coast" WCT killer whales. The rarity of encounters with outer coast WCT individuals is likely a result of the comparatively little survey effort conducted in exposed coastal waters more than 10 km from shore. Because outer coast WCT killer whales may represent a

discrete subpopulation that differs in habitat use patterns from the more commonly encountered inner coast WCT killer whales, they have not been included in descriptions of habitat use in this report. Detailed analyses were thus restricted to 304 individuals that were each identified on 15 or more occasions (mean of 44 encounters each versus mean of 3 encounters for each outer coast WCT killer whale). Spatial analyses were further restricted to the period of 1990 to 2011, as this period likely best represents current habitat use patterns.

Abundance and Distribution

Previous abundance estimates using photo-identification data for WCT killer whales indicated that the population has increased significantly since field studies began in the early 1970s (Ford et al. 2007). Between 1975 and about 1990, growth was driven largely by immigration of animals into the study area. Immigration slowed during the late 1980s, with continued growth being driven primarily by recruitment of new calves. The abundance of the putative inner coast subpopulation in 2006 was estimated to be 262 whales. Updated analyses through 2010 indicate that growth is continuing. Growth in the population is also reflected in gradually increasing average group sizes over the time series. The abundance of the outer coast subpopulation is unknown. A total of 217 individuals have been identified and assigned to this subpopulation to date.

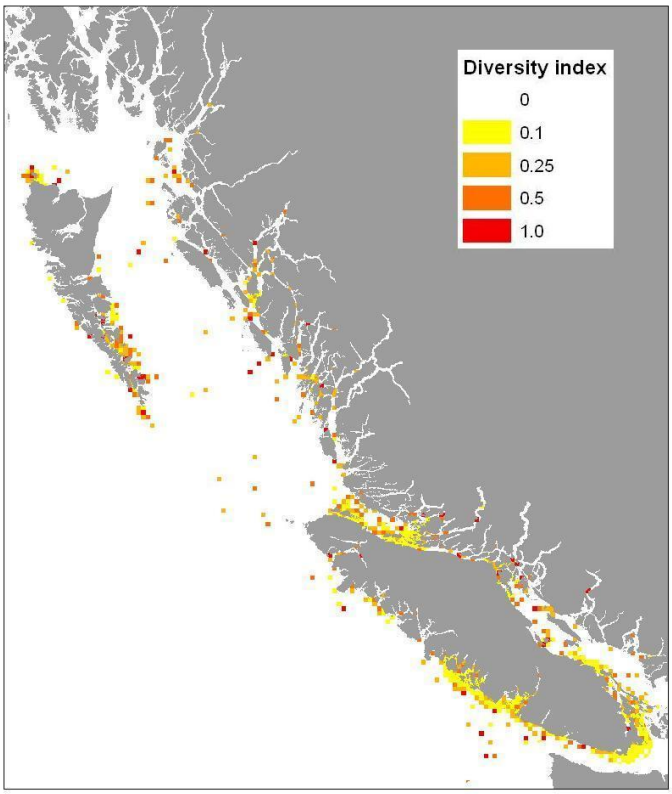

Figure 2. Map showing the relative diversity of inner coast WCT killer whales in BC waters, by 5x5 km grid cells. Colours correspond to values of a diversity index derived from the effective count of unique individuals identified per grid cell normalized by the total encounters in that cell (see Ford et al. 2012 for further details).

WCT killer whales are widely distributed in coastal waters of western Canada (Figure 1). They occur along the exposed outer coast as well as in protected inshore channels, straits, passages and inlets. They are most commonly observed within 10 km of the coast but, this may reflect a

bias in sighting effort favouring nearshore waters. Within this overall range, encounters have been concentrated in four hotspots – Clayoquot Sound along the west coast of Vancouver Island, near Victoria off southern Vancouver Island, near Nanaimo off the east coast of Vancouver Island, and in Johnstone Strait off northeastern Vancouver Island. It is important to recognize that these areas of apparent high density are also areas of long-term high observer effort, and that portions of coast with few or no encounters are, in most cases, areas with minimal observer effort. To partially mitigate the effect of this bias, we derived an index of WCT diversity based on the total number of individuals (the 'effective count'; see Ford et al. 2012) relative to number of encounters and mapped it on a 5x5 km grid (Figure 2). This indicates that the relatively high densities of WCT whales in these hotspots is driven more by spatially-biased effort than an actual heterogeneity in habitat use. WCT killer whales are broadly distributed throughout BC in nearshore waters and there is little evidence for areas that are strongly favoured by WCT killer whales over others.

Large-Scale Movements and Site Fidelity

WCT killer whales are highly mobile and travel widely throughout their range. Most whales in the inner coast subpopulation have been encountered in locations spread over hundreds of kilometres of coastline, and often make extensive transits of their range over relatively short periods of time. Most individuals have been identified in multiple regions of coastal BC, including both the east and west coasts of Vancouver Island, the central and northern BC mainland coasts, and in Haida Gwaii. Movement models indicate that individuals spend only a week or two in particular regions. Despite these broad movements, many individuals show a relatively high degree of site fidelity, returning repeatedly to particular coastal regions. Site fidelity may result from the benefits individuals would gain from familiarity with particular habitats and the location of prey resources within them, thereby improving their foraging success.

WCT killer whales occupy waters of BC year round. Detailed assessment of seasonal movement patterns of WCT killer whales was confounded by uneven timing of sampling effort. In most survey areas, effort was concentrated during June through September, when weather is favourable for field work and days are long. Survey effort outside of this period has been, in most areas, minimal or non-existent. However, effort has been reasonably consistent throughout the year off southeastern Vancouver Island. This shows fairly consistent occurrence of transients in most months, with a peak in August and September. Use of the area in June and July is lower than what might be expected given long days and favourable weather.

Distribution and Large-scale Movements Related to Predation

WCT killer whales are marine-mammal hunting specialists. Like most mammalian predators, their distribution and movement patterns are likely linked to the seasonal abundance and distribution of their prey. WCT killer whales hunt most species of marine mammals commonly found within their coastal range, with the exception of adults of the largest whales in the region. The most common of the nine marine mammal prey species identified was harbour seal, representing 52% of all predation events, followed by harbour porpoise (17%), Steller sea lion (13%) and Dall's porpoise (9%, n = 419 predation events). There is no evidence that individual WCT killer whales specialize on particular prey species or types (e.g., porpoises versus seals).

The important prey species consumed by WCT killer whales are widely distributed in the study area, although each differs somewhat in habitat preferences. There is little evidence for significant regional differences in frequencies of prey species consumed, although harbour seals represented a larger component of diet off southeastern Vancouver Island likely due to the higher density of this species in these waters compared to other areas along the BC coast.

It is difficult to assess quantitatively whether large-scale movements of WCT killer whales vary in relation to any temporal or spatial variation in the availability of important prey species. The majority of WCT sightings were opportunistic and insufficient data are available on survey effort with which to correct for seasonal or geographic bias. There is some evidence that seasonal distribution may be influenced to some degree by the timing of harbour seal pupping, which varies latitudinally over the whales' range. This may explain the peak in WCT sightings off southern Vancouver Island typically observed during August and September, which is the period of weaning of harbour seal pups in this region.

Small-scale Patterns of Habitat Use

Small-scale movement patterns of WCT killer whales in their habitat can be characterized as constant, unpredictable, and at times erratic. The animals tend to travel in small groups, swimming constantly and covering 75-150 km per day. WCT killer whales are usually found close to land – over half of all encounters took place within 1 km of the nearest shore. They often swim in very shallow water within tens of metres of shorelines and around rocky reefs and islets, and tend to enter inlets and bays rather than crossing their entrances. The patterns of local movements of WCT killer whales are most likely a reflection of the method by which they hunt their marine mammal prey. Foraging occupies the majority of their daylight activity budget. Their hunting strategy appears to depend on stealth and surprise attack on marine mammals that they detect visually or perhaps through passive listening to hydrodynamic sounds or vocalizations produced by the prey. WCT killer whales detect and attack prey opportunistically in open water, rather than targeting particular species. Although killer whales may closely approach pinniped haulouts, they do not linger at such sites nor do predation events appear to be related to proximity to haulouts.

Resource depression – a decrease in the rate of prey capture owing to the activities of the predator – may play an important role in determining local movement patterns of WCT killer whales in their habitat. Given that WCT killer whales hunt by stealth and sneak attack, once the element of surprise is gone it is likely more profitable for a group to move out of the area in search of new prey that would be unaware of their presence. This would explain why WCT killer whales are constantly on the move, spending very little time in any given area, even if that area contains high densities of marine mammal prey. The effects of resource depression may be an issue for more than just the whales that have caused it – other WCT groups coming into an area would likely experience reduced hunting success caused by the transit of an earlier group until such effects have diminished. This likely promotes separation of WCT groups in space and time in their habitat.

Critical Habitat: Biophysical Functions, Features and Their Attributes

According to DFO's guidelines for the identification of critical habitat (Fisheries and Oceans Canada. Species at Risk Act (SARA) Operational Guidelines for the Identification of Critical Habitat for Aquatic Species at Risk. Unpublished report dated April 26, 2011), its biophysical function describes how the critical habitat is used by the species to support specific life processes. In the case of WCT killer whales, the population is non-migratory and a substantial proportion of the putative inner coast subpopulation spends the majority of its life cycle within coastal waters of British Columbia. Critical habitat in Canada must, therefore, support all life processes necessary for the survival and recovery of WCT killer whales. Clearly of prominent importance is feeding, but other vital life processes would include reproduction (courtship, mating, calving, nursing, etc), socializing, and resting. Foraging or travelling between foraging locations dominates the activity budget of WCT killer whales, and many life processes are no doubt undertaken concurrently with this activity. No specific locations or habitat types are known to be utilized for processes other than feeding.

The biophysical features of critical habitat are how that habitat provides for the functions described (Fisheries and Oceans Canada. Species at Risk Act (SARA) Operational Guidelines for the Identification of Critical Habitat for Aquatic Species at Risk. Unpublished report dated April 26, 2011). Since a primary function of critical habitat for WCT killer whales is feeding, food availability is certainly of paramount importance. Based on the foraging ecology of WCT killer whales, food availability would require adequate year-round supplies of a variety of marine mammal prey species, especially harbour seals, harbour porpoises, Steller sea lions, and Dall's porpoises. These prey species in aggregate comprise over 90% of observed predation. Adequate food availability also requires that the critical habitat be of sufficient geographical extent to allow potential exploitation of locally abundant prey resources that may vary seasonally (e.g. harbour seal pups). Another important feature of critical habitat may be the underwater acoustic environment, which must be of sufficient quality (i.e., low levels of anthropogenic ambient noise) that it enables the animals to utilize passive listening to detect prey and to communicate vocally.

The biophysical attributes of critical habitat can be defined as the components of the features that together allow those features to support the function of the habitat (Fisheries and Oceans Canada. Species at Risk Act (SARA) Operational Guidelines for the Identification of Critical Habitat for Aquatic Species at Risk. Unpublished report dated April 26, 2011). For there to be sufficient food availability, important prey species must not only be abundant enough to support the WCT population, they must be distributed widely in the whales' habitat so that efficient foraging is possible. Although it is possible to estimate the energetic (i.e., caloric) requirements of WCT killer whales, it is difficult to translate this into the biomass and number of individuals of various prey species needed to support the existing population or to sustain continued growth. More information is needed on the age and size classes (and thus, mass) of individuals preyed upon by WCT killer whales, the relative profitability of each prey species, and the factors that lead the whales to choose one prey species over another. It is reasonable to conclude that current prey abundance is sufficient to sustain the existing population of WCT killer whales, which has been growing for several decades and continues to grow.

In terms of the extent of habitat needed for sufficient food availability, however, the overall abundance of prey species in that habitat is not the only important attribute. Others include a wide distribution of this prey over a geographical area that is sufficient to allow the whales to maintain adequate capture rates by mitigating the effects of local resource depression through continual movement. There is, however, insufficient information with which to quantitatively estimate the geographical densities of different prey species that support the food availability feature of critical habitat. Attributes that are important in the acoustic environment of critical habitat are similarly difficult to assess. There is considerable uncertainty about the effects of both chronic and acute anthropogenic noise on cetaceans generally and WCT killer whales specifically (Fisheries and Oceans Canada 2007). Furthermore, the extent to which WCT killer whales rely on underwater acoustics to detect prey and undertake other important life processes is not fully known. It is currently not possible to define quantitatively the specific attributes that contribute to the features of the acoustic environment that facilitate critical habitat functions. However, past research has shown that both WCT killer whales and their prey can be displaced from habitats by the introduction of intense anthropogenic noise.

Identification of Habitat Necessary to Meet Recovery Objectives

Following recommendations provided in DFO's operational guidelines for the identification of critical habitat, the *bounding box* approach is used to define the extent of habitat that is likely to be required in order to meet population and distribution recovery objectives for WCT killer whales (Fisheries and Oceans Canada 2007). For wide-ranging marine species such as WCT killer whales, the bounding box containing critical habitat may be the overall area of occupancy

of the species. For WCT killer whales, the area of occupancy is extensive and likely includes some offshore waters that have not yet been identified. By including all nearshore marine waters within 3 nautical miles (5.56 km) of land, the habitat area encompasses the locations of 92% of all individual identifications of all inner coast WCT killer whales and 64% of outer coast WCT whales made in BC waters between 1990 and 2011. Furthermore, this area also includes the locations of 90% of all predation events observed during the same period. A map showing the boundaries of this habitat is provided in Figure 3.

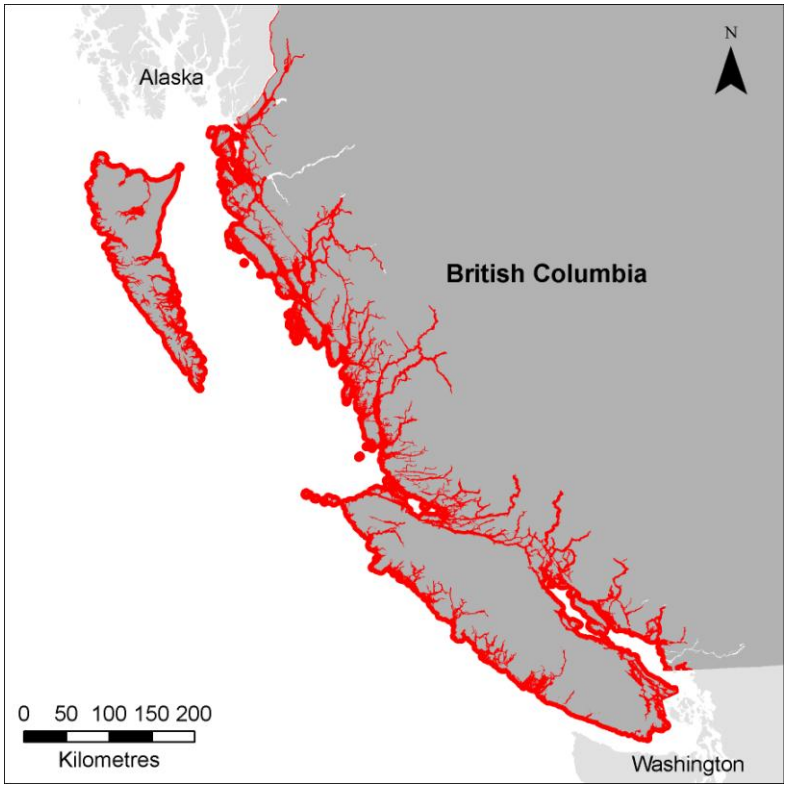

Figure 3. Map showing the habitat considered to be necessary to meet population and distribution recovery objectives for inner coast WCT killer whales. Area includes marine waters bounded by a distance of 3 nautical miles (5.56 km) from the nearest shore. This area includes the locations of over 90% of all individual identifications and predation events of inner coast WCT killer whales documented in Canadian waters during 1990-2011.

Activities Likely to Result in the Destruction of Critical Habitat

When critical habitat is identified, SARA requires that "examples of activities that are likely to result in its destruction will be provided". Most known threats to WCT killer whales and their habitat are described in detail in the recovery strategy (Fisheries and Oceans Canada 2007) or recovery potential assessment (Ford et al. 2007) for this population. Threats that meet the criteria for consideration as activities likely to result in the destruction of critical habitat, as outlined in Fisheries and Oceans Canada Species at Risk Act (SARA) Operational Guidelines for the Identification of Critical Habitat for Aquatic Species at Risk (unpublished report dated April 26, 2011), are included below.

Reduction in Prey Abundance or Availability

Any activity that would result in reduced abundance or availability of prey could be considered destruction of WCT critical habitat. Large-scale culls and harvests of pinnipeds in the late 1800s to mid 1900s depleted populations of harbour seals and Steller sea lions. This likely had

a major effect on the abundance and distribution of WCT killer whales in BC waters. Occurrence of WCT killer whales in the Strait of Georgia has shown a strong increase over the past four decades, associated with the return of harbour seal abundance to historical levels in this area. No renewed harvesting or large-scale culling of pinnipeds is anticipated.

Spills Resulting from Marine Transportation of Oil

Spills from marine transportation of oil are known to result in significant mortality to marine mammals, including killer whales. The 1989 Exxon Valdez oil spill in Prince William Sound, Alaska, was linked to unprecedented mortality rates of both fish-eating resident killer whales and mammal-eating transient killer whales. The spill also resulted in direct mortality to harbour seals during and immediately following the spill and continued declines over the next decade. Given that significant volumes of oil are transported through inside passages along the BC coast each year and that there are new proposals currently in review for a substantial expansion of this activity, oil spills should be considered as a potential cause of destruction of critical habitat through mortality and subsequent reduced availability of prey of WCT killer whales. The amount of habitat destruction caused by an oil spill would depend on the location, volume of oil spilled, and the extent of area impacted.

Industrial Developments in Confined Passages

Developments that involve the introduction of novel objects and/or noise, especially in confined passages, could result in displacement or barriers to movements in critical habitat. New technologies being developed to exploit sources of energy in the marine environment include the installation of underwater hydroelectric turbines in areas of high tidal flows. Turbines have multiple blades that are either open or shielded within a duct or tube to direct water flow. Turbine rotation speed depends on current velocity, but speeds of up to 20–30 RPM are typical with blade tip velocities of up to 12 m/s (23 knots). Although potential blade strikes are an issue of concern for marine mammals, the physical presence of such devices, and the underwater noise they produce during operation, could affect critical habitat. Although sound levels are no greater than a moderate sized motorized vessel, the frequency spectrum of turbine noise is unlike that of vessels and thus would be unfamiliar to whales. This, coupled with the physical presence of a novel rotating underwater object, may cause whales to avoid areas with these devices. Impacts on WCT prey from such developments could also affect the function of WCT critical habitat.

Several project proposals in BC involve placement of tidal energy turbines in narrow passages between 100 and 800 m wide, where tidal currents are concentrated. Many of these passages are important thoroughfares for WCT killer whales as they move through their habitat. Should these devices present an obstacle to passage by WCT whales, it may prevent them from efficiently utilizing important feeding areas or otherwise restrict free movements through their habitat. Because there have been very few deployments of underwater turbines within WCT range to date, there is no information on the probability of avoidance of these devices. However, there is at least once precedent for a novel, man-made structure, the Hood Canal bridge in Washington State, having apparently impeded the passage of WCT whales. The potential for the installation of tidal energy turbines in key passageways to detrimentally alter WCT killer whales' use of proposed critical habitat requires further study.

Environmental Contaminants

Killer whales in coastal waters of the northeastern Pacific carry significant concentrations of Persistent Bioaccumulating Toxins (PBTs) in their tissue. Of greatest concern are polychlorinated biphenyls (PCBs), which are found at extremely high concentrations in WCT killer whales due to their consumption of marine mammals that are already contaminated with

PCBs. Although PCB levels are declining in the environment, new emerging contaminants such as polybrominated diphenyl ethers (PBDEs), are increasing. As with PCBs, the potential direct effect of PBDEs on transient killer whale health is not clear, though there is growing evidence of endocrine disruption and immunotoxicity in other species (Fisheries and Oceans Canada 2007). Should high levels of PBTs be introduced into WCT killer whale critical habitat, concentrations of these toxins in WCT killer whales will continue to bioaccumulate through consumption of marine mammal prey.

Acoustic Disturbance from Human Activities

There has been increasing evidence in recent years of negative effects of underwater noise on cetaceans. Acoustic disturbance can be of two types: chronic and acute. Chronic noise is primarily associated with motorized vessel traffic of all types, from commercial shipping to whale watching. Chronic noise can result in masking of communication signals used for social contact or behavioural coordination, or interfere with echolocation signals used for navigation and discrimination. WCT killer whales often forage silently and may rely on passive listening to locate their prey. Masking effects of increasing background noise could thus reduce their foraging efficiency and the function of critical habitat.

Sources of acute noise include military and commercial sonars, airguns used in seismic surveys, and underwater explosions usually associated with construction. These sounds can be extremely intense and may travel large distances underwater. Acute noises have the potential to cause a variety of effects in cetaceans, including hearing threshold shifts, production of stress hormones, and tissue damage, as well as a variety of behavioural responses. Intense sounds generated by acoustic deterrent devices (ADDs) used to deter pinnipeds from aquaculture facilities off northeastern Vancouver Island appeared to displace WCT killer whales from important feeding habitats. These sounds also caused harbour porpoises, an important WCT prey species, to leave the ensonified areas.

Physical Disturbance

Vessels moving in close proximity to killer whales have the potential to disrupt behaviours. Although no studies have focused on WCT killer whales specifically, resident killer whales have been shown to alter their swimming behaviour when approached by boats. With the increased intensity of whale watching activity in the vicinity of WCT killer whales in some areas, there is a potential for vessels to disrupt hunting behaviour, thereby reducing overall foraging success. WCT killer whale attacks on marine mammals are often protracted and involve energetic, high-speed swimming, and vessels in close proximity can cause the whales to abandon their attack, or provide the prey item with a refuge to escape from the attacking whales.

Sources of Uncertainty

Although habitat use patterns of WCT killer whales that use inner coast waters are reasonably well known, there is insufficient information available to characterize habitats of the component of the population that is found mostly in outer coast waters. This subpopulation comprises 42% of the WCT killer whales identified in the region. Thus, the habitat considered to be necessary to meet population and distribution recovery objectives (Figure 3) applies only to the 58% of the population that prefer inner coast waters. Further studies are needed to document distribution, movements and foraging ecology of outer coast WCT killer whales in order to document additional critical habitats.

The functions, features and attributes of critical habitat for WCT killer whales are not fully known. The relative profitability of different marine mammal prey species and its role in determining prey preferences requires further study, as does the importance of resource

depression in driving whale movements and determining the overall area of habitat required for the population. The relative importance of passive listening by the whales in locating prey, and thus the potential for anthropogenic noise to reduce foraging success, is poorly known.

CONCLUSIONS AND ADVICE

A population of more than 500 mammal-hunting WCT killer whales is known to use coastal waters of British Columbia. There is evidence that there are two fairly discrete subpopulations in this area that differ in distribution – "inner coast" WCT killer whales are commonly found in inshore, protected waters and in nearshore waters along the exposed west coasts of Vancouver Island and Haida Gwaii, and "outer coast" WCT killer whales are rarely encountered, mostly in deeper waters closer to the continental shelf break. Based on encounter locations and frequencies, a total of 304 individuals have been identified, each on an average of 44 occasions, and assigned to the inner coast subpopulation. An additional 217 rarely seen individuals, each identified on an average of only 3 occasions, are considered to be members of the outer coast WCT subpopulation. The inner coast subpopulation appears to be increasing.

WCT killer whales are highly mobile in Canadian nearshore waters, with the majority whales having been recorded in multiple regions, from southern Vancouver Island to the Alaska border. Despite this mobility, there are reasonably high levels of site fidelity with many individuals returning repeatedly to particular regions, likely to benefit from familiarity with local habitats. On a finer-scale, movements of WCT killer whales can be characterized as constant, unpredictable and erratic. The great majority of time is spent feeding or moving between foraging locations. WCT killer whales hunt most marine mammals found in nearshore waters, using stealth to surprise unsuspecting prey. They appear to hunt opportunistically, with no evidence of specialization on particular prey species. The primary prey species of WCT killer whales are distributed widely in nearshore waters of their habitat. WCT killer whales are likely vulnerable to local resource depression in foraging locations, whereby prey becomes alerted to the whales' presence and thus less vulnerable to predation. For this reason, WCT killer whales tend to move continuously through their habitat and do not remain long in particular locations.

A bounding box approach (Fisheries and Oceans Canada. Species at Risk Act (SARA) Operational Guidelines for Identification of Critical Habitat for Aquatic Species at Risk. Unpublished report dated April 26, 2011) is considered to be the best method to use to identify the extent of habitat that is considered to be required in order to meet population and distribution recovery objectives for WCT killer whales. Due to the high mobility of these whales and the large-scale movements of individuals throughout their coastal range, a substantial portion of their area of occupancy should be included as critical habitat. The widespread distribution of their primary prey species as well as the need for the whales to continually move between foraging locations to avoid the effects of resource depression similarly indicate that an extensive area of habitat is required. Site fidelity of individuals to various regions within the population's overall range highlights the importance of habitats distributed broadly throughout the area of occupancy. It is thus proposed that all marine waters within 3 nautical miles (5.56 km) of the nearest shoreline be considered as the habitat necessary to meet recovery objectives. This area encompasses the locations of 92% of all individual identifications of inner coast WCT killer whales and 64% of identifications of outer coast WCT killer whales made in BC waters between 1990 and 2011. Furthermore, this area also includes the locations of 90% of all predation events observed during the same period.

The biophysical functions, features and attributes of habitat considered necessary for recovery of WCT killer whales are essentially the same as those of potential critical habitat to be designated under SARA. WCT killer whales are year-round residents off Canada's west coast and thus this habitat must support all life processes necessary for the survival and recovery of WCT killer whales. Feeding is a primary function but other vital life processes include

reproduction, socializing, and resting. The biophysical features and attributes to support a feeding function for this habitat is adequate year-round supplies of the whales' primary prey species, distributed over a sufficient geographical scope to allow potential exploitation of locally abundant prey resources that may vary seasonally and to offset the effects of resource depression. Another important feature is the underwater acoustic environment, which must be of sufficient quality (i.e., low levels of anthropogenic ambient noise) that it enables the animals to utilize passive listening to detect prey and to communicate vocally.

Activities likely to destroy WCT killer whale habitat essential for recovery include the following:

- any activity that would reduce prey abundance or accessibility, such as an oil spill resulting from a marine transportation accident or other incident, which has the potential to deplete prey
- industrial developments in confined passages, such as tidal energy installations, which could present barriers to movements through the whales' foraging habitats
- the introduction of persistent bioaccumulating toxins (PBTs) into the habitat
- acoustic disturbance from anthropogenic noise
- physical disturbance from vessels

The extent of habitat destruction would depend on the geographic scope and intensity of the activity. In some cases, particularly those related to PBT contamination and anthropogenic noise, effects are poorly known and it is difficult to establish thresholds that would be considered destruction under SARA.

SOURCES OF INFORMATION

This Science Advisory Report is from the October 29 to November 2, 2012 Annual meeting of the National Marine Mammal Peer Review Committee (NMMPRC). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Fisheries and Oceans Canada. 2007. Recovery Strategy for the Transient Killer Whale (*Orcinus orca)* in Canada. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Vancouver, vi + 46 pp.

Ford, J.K.B., G.M. Ellis, and J.W. Durban. 2007. An assessment of the potential for recovery of West Coast transient killer whales using coastal waters of British Columbia. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/088. Iv + 34 pp.

Ford, J.K.B, E.H. Stredulinsky, J.R. Towers and G.M. Ellis. 2013. Information in Support of the Identification of Critical Habitat for Transient Killer Whales (*Orcinus orca*) off the West Coast of Canada DFO Can. Sci. Advis. Sec. Res. Doc. 2012/155. v + 46 p.

THIS REPORT IS AVAILABLE FROM THE:

Centre for Science Advice (CSA)
Pacific Region
Fisheries and Oceans Canada
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

Telephone: (250) 756-7208
E-Mail: csap@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-5087

Correct Citation for this Publication:

DFO. 2013. Information in Support of the Identification of Critical Habitat for Transient Killer Whales (*Orcinus orca*) off the West Coast of Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/025.

Aussi disponible en français :

MPO. 2013. Renseignements à l'appui de la désignation de l'habitat essentiel des épaulards migrateurs (Orcinus orca) au large de la côte Ouest canadienne. Secr. can. de consult. sci. du MPO, Avis sci. 2013/025.