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KILLER WHALE (*Orcinus orca*): Eastern North Pacific Northern Resident Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

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;

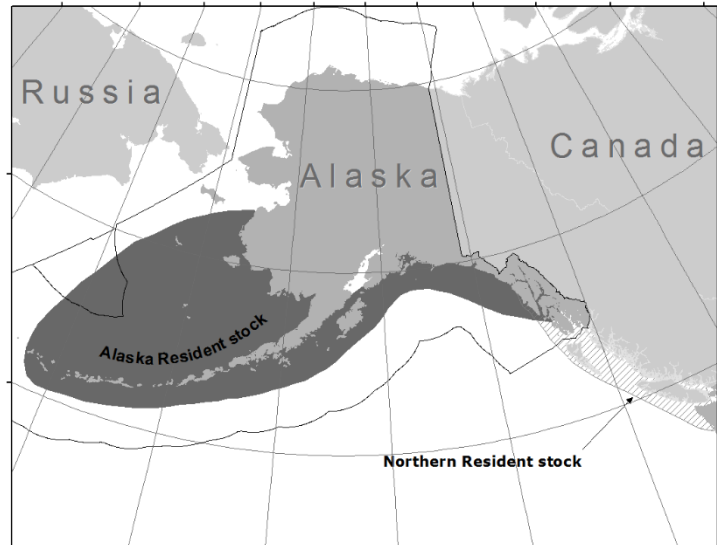


Figure 1. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the eastern North Pacific Resident and Transient stocks are largely overlapping (see text). The U.S. Exclusive Economic Zone is delineated by a black line.

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 2018). 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.

Acoustic data (Ford 1989, 1991; Yurk et al. 2002), association data (Bigg et al. 1990; Ford et al. 1994, 2000; Dahlheim et al. 1997; Matkin et al. 1999), and genetic data (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000) confirm that Southern Residents, Northern Residents, and Alaska Residents are discrete populations. The Southern Resident population is found in summer primarily in waters of Washington State and southern British Columbia and has never been seen to associate with other resident stocks. The Eastern North Pacific Northern Resident stock is a

transboundary stock and includes killer whales that frequent British Columbia, Canada, and Southeast Alaska (Dahlheim et al. 1997, Ford et al. 2000). They have been seen infrequently in Washington State waters. Members of the Northern Resident population have been documented in Southeast Alaska; however, they have not been seen to intermix with Alaska Residents (Fig. 1).

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 (Fig. 1), 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, 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

Photo-identification studies since 1970 (e.g., Ford et al. 2000) have attempted to catalogue every individual belonging to the Eastern North Pacific Northern Resident population. The Canadian government published a recent summary of abundance and trends for the population (Fisheries and Oceans Canada 2019). The abundance numbers reported in that document are based on the most recent census data. They report the population was approximately 122 when first censused in 1974, and the number known to be alive in a specified year has grown over the years as the photo-identification catalogue has been updated. Note that the number reported from the Northern Resident catalogue is calculated slightly differently than the number reported in the Southern Resident catalogue; for Northern Residents, it represents the number of whales known to be alive at any time during the year, even if known or suspected to have died later in the calendar year (Fisheries and Oceans Canada 2018).

Although the majority of Northern Resident killer whales are photographed each year, it is not always possible to locate every matrilineal group during each field season, and there can remain some uncertainty about the status of missing individuals until their death is confirmed in subsequent years. For this reason, the census reports a minimum and a maximum population size, as well as a “best” number derived from the best estimates of the year of birth and year of death of individuals. For 2018, the total best population size was estimated at 302 individuals (range = 302 to 310).

Minimum Population Estimate

The technique used for estimating abundance of Northern Resident killer whales is a direct count of individually identifiable animals known to be alive in a specified year. Because this population has been studied for such a long time, each individual is well documented and, except for births, no new individuals are expected to be discovered. For populations with a statistical estimate of the overall population size (i.e., N_{BEST}) and its associated precision (i.e., coefficient of variation $CV(N)$), the minimum population estimate can be substantially lower than the best estimate of abundance. This is not the case here, as the minimum population estimate of 302 whales reported in Fisheries and Oceans Canada (2019) can serve as a minimum count of the population.

Thus, the minimum population estimate (N_{MIN}) for the Northern Resident stock of killer whales is 302 whales, which includes whales found in Canadian waters (see PBR Guidelines (NMFS 2016) regarding the status of migratory transboundary stocks). Information on the percentage of time animals typically encountered in Canadian waters spend in U.S. waters is unquantified.

Current Population Trend

Trends for this population have been recently summarized and contrasted with trends for the Southern Resident population (Fisheries and Oceans Canada 2018). From the mid-1970s to the 1990s, the Northern Resident killer whale population increased at an annual rate of 2.6% (i.e., from 122 whales in 1974 to 218 in 1997). A decline was reported from 1998 to 2001 at a rate of 7% per year. The increased mortality that drove this decline coincided with a period of reduced range-wide Chinook salmon abundance, their primary prey (Ford et al. 2010). Then, after 2001, the growth was positive again with the population increasing at an average rate of 2.9% per year from 2002 to 2014. At the end of the 2015 field season, 290 whales were catalogued alive for the 2014 assessment.

This represents an average annual increase of 2.2% over the 40-year time series (Towers et al. 2015). However, annual Northern Resident killer whale population growth rates have slowed over the past five census years, from 5.1% in 2014 to -0.3% in 2018 (Fisheries and Oceans Canada 2019).

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

As summarized in the previous paragraph, studies of Northern Resident killer whale pods in British Columbia and Washington waters resulted in estimated population growth rates of 2.6% from 1974 to 1997 and 2.9% from 2002 to 2014 (Towers et al. 2015), separated by a short period of decline from 1998 to 2001. The period from 2002 to 2014 was a period of maximum growth for this population when it grew at an average rate of 2.9% per year. Therefore, the maximum net productivity rate (R_{MAX}) is estimated to be 2.9% (Towers et al. 2015).

POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) is defined as the product of the minimum population estimate, one-half the maximum estimated 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 Eastern North Pacific Northern Resident killer whale stock, $PBR = 2.2$ animals ($302 \times 0.0145 \times 0.5$).

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 2013 and 2017 is listed, by marine mammal stock, in Delean 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 Northern Resident killer whales between 2013 and 2017 is 0.2 killer whales 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 on U.S. commercial fisheries in Alaska waters (including observer programs, observer coverage, and observed incidental takes of marine mammals) is presented in Appendices 3-6 of the Alaska Stock Assessment Reports.

Incidental mortality or serious injury of Northern Resident killer whales has not been observed in federally-managed or state-managed U.S. commercial fisheries which operate within the range of this stock; however, the state-managed fisheries are not observed or have not been observed in a long time.

Reports from the NMFS Alaska Region stranding network of killer whales entangled in fishing gear or with injuries caused by interactions with gear are another source of mortality and serious injury data. There was one report 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 fisheries between 2013 and 2017 (Table 1; Delean et al. 2020). Because the killer whale stock identification is unknown, this mortality and serious injury was assigned to the three killer whale stocks that occur in the area: the Eastern North Pacific Alaska Resident, Eastern North Pacific Northern Resident, and West Coast Transient stocks. This mortality and serious injury estimate results from an actual count of verified human-caused deaths and serious injuries and is a minimum because not all entangled animals strand nor are all stranded animals found or reported.

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. 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).

Table 1. Summary of mortality and serious injury of Northern Resident killer whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network between 2013 and 2017 (Delean et al. 2020).

| Cause of injury | 2013 | 2014 | 2015 | 2016 | 2017 | Mean annual mortality |
|--|------|------|------|----------------|------|-----------------------|
| Entangled in Southeast Alaska pot gear* | 0 | 0 | 0 | 1 ^a | 0 | 0.2 |
| *Total in unknown (commercial, recreational, or subsistence) fisheries | | | | | | 0.2 |

^aThis mortality and serious injury was assigned to the Eastern North Pacific Alaska Resident, Eastern North Pacific Northern Resident, and West Coast Transient stocks of killer whales since the stock is unknown and these three stocks overlap in the area where the event occurred.

Subsistence/Native Harvest Information

Killer whales are not harvested for subsistence in Alaska.

Other Mortality

Collisions of killer whales with vessels occur occasionally. One ship-strike mortality of a Northern Resident killer whale (C21) in Prince Rupert, BC, was reported in 2006 (Williams and O'Hara 2010). 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).

Other Issues

Killer whales are known to depredate longline catches in the Bering Sea (Dahlheim 1988; Yano and Dahlheim 1995; Perez 2003, 2006; Sigler et al. 2003) and in the Gulf of Alaska (Sigler et al. 2003, Perez 2006). In Canada, Northern Resident killer whales have been reported to depredate fish from both commercial salmon trollers and recreational sportfishermen, as well as Pacific halibut longliners (Ford 2014). Most reports occur in the northern half of the coast, especially Dixon Entrance, and early in the season (April to June), although some are scattered throughout the summer (J. Ford, pers. comm., Department of Fisheries and Oceans, BC, Canada, 3 December 2012).

STATUS OF STOCK

The Northern Resident 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 Northern Resident killer whales in British Columbia as threatened and listed in Schedule 1 of the Species at Risk Act (SARA) for Canada. Resident killer whales in British Columbia are considered to be at risk based on their small population size, low reproductive rate, and the existence of a variety of anthropogenic threats that have the potential to prevent recovery or to cause further declines (Fisheries and Oceans Canada 2008). Monitoring of fisheries in BC over the past decade has been quite extensive and likely at the same level as in U.S. waters. One serious injury from an entanglement in unidentified pot gear was reported in Alaska waters in 2016 and a Northern Resident killer whale entangled in a gillnet in British Columbia waters in 2014 but was quickly released. Northern Resident killer whale interactions with longline and troll fisheries in British Columbia waters have also been reported.

Based on currently available data, the minimum estimated mean annual U.S. commercial fishery-related mortality and serious injury rate is zero, which does not exceed 10% of the PBR (10% of PBR = 0.22) 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 (0.2) is not known to exceed the PBR (2.2). Therefore, the Eastern North Pacific Northern Resident stock of killer whales is not classified as a strategic stock. Status of this stock relative to its Optimum Sustainable Population size has not been quantified.

There are few other uncertainties in the assessment of the Northern Resident stock of killer whales. Individual whales can be counted annually and the stock increased at an average rate of 2.9% per year from 2002 to 2014, although the growth rate has slowed in the last five census years.

HABITAT CONCERNS

Ford et al. (2005) showed that a sharp drop in coast-wide Chinook salmon abundance during the late 1990s was correlated with a significant decline in resident killer whale survival. They noted that the whales' preference for

Chinook salmon is likely due to this species' relatively large size, high lipid content and, unlike other salmonids, its year-round presence in the whales' range. They further note that resident killer whales may be especially dependent on Chinook during winter, when this species is the primary salmonid available in coastal waters, and the whales may be subject to nutritional stress leading to increased mortality if the quantity and/or quality of this prey resource declines.

Environmental contaminants and vessel traffic, particularly increased whale-watching activity, are other potential concerns for this stock (Fisheries and Oceans Canada 2018).

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