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KILLER WHALE (*Orcinus orca*): West Coast Transient Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

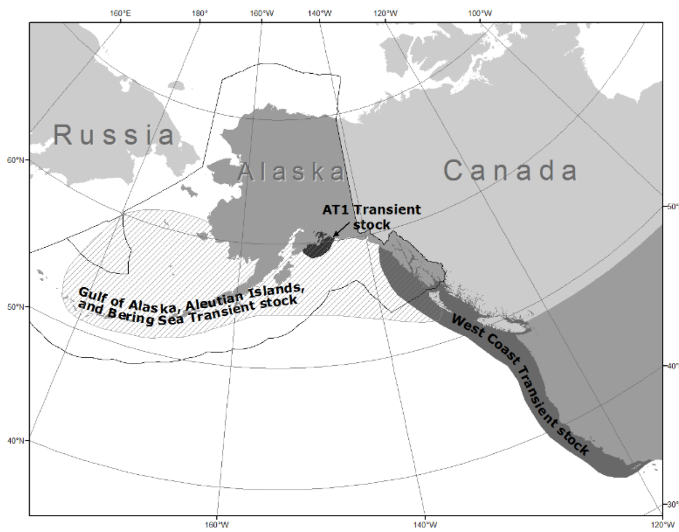

Figure 1. Approximate distribution of transient killer whales in the eastern North Pacific (shaded areas). The distribution of resident and transient killer whale stocks in the eastern North Pacific largely overlap (see text). The U.S. Exclusive Economic Zone is delineated by a black line.

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes (Mitchell 1975, Leatherwood and Dahlheim 1978, Forney and Wade 2006). Killer whales are found throughout the North Pacific Ocean. Along the west coast of North America, seasonal and year-round occurrence of killer whales has been noted along the entire Alaska coast (Braham and Dahlheim 1982), in British Columbia and Washington inland waterways (Bigg et al. 1990), and along the outer coasts of Washington, Oregon, and California (Green et al. 1992; Barlow 1995, 1997; Forney et al. 1995). Killer whales from these areas have been labeled as "resident," "transient," and "offshore" type killer whales (Bigg et al. 1990, Ford et al. 2000, Dahlheim et al. 2008) based on aspects of morphology, ecology, genetics, and behavior (Ford and Fisher 1982; Baird and Stacey 1988; Baird et al. 1992; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000; Dahlheim et al. 2008). Through examination of photographs of recognizable individuals and pods, movements of whales between geographical areas have been documented. For example, whales identified in Prince William Sound have been observed near Kodiak Island (Matkin et al. 1999) and whales identified in Southeast Alaska have been observed in Prince William Sound, British Columbia, and Puget Sound (Leatherwood et al. 1990, Dahlheim et al. 1997). Movements of killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994, Black et al. 1997, Dahlheim and White 2010).

Several studies provide evidence that the resident, offshore, and transient ecotypes are genetically distinct in both mtDNA and nuclear DNA (Hoelzel and Dover 1991; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). Genetic differences have also been found between populations within the transient and resident ecotypes (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000). A global genetic study of killer whales using the entire mitochondrial genome found that some killer whale ecotypes represent deeply divergent evolutionary lineages and warrant elevation to species or subspecies status (Morin et al. 2010). In particular, estimates from mitogenome sequence data indicate that transient killer whales diverged from all other killer whale lineages approximately 700,000 years ago. In light of these differences, the Society for Marine Mammalogy's Committee on Taxonomy currently recognizes the resident and transient North Pacific ecotypes as un-named *Orcinus orca* subspecies (Committee on Taxonomy 2019). In recognition of its status as an un-named subspecies or species, some researchers now refer to transient-type killer whales as Bigg's killer whales (e.g., Ford 2011, Riesch et al. 2012), in tribute to the late Dr. Michael Bigg.

The first studies of transient killer whales in Alaska were conducted in Southeast Alaska and in the Gulf of Alaska (from Prince William Sound, through the Kenai Fjords, and around Kodiak Island). In the Gulf of Alaska, Matkin et al. (1999) described two genetically distinct populations of transients which were never found in association with one another, the so-called "Gulf of Alaska" transients and "AT1" transients. In the past, neither of these populations were known to associate with the population of transient killer whales that ranged from California to Southeast Alaska, which are described as the West Coast Transient stock. Gulf of Alaska transients are documented throughout the Gulf of Alaska, including occasional sightings in Prince William Sound. AT1 transients have been seen only in Prince William Sound and in the Kenai Fjords region, and are therefore partially sympatric with Gulf of Alaska transients. In addition, 14 out of 217 transients on the outer coast of Southeast Alaska and British Columbia were identified as Gulf of Alaska transients and in one encounter they were observed mixing with West Coast transients (Matkin et al. 2012, Ford et al. 2013). Transients within the Gulf of Alaska population have been found to have two mtDNA haplotypes, neither of which is found in the West Coast or AT1 populations. Members of the AT1 population share a single mtDNA haplotype. Transient killer whales from the West Coast population have been found to share a single mtDNA haplotype that is not found in the other populations. Additionally, all three populations have been found to have significant differences in nuclear (microsatellite) DNA (Barrett-Lennard 2000). Acoustic differences have been found as well; Saulitis et al. (2005) described acoustic differences between Gulf of Alaska transients and AT1 transients. For these reasons, the Gulf of Alaska transients are considered part of a population that is discrete from the AT1 population, and both of these populations are considered discrete from the West Coast transients.

Transient-type killer whales from the Aleutian Islands and Bering Sea are currently considered to be part of a single population that includes Gulf of Alaska transients; however, recent genetic analyses suggest substructure within the region. Biopsy samples from the eastern Aleutians and the south side of the west end of the Alaska Peninsula have produced the same haplotypes as killer whales in the northern Gulf of Alaska; however, nuclear DNA analysis strongly suggests they belong to a separate population (Parsons et al. 2013). The geographic distribution of mtDNA haplotypes revealed samples from the central Aleutian Islands and Bering Sea with haplotypes not found in Gulf of Alaska transients, suggesting additional population structure in western Alaska. Killer whales observed in the northern Bering Sea and north and east to the western Beaufort Sea have characteristics of transient-type whales, but little is known about these whales (Braham and Dahlheim 1982, George and Suydam 1998). AT1 haplotype whales are also present west of the Aleutian Islands and into the Bering Sea; however, nuclear DNA analysis indicates these animals are not part of the AT1 transient population in the Gulf of Alaska (Parsons et al. 2013).

In summary, within the transient ecotype, association data (Ford et al. 1994, Ford and Ellis 1999, Matkin et al. 1999), acoustic data (Ford and Ellis 1999, Saulitis et al. 2005), and genetic data (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000) confirm that at least three communities of transient whales exist and represent three discrete populations: 1) Gulf of Alaska, Aleutian Islands, and Bering Sea transients, 2) AT1 transients, and 3) West Coast transients.

Most of the transient killer whales photographed in the inland waters of Southeast Alaska share the West Coast Transient haplotype and have been seen in association with British Columbia/Washington State transients. Transients most often seen off California also share the West Coast Transient (WCT) haplotype and have been observed in association with transients in Washington and British Columbia. The West Coast Transient stock is therefore considered to include transient killer whales from California through Southeast Alaska. However, it should be noted that Fisheries and Oceans Canada no longer includes whales from California in their assessment of the "West Coast Transient (WCT) Population" (Fisheries and Oceans Canada 2007). They noted that 100 or so transient killer whales identified off the central coast of California (Black et al. 1997) were in the past considered to be an extension of this population because of acoustical similarities and occasional mixing with WCT individuals in BC waters (Ford and Ellis 1999), but that a recent reassessment indicated that the available evidence was insufficient to warrant inclusion of those whales in the WCT population (Fisheries and Oceans Canada 2010). Canadian researchers have now identified 46 individual whales in British Columbia that are known from California (J. Ford, pers. comm., Department of Fisheries and Oceans, British Columbia, Canada, 30 January 2013). They also noted that the Gulf of Alaska transients are seen occasionally within the range of WCTs (in Southeast Alaska and off British Columbia) but have only been observed to travel in association with WCTs on one occasion (Fisheries and Oceans Canada 2007, Matkin et al. 2012). For the purposes of this stock assessment report, the West Coast Transient stock continues to include animals that occur in California, Oregon, Washington, British Columbia, and Southeast Alaska. Based on data regarding association patterns, acoustics, movements, and genetic differences, eight killer whale stocks are now recognized within the Pacific U.S. Exclusive Economic Zone: 1) the Alaska Resident stock - occurring from Southeast Alaska to the Aleutian Islands and Bering Sea, 2) the Northern Resident stock - occurring from Washington State through part of Southeast Alaska, 3) the Southern Resident stock - occurring mainly within the inland waters of Washington State and southern British Columbia, but also in coastal waters from Southeast Alaska through California, 4) the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock - occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea, 5) the AT1

Transient stock - occurring in Alaska from Prince William Sound through the Kenai Fjords, 6) the West Coast Transient stock - occurring from California through Southeast Alaska (Fig. 1), 7) the Offshore stock - occurring from California through Alaska, and 8) the Hawaiian stock. Transient killer whales in Canadian waters are considered part of the West Coast Transient stock. The Hawaiian and Offshore stocks are reported in the Stock Assessment Reports for the U.S. Pacific Region.

POPULATION SIZE

The West Coast Transient stock is a trans-boundary stock, including killer whales from British Columbia. Preliminary analysis of photographic data resulted in the following minimum counts for transient killer whales belonging to the West Coast Transient stock. Towers et al. (2019) used a 61-year archive of photo-identification data (1958-2018) to assess the portion of the West Coast Transient stock that inhabits Canadian coastal waters and, therefore, was most likely to be impacted by human activity in Canada. Because there is evidence that this population may be composed of discrete population clusters (Parsons et al. 2013, Sharpe et al. 2017), they used a set of criteria to ensure that their analysis represented the animals that were the most regularly and recently documented in Canadian waters. Using only mature individuals, the criteria included the number of encounters, the cumulative number of years documented, and the time since the last encounter. Examination of these data produced a population subset of 349 individuals, including 206 mature individuals plus 143 individuals who were offspring and other inferred maternally related kin. Given that this number was limited to the population likely to be impacted by human activity in British Columbia, and that the California transient numbers have not been updated since the publication of the catalogue in 1997 (Black et al. 1997), the total number of transient killer whales reported above should be considered a minimum count for the West Coast Transient stock.

Minimum Population Estimate

The abundance estimate of killer whales is an analysis of individually identifiable animals. However, the number of catalogued whales does not necessarily represent the number of live animals. Some whales may have died, but they cannot be presumed dead if not resighted because long periods of time between sightings are common for some transient whales. The connection of the “outer coast” whales with the West Coast transient population of inshore waters is not well established, and the photographic catalogue from California has not been updated in 23 years. Estimates of the overall population size (i.e., N_{BEST}) and associated CV(N) that include the outer coast whales are not currently available. Thus, the minimum population estimate (N_{MIN}) of 349 whales for the West Coast Transient stock of killer whales is derived from the recent catalogue for West Coast transient population whales from the inside waters of British Columbia (Towers et al. 2019), which focuses on whales found in Canadian waters (see PBR Guidelines regarding the status of migratory trans-boundary stocks, NMFS 2016). Information on the percentage of time whales typically encountered in Canadian waters spend in U.S. waters is unknown. However, as noted above, this minimum population estimate is considered conservative. This approach is consistent with previous recommendations of the Alaska Scientific Review Group (DeMaster 1996).

Current Population Trend

Recent analyses of the inshore West Coast Transient population indicate that this segment grew rapidly from the mid-1970s to mid-1990s as a result of a combination of high birth rate and survival, as well as greater immigration of animals into the nearshore study area (Fisheries and Oceans Canada 2009). The rapid growth of the West Coast Transient population in the mid-1970s to mid-1990s coincided with a dramatic increase in the abundance of the whales’ primary prey, harbor seals, in nearshore waters. Population growth began slowing in the mid-1990s but has increased in recent years (Fisheries and Oceans Canada 2009, Towers et al. 2019). Given that population estimates are based on photo identification of individuals and considered minimum estimates, no reliable estimate of trend is available.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate (R_{MAX}) is not available for the West Coast Transient stock of killer whales. Analyses by Fisheries and Oceans Canada (2009) estimated a rate of increase of about 6% per year in this population from 1975 to 2006; however, this included recruitment of non-calf whales into the population, at least in the first half of the time period, interpreted as either a movement of some whales into nearshore waters from elsewhere or a result of better spatial sampling coverage. The population increased at a rate of approximately 2% for the second half of the time period, when recruitment of new individuals was nearly exclusively from new-born individuals (Fisheries and Oceans Canada 2009). Between 2012 and 2018, Towers et al.

(2019) observed a mean annual growth rate of 4.1% for a population subset in Canadian coastal waters, which was higher than the mean annual growth rate of 2.7% documented by Ford et al. (2013) between 2006 and 2011 for a sub-population of inner-coast transient killer whales that contained most of the same individuals. This rate was also higher than Ford et al.'s (2007) mean annual growth rate of 2% estimated for the same population between 1991 and 2006. However, until additional data become available for the West Coast Transient stock of killer whales, the default cetacean maximum theoretical net productivity rate of 4% will be used for this stock (NMFS 2016).

POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = $N_{MIN} \times 0.5R_{MAX} \times F_R$. The recovery factor ($F_R$) for this stock is 0.5, the value for cetacean stocks with unknown population status (NMFS 2016). Thus, for the West Coast Transient killer whale stock, PBR is 3.5 whales (349 × 0.02 × 0.5). The proportion of time that this trans-boundary stock spends in Canadian waters cannot be determined (G. Ellis, Pacific Biological Station, Canada, pers. comm.).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Information for each human-caused mortality, serious injury, and non-serious injury reported for NMFS-managed Alaska marine mammals between 2014 and 2018 is listed, by marine mammal stock, in Young et al. (2020); however, only the mortality and serious injury data are included in the Stock Assessment Reports. The minimum estimated mean annual level of human-caused mortality and serious injury for the West Coast Transient stock of killer whales between 2014 and 2018 is 0.4 killer whales: 0.2 in U.S. commercial fisheries and 0.2 in unknown (commercial, recreational, or subsistence) fisheries. Potential threats most likely to result in direct human-caused mortality or serious injury of this stock include oil spills, vessel strikes, and interactions with fisheries.

Fisheries Information

Information for federally-managed and state-managed U.S. commercial fisheries in Alaska waters is available in Appendix 3 of the Alaska Stock Assessment Reports (observer coverage) and in the NMFS List of Fisheries (LOF) and the fact sheets linked to fishery names in the LOF (observer coverage and reported incidental takes of marine mammals: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries, accessed December 2020).

NMFS observers monitored the California swordfish drift gillnet fishery from 1990 to 2017 (Carretta et al. 2019). The one killer whale mortality observed in this fishery, in 1995, was genetically identified as a transient ecotype. Bycatch estimates for 2013-2017, based on a bycatch model, result in a minimum mean annual mortality and serious injury rate of zero killer whales for this stock (Carretta et al. 2019).

Reports to NMFS Region marine mammal stranding networks of killer whales entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data. A killer whale mortality in commercial California Dungeness crab pot gear in 2015 reported to the NMFS West Coast Region marine mammal stranding network was genetically identified as a transient ecotype. Because the whale could not be assigned to a specific stock, the mean annual mortality and serious injury rate of 0.2 killer whales between 2014 and 2018 was assigned to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient and the West Coast Transient killer whale stocks; it was not assigned to the AT1 Transient killer whale stock because none of the whales in this population are missing (Table 1; Young et al. 2020). An additional whale, photographically identified as a member of the West Coast Transient stock of killer whales, entangled in and self-released from commercial California Dungeness crab pot gear in 2016; however, this was considered to be a non-serious injury (Young et al. 2020). There was also a report to the NMFS Alaska Region marine mammal stranding network of a killer whale entangled in pot gear in Icy Strait in 2016, resulting in a mean annual mortality and serious injury rate of 0.2 killer whales in unknown (commercial, recreational, or subsistence) Southeast Alaska pot fishery gear between 2014 and 2018 (Table 1; Young et al. 2020). Because the stock identification is unknown, this mortality and serious injury was assigned to the three killer whale stocks that occur in the area: the Alaska Resident, Northern Resident, and West Coast Transient stocks. These mortality and serious injury estimates result from an actual count of verified human-caused deaths and serious injuries and are minimums because not all entangled animals strand nor are all stranded animals found or reported.

The minimum estimated mean annual mortality and serious injury rate incidental to fisheries between 2014 and 2018 is 0.4 killer whales: 0.2 in U.S. commercial fisheries and 0.2 in unknown (commercial, recreational, or subsistence) fisheries.

Table 1. Summary of mortality and serious injury of West Coast Transient killer whales, by year and type, reported to the NMFS Alaska Region and NMFS West Coast Region marine mammal stranding networks between 2014 and 2018 (Young et al. 2020).

Cause of Injury	**2014**	**2015**	**2016**	**2017**	**2018**	**Mean annual mortality**
Entangled in commercial CA Dungeness crab pot gear	0	1[a]	0	0	0	0.2
Entangled in Southeast Alaska pot gear*	0	0	1[b]	0	0	0.2
Total in commercial fisheries						0.2
*Total in unknown (commercial, recreational, or subsistence) fisheries						0.2

[a]This whale was genetically identified as a transient ecotype but could not be assigned to a specific stock; therefore, the mortality was assigned to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient and the West Coast Transient killer whale stocks.
[b]The stock identification of this whale is unknown; therefore, this mortality was assigned to the three killer whale stocks in the area: the Alaska Resident, Northern Resident, and West Coast Transient killer whale stocks.

All Canadian longline fisheries (including halibut, rockfish, dogfish, sablefish, jig for lingcod, and troll for lingcod and Chinook salmon) are monitored by observers or video. However, only groundfish trawl fisheries have observer or electronic monitoring in Canada, whereas, trawl fisheries for krill, scallop, and shrimp have no observer coverage and salmon net fisheries are not observed (T. Doniol-Valcroze, pers. comm., Department of Fisheries and Oceans, BC, Canada, 14 May 2019). The interaction of Alaska Resident killer whales with the sablefish longline fishery accounts for a large proportion of the commercial fishing/killer whale interactions in Alaska waters. However, transient killer whales typically are not involved in these interactions. Such interactions have not been reported in Canadian waters where sablefish are taken via a pot fishery; however, Northern Resident killer whale interactions with Pacific halibut longline and salmon troll fisheries in British Columbia have been reported (Ford 2014). Reports of killer whale interactions with gillnets in Canadian waters include one killer whale that contacted a salmon gillnet in 1994 but did not entangle (Guenther et al. 1995) and one killer whale (Northern Resident I103) that entangled in a gillnet in 2014 but was quickly released (Fisheries and Oceans Canada 2018).

Alaska Native Subsistence/Harvest Information

Killer whales are not harvested for subsistence in Alaska.

Other Mortality

The shooting of killer whales in Canadian waters has been a concern in the past. Since 1974, however, fresh bullet wounds are rarely, if ever, seen on whales in British Columbia and Washington (Ford et al. 2000, Fisheries and Oceans Canada 2018). In fact, the likelihood of shooting incidents involving transient killer whales is thought to be minimal since commercial fishermen are most likely to observe transients feeding on seals or sea lions instead of interacting with their fishing gear (G. Ellis, Pacific Biological Station, Canada, pers. comm.).

Collisions with vessels are an occasional source of mortality or serious injury of killer whales. For example, a killer whale struck the propeller of a vessel in the Bering Sea/Aleutian Islands flatfish trawl fishery in 2016. Stock identification of this whale is unknown; however, this fishery is outside of the known range of the West Coast Transient stock. There has been no known mortality or serious injury of West Coast Transient killer whales due to vessel collisions.

STATUS OF STOCK

The West Coast Transient killer whale stock is not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. In 2001, the Committee on the Status of Endangered Wildlife in Canada designated West Coast Transient killer whales in British Columbia as threatened under the Species at Risk Act (SARA) for Canada. Human-caused mortality may have been underestimated, primarily due to a lack of information on Canadian fisheries, and the minimum abundance estimate is considered conservative (because researchers continue to encounter new whales and provisionally classified whales from Southeast Alaska and off the coast of California were not included), resulting in a conservative PBR estimate. Based on currently available data, the minimum estimated mean annual U.S. commercial fishery-related mortality and serious injury rate (0.2) does not exceed 10% of the PBR (10% of PBR = 0.3) and, therefore, is considered to be insignificant and approaching a zero mortality and serious injury rate. The minimum estimated mean annual level of human-caused mortality and serious injury (0.4) is not known to exceed the PBR (3.5). Therefore, the West Coast Transient stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population size are currently unknown.

There are key uncertainties in the assessment of the West Coast Transient stock of killer whales. The current population estimate is for a subset of whales that inhabits Canadian coastal waters and this subset has increased at an average rate of 4.1% per year from 2012 to 2018. However, an updated abundance estimate and growth rate is not available for the entire stock.

HABITAT CONCERNS

Analyses of blubber biopsies collected from mammal-eating transient killer whales and fish-eating resident killer whales in Canadian waters between 1993 and 1996 revealed that transient killer whales and Southern Resident killer whales had surprisingly high levels of persistent PCB contamination; the particularly high levels of contamination found in transient killer whales most likely reflected their higher trophic level (Ross et al. 2000). Due to these high levels of contamination, transient and Southern Resident killer whales in Canadian waters were considered to be at risk for toxic effects (Ross et al. 2000).

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