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

**NOTE – NMFS has genetic information on killer whales in Alaska that indicates the current stock structure of killer whales in Alaska needs to be reassessed (Parsons et al. 2013). NMFS is evaluating this genetic information, along with all other available data that inform stock structure (e.g., movements, tagging data, social association patterns, call types, etc.; see Martien et al. 2019). Should the evaluation identify a different population structure than is currently reflected in the Alaska SARs, we will consider how best to revise stock designations in a future SAR following NMFS Procedure "Reviewing and Designating Stocks and Issuing Stock Assessment Reports under the Marine Mammal Protection Act" (NMFS 2019).**

## STOCK DEFINITION AND GEOGRAPHIC RANGE

Killer whales have been observed in all oceans and seas of the world (Leatherwood and Dahlheim 1978). Although reported occurring in tropical 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). 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," or "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 recognizable individuals in photographs, movements of whales and pods 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).

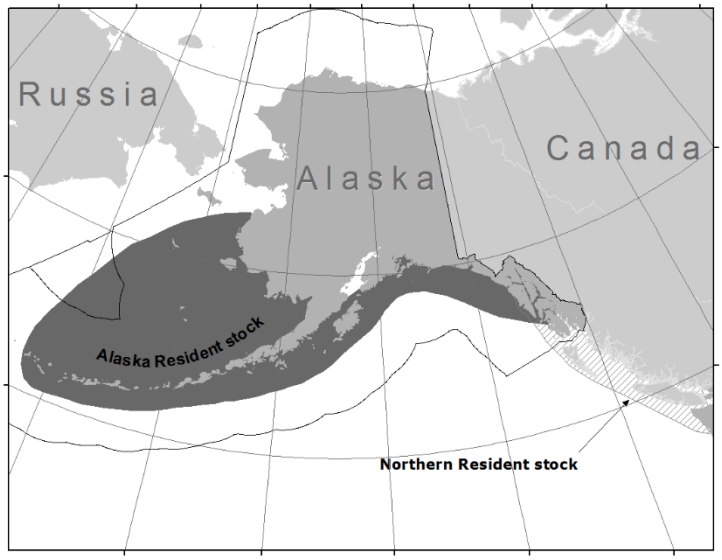


**Figure 1.** Approximate distribution of resident killer whales in the eastern North Pacific (shaded areas). The distribution of resident and transient killer whale stocks in the eastern North Pacific largely overlap (see text). The U.S. Exclusive Economic Zone is delineated by a black line.

Several studies provide evidence that the resident, offshore, and transient ecotypes are genetically distinct in both mtDNA and nuclear DNA. 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. 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.

Based on data regarding association patterns (Matkin et al. 2010), acoustics (Ford 1989, 1991; Yurk et al. 2002; Matkin et al. 2007), movements (Matkin et al. 2010), and genetic differences (Hoelzel and Dover 1991; Hoelzel et al. 1998, 2002; Barrett-Lennard 2000), 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 (Fig. 1), 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, 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 Southern Resident, Offshore, and Hawaiian stocks are reported in the Stock Assessment Reports for the U.S. Pacific Region.

## POPULATION SIZE

The Alaska Resident stock includes killer whales from Southeast Alaska to the Aleutian Islands and Bering Sea.

Gulf of Alaska

Long-term photo-identification studies by the North Gulf Oceanic Society (NGOS) and collaborators have provided minimum counts for resident killer whales belonging to the Alaska Resident stock in Prince William Sound, Kenai Fjords, Kodiak, and Southeast Alaska (e.g., Matkin et al. 1999, 2014). For the time period 2005-2012, this resulted in a minimum count of 121 whales for Southeast Alaska and 751 whales for Prince William Sound, Kodiak, and Kenai Fjords (Table 1). NGOS has updated the counts for many of the pods seen most frequently in more recent years and has documented the most recent count for those pods on their website (https://www.whalesalaska.org/salmon-specialist-residents, accessed May 2023); most pods have continued to increase in size. Those updated counts result in revised minimum counts of 137 whales for Southeast Alaska and 784 whales for Prince William Sound, Kodiak, and Kenai Fjords, for a total of 921 for the Gulf of Alaska for the years 2005-2019 (years in parentheses in Table 1 represent the most recent year a count is available for each pod).

Aleutian Islands and Bering Sea

Beginning in 2001, dedicated killer whale studies were initiated by the NMFS Marine Mammal Laboratory (MML) in Alaska waters, including the Aleutian Islands and Bering Sea (e.g., Fearnbach et al. 2012, 2014; Zerbini et al. 2007), and by the NGOS in the eastern Aleutians. For the first 3 years (2001-2003), MML conducted killer whale line-transect surveys in July and August. These surveys covered an area from approximately Resurrection Bay in the Kenai Fjords area to the central Aleutians. The surveys covered an area from shore to 30-45 nautical miles offshore, with randomly located transects in a zigzag pattern. A total of 9,053 km of tracklines were surveyed between the Kenai Peninsula (~150°W) and Amchitka Pass (~179ºW). A total of 41 on-effort sightings of killer whales were recorded, with an additional 16 sightings off-effort. Estimated abundance of resident killer whales from these surveys was 991 (CV = 0.52), with a 95% confidence interval of 380-2,585 (Zerbini et al. 2007). However, the first four strata of that survey overlap with the NGOS photo-identification study areas around Kodiak and Kenai Fjords. The estimated abundance for strata 1-4 was 208 (Zerbini et al. 2007: Table 4). Subtracting 208 from 991 leaves a line-transect abundance estimate of 783 for the areas from Kodiak to the west.

Identification photographs were collected on those and subsequent MML biopsy and tagging surveys from 2001 to 2010 and on NGOS surveys (2001-2005). These two data sets were matched and reconciled, with Fearnbach et al. (2014: Table 2, areas 4-8) reporting a total of 999 distinct individuals for the Aleutian Islands and Bering Sea from 2001 to 2010.

The line-transect surveys provide an "instantaneous" (across ~40 days) estimate of the number of resident killer whales in the survey area. It should be noted that the photographic catalog encompasses a larger area, including some data from areas such as Prince William Sound and the Bering Sea that were outside the line-transect survey area. Additionally, the number of whales in the photographic catalog is a documentation of all whales seen in the area over the time period of the catalog; movements of some individual whales have been documented between the line-transect survey area and locations outside the survey area. Accordingly, a larger number of resident killer whales may use the line-transect survey area at some point over the 3 years than would necessarily be found at one time in the survey area in July and August in a particular year.

Using essentially the same combined dataset of photographs from MML and NGOS, Fearnbach (2014) used photographic mark-recapture methods to estimate abundance of resident killer whales in the coastal waters (typically within 30 km from the shore or continental shelf edge) around the central and eastern Aleutians (~160°W to 180°), and extending northwards up the Bering Sea shelf edge to the Pribilof Islands (~57°N). The yearly estimates ranged

from 732 (95% highest density probability intervals = 493-1,561) to 2,260 individuals (95% highest density probability intervals = 1,255-4,112) using this area annually during summer sampling periods from 2001 to 2010. These estimates refer to the number of whales using (rather than necessarily resident in) these coastal waters during an annual May-September sampling period. Of these, the highest estimate is thought to be the best representation of summer abundance in this region, as it was obtained in the year (2002) when there was the greatest extent of survey effort (Fearnbach 2014).

In summary, for resident type killer whales in the areas west of Kodiak, primarily the Aleutian Islands and Bering Sea, there is a line-transect estimate of 783 (CV = 0.52) for the years 2001-2003 (Zerbini et al. 2007: Table 4, strata 5-16), mark-recapture estimates ranging from 732 to 2,260, with the highest estimate of 2,260 (CV = 0.32) occurring in the year 2002 (Fearnbach 2012), and a minimum count of unique identified individual whales of 999 whales for the years 2001-2010 (Fearnbach et al. 2014: Table 2, areas 4-8). These estimates are relatively consistent with one another. For the sake of consistency across areas, the minimum count of unique identified individuals (999) will be used for the Aleutian Islands and Bering Sea area.

Total for Alaska

The number of unique identified individual whales in the Gulf of Alaska is 921, with the estimates for different pods occurring in different years, ranging from 2005 to 2019 (Table 1). The only available number of unique identified individuals for the Aleutian Islands and Bering Sea is 999, for the years 2001 to 2010. Combining those two counts results in a total for Alaska of 1,920 resident killer whales (Table 1).

**Minimum Population Estimate**

For the Gulf of Alaska, a minimum count of photographically identified whales for Prince William Sound, Kodiak, Kenai Fjords, and Southeast Alaska results in a total of 921 whales for the years 2005-2019 (the years in parentheses in Table 1 represent the most recent years a count is available for each pod). Although some of the counts are fairly old, nearly all pods that have been recently counted have continued to increase, suggesting this number can still represent a conservative estimate of the minimum number of resident killer whales in the Gulf of Alaska. Therefore, we use this estimate even though parts of it are older than 8 years because there is reasonable assurance the population has not declined in the Gulf of Alaska.

For the Aleutian Islands and Bering Sea, the minimum count of photographically identified whales is 999 for the years 2001 to 2010. This is a minimum count over a 10-year period, so some identified whales could have died by the end of the study in 2010. However, there are two reasons to suggest this number can be used as a minimum abundance estimate. First, the great majority of whales in this study were only seen in one year, meaning that capture probability was relatively low, suggesting there are a large number of distinctive whales that have never been identified. This is supported by annual mark-recapture estimates for a portion of the area that are much higher than the number of identified individuals in each year (Fearnbach 2012). Second, Fearnbach (2012) used photo identification data to estimate that the proportion of the population that was distinctive was, on average, 0.67, with annual estimates ranging from 0.59 to 0.73. Therefore, the number of identified whales represents only about two-thirds of the total population, meaning that number should be re-scaled by ~1.5 to account for whales (mainly younger animals) that are not sufficiently marked to be distinctive and thus are unable to be re-identified. Therefore, we use this estimate as a minimum abundance for the Aleutians and Bering Sea even though it is older than 8 years, because there is reasonable assurance the true abundance of resident killer whales is much greater than the number counted.

Therefore, the minimum population estimate ($N_{MIN}$) for resident-type killer whales in Alaska is 1,920, based on adding 921 identified individuals from the Gulf of Alaska with 999 identified individuals from the Aleutian Islands and Bering Sea.

**Current Population Trend**

Data from Matkin et al. (2003, 2014) indicate that the component of the Alaska Resident stock that summers in the Prince William Sound and Kenai Fjords area is increasing. With the exception of AB pod, which declined drastically after the *Exxon Valdez* oil spill and has not yet recovered, the component of the Alaska Resident stock in the Prince William Sound and Kenai Fjords area increased 3.2% (95% CI = 1.94 to 4.36%) per year from 1990 to 2005 (Matkin et al. 2008); the 10 pods seen most frequently increased by 3.4% per year from 1984 to 2005, with evidence of continued increase through 2010 by 7 of those pods (Matkin et al. 2014). At present, reliable data on trends in population abundance for the entire Alaska Resident stock of killer whales are unavailable, due to a lack of trend data from the Aleutian Islands and Bering Sea.

**Table 1.** Numbers of animals in each pod of killer whales belonging to the Alaska Resident stock of killer whales.

| Pod ID | 2005-2012 estimate (and source) | 2005-2019 estimate |
|---|---|---|
| **Southeast Alaska** | | Source: NGOS website https://www.whalesalaska.org/salmon-specialist-residents |
| AF22 | 33 (Matkin et al. 2013) | 33 (2012) |
| AF5 | 46 (Matkin et al. 2013) | 45 (2012) |
| AG | 42 (Matkin et al. 2013) | 59 (2017) |
| AZ | Not seen since prior to 1997 | |
| **Total, Southeast Alaska** | **121 (excluding AZ)** | **137 (excluding AZ)** |
| **Prince William Sound** | **Matkin et al. 2013** | **NGOS website https://www.whalesalaska.org/salmon-specialist-residents** |
| AA1 | 8 | 8 (2005-2012) |
| AA30 | 24 | 24 (2005-2012) |
| AB | 20 | 20 (2014) |
| AB25 | 19 | 25 (2018) |
| AD05 | 22 | 11 (2015) |
| AD08 | | 9 (2019) |
| AD11 | | 6 (2018) |
| AD16 | 9 | 12 (2017) |
| AE | 17 | 19 (2019) |
| AH01 | 9 | 9 (2005-2012) |
| AH20 | 12 | 12 (2005-2012) |
| AI | 8 | 8 (2019) |
| AJ (AJ+AJ8) | 57 | 64 (2018-2019) |
| AK (AK2+AK6) | 19 | 24 (2019) |
| AL | 23 | 23 (2005-2012) |
| AN10 | 36 | 36 (2005-2012) |
| AN20 | 30 | 30 (2005-2012) |
| AS2 | 31 | 31 (2005-2012) |
| AS30 | 19 | 19 (2005-2012) |
| AW | 27 | 27 (2005-2012) |
| AX01 | 33 | 33 (2005-2012) |
| AX27 | 26 | 26 (2005-2012) |
| AX32 | 18 | 18 (2005-2012) |
| AX40 | 16 | 16 (2005-2012) |
| AX48 | 23 | 31 (2015) |
| AY | 21 | 23 (2015) |
| Unassigned to pods | 220 | 220 (2005-2012) |
| **Total, Prince William Sound/ Kenai Fjord/ Kodiak** | **751** | **784** |
| **Western Alaska** | **2001-2010 MML/NGOS total unique IDs (Fearnbach et al. 2014)** | **2001-2010 MML/NGOS total unique IDs (Fearnbach et al. 2014)** |
| Unassigned to pods (MML) | 999 | 999 |
| **Total, Western Alaska** | **999** | **999** |
| **Total, all areas** | **1,871** | **1,920** |

## CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

A reliable estimate of the maximum net productivity rate is currently unavailable for this stock of killer whales. Studies of resident killer whale pods in the Pacific Northwest resulted in estimated population growth rates of 2.92% and 2.54% from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993) and 3.3% from 1984 to 2002 (Matkin et al. 2003). Until additional stock-specific data become available, the cetacean maximum theoretical net productivity rate ($R_{MAX}$) of 4% is used for this stock (NMFS 2023).

## 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 2023). Thus, for the Eastern North Pacific Alaska Resident killer whale stock, PBR = 19 whales (1,920 × 0.02 × 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 2016 and 2020 is listed, by marine mammal stock, in Freed et al. (2022); 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 Alaska Resident killer whales between 2016 and 2020 is 1.3 killer whales: 1.1 in 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 May 2023).

Between 2016 and 2020, mortality and serious injury of killer whales occurred in two of the federally-regulated U.S. commercial fisheries that are monitored for incidental mortality and serious injury of marine mammals by fishery observers: the Bering Sea/Aleutian Islands flatfish trawl and Bering Sea/Aleutian Islands Pacific cod longline fisheries (Table 2; Breiwick 2013; MML, unpubl. data).

Fishery observers have collected tissue samples from many of the killer whales that were killed incidental to U.S. commercial fisheries. Genetic analyses of samples from seven killer whales collected between 1999 and 2004 confirmed that Alaska Resident killer whale mortality occurred incidental to the Bering Sea/Aleutian Islands flatfish trawl fishery (n = 3) and Bering Sea/Aleutian Islands Pacific cod longline fishery (n = 1) and that Gulf of Alaska, Aleutian Islands, and Bering Sea Transient killer whale mortality occurred incidental to the Bering Sea/Aleutian Islands pollock trawl fishery (n = 3) (M. Dahlheim, NMFS-AFSC-MML, pers. comm., 20 February 2013). Given the overlap in the range of transient and resident stocks in Alaska waters, unless genetic samples can be collected from animals injured or killed by gear or the vessel's propeller, the events are assigned to both the transient and resident killer whale stocks occurring in the area. Thus, an estimated mean annual mortality and serious injury rate of 0.4 killer whales in the Bering Sea/Aleutian Islands flatfish trawl fishery between 2016 and 2020 is assigned to both the Alaska Resident and Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stocks of killer whales. A mean annual mortality and serious injury rate of 0.4 killer whales in the Bering Sea/Aleutian Islands flatfish trawl fishery and 0.3 in the Bering Sea/Aleutian Islands Pacific cod longline fishery between 2016 and 2020 is assigned to the Alaska Resident stock (Table 2; Breiwick 2013; MML, unpubl. data).

Typically, if mortality or serious injury occurs incidental to U.S. commercial fishing, it is due to interactions with the fishing gear. However, reports indicate that observed killer whale mortality incidental to the Bering Sea/Aleutian Islands trawl fisheries often occurs due to contact with the vessel's propeller (e.g., the 2016 serious injury in the Bering Sea/Aleutian Islands flatfish trawl fishery). Fisheries observers report that large groups of killer whales in the Bering Sea follow vessels for days at a time, actively consuming the processing waste (NMFS-AFSC, Fishery Observer Program, unpubl. data). On some vessels, the waste is discharged in the vicinity of the vessel's propeller (NMFS, unpubl. data); consumption of the processing waste in the vicinity of the propeller may be the cause of the propeller-caused mortalities of killer whales in the trawl fisheries.

**Table 2.** Summary of incidental mortality and serious injury of Alaska Resident killer whales due to U.S. commercial fisheries in 2016-2020 and calculation of the mean annual mortality and serious injury rate (Breiwick 2013; MML, unpubl. data). Methods for calculating percent observer coverage are described in Appendix 3 of the Alaska Stock Assessment Reports.

| Fishery name | Years | Data type | Percent observer coverage | Observed mortality | Estimated mortality (CV) | Mean estimated annual mortality |
|---|---|---|---|---|---|---|
| Bering Sea/Aleutian Is. flatfish trawl | 2016<br>2017<br>2018<br>2019<br>2020 | obs data | 99<br>100<br>100<br>100<br>100 | 1[a]<br>0<br>1[a]<br>0<br>2 | 1 (0)<br>0<br>1 (0.05)<br>0<br>2 (0.02) | 0.8<br>(CV = 0.02) |
| | | | | | | |
| Bering Sea/Aleutian Is. Pacific cod longline | 2016<br>2017<br>2018<br>2019<br>2020 | obs data | 57<br>58<br>55<br>52<br>53 | 1 | 1.7 (0.64) | 0.3<br>(CV = 0.64) |
| Minimum total estimated annual mortality | | | | | | 1.1<br>(CV = 0.19) |

[a]The mortality or serious injury was assigned to the Eastern North Pacific Alaska Resident and Eastern North Pacific Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stocks of killer whales because the stock is unknown and these two stocks overlap in the area where the event occurred..

A minimum estimate of the mean annual mortality and serious injury rate incidental to U.S. commercial fisheries between 2016 and 2020, based on observer data, is 1.1 Alaska Resident killer whales, (Table 2).

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 seriously injured by entanglement 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 2016 and 2020 (Table 3; Freed et al. 2022). Because the stock is unknown, this 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.

**Table 3.** Summary of mortality and serious injury of Alaska Resident killer whales, by year and type, reported to the NMFS Alaska Region marine mammal stranding network between 2016 and 2020 (Freed et al. 2022).

| Cause of injury | 2016 | 2017 | 2018 | 2019 | 2020 | Mean annual mortality |
|---|---|---|---|---|---|---|
| Entangled in Southeast Alaska pot gear* | 1[a] | 0 | 0 | 0 | 0 | 0.2 |
| *Total in unknown (commercial, recreational, or subsistence) fisheries | | | | | | 0.2 |

[a]This serious injury was assigned to the Eastern North Pacific Alaska Resident, Eastern North Pacific Northern Resident, and West Coast Transient stocks of killer whales because the stock is unknown and these three stocks overlap in the area where the event occurred.

**Subsistence/Native Harvest Information**

There are no reports of a subsistence harvest of killer whales in Alaska.

**Other Mortality**

During the 1992 killer whale surveys conducted in the Bering Sea and western Gulf of Alaska, 9 of 182 (4.9%) individual whales in 7 of the 12 (58%) pods encountered had evidence of bullet wounds (Dahlheim and Waite

1993). The relationship between wounding due to shooting and survival is unknown. In Prince William Sound, the pod responsible for most of the fishery interactions experienced a high level of mortality: between 1986 and 1991, 22 whales out of a pod of 37 (59%) disappeared (Matkin et al. 1994). The cause of death for these whales is unknown, but it may be related to gunshot wounds or effects of the *Exxon Valdez* oil spill (Dahlheim and Matkin 1994). It is unknown who was responsible for shooting at the killer whales.

There have been no obvious bullet wounds observed on killer whales during surveys in the Bering Sea and western Gulf of Alaska (J. Durban, NMFS-SWFSC, pers. comm.). However, researchers have reported that killer whale pods in certain areas exhibit vessel avoidance behavior, which may indicate that shootings occur in some places.

**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 addition, there have been many reports of killer whales consuming the processing waste of Bering Sea groundfish trawl fishing vessels (Perez 2006). More recently, Peterson and Hanselman (2017) estimated that killer whales reduce commercial sablefish fishery catch rates by approximately 45% to 70%. Resident killer whales are most likely to be involved in such fishery interactions since these whales are known to be fish eaters.

## STATUS OF STOCK

The Eastern North Pacific Alaska Resident stock of killer whales is not designated as depleted under the MMPA or listed as threatened or endangered under the Endangered Species Act. The minimum abundance estimate for the Alaska Resident stock is likely underestimated because researchers continue to encounter new whales in the Gulf of Alaska and in western Alaska waters. Because the population estimate is likely to be conservative, the PBR is also conservative.

Based on currently available data, a minimum estimate of the mean annual mortality and serious injury rate due to U.S. commercial fisheries (1.1 killer whales) is less than 10% of the PBR (10% of PBR = 1.9) and, therefore, is considered to be insignificant and approaching a zero mortality and serious injury rate. A minimum estimate of the total annual level of human-caused mortality and serious injury (1.3 killer whales) is not known to exceed the PBR (19). Therefore, the Eastern North Pacific Alaska Resident stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population are currently unknown.

There are key uncertainties in the assessment of the Alaska Resident stock of killer whales. Some of the pods have not been photographically identified since 2005-2012 and the population estimate and PBR are likely conservative because researchers continue to encounter new whales.

## CITATIONS

Baird, R. W., and P. J. Stacey. 1988. Variation in saddle patch pigmentation in populations of killer whales (*Orcinus orca*) from British Columbia, Alaska, and Washington State. Can. J. Zool. 66(11):2582-2585.

Baird, R. W., P. A. Abrams, and L. M. Dill. 1992. Possible indirect interactions between transient and resident killer whales: implications for the evolution of foraging specializations in the genus *Orcinus*. Oecologia 89:125-132.

Barlow, J. 1995. The abundance of cetaceans in California waters. Part I: Ship surveys in summer and fall of 1991. Fish. Bull., U.S. 93:1-14.

Barlow, J. 1997. Preliminary estimates of cetacean abundance off California, Oregon and Washington based on a 1996 ship survey and comparisons of passing and closing modes. Southwest Fisheries Science Center Administrative Report LJ-97-11, 25 p. Available from Southwest Fisheries Science Center, NMFS, 8901 La Jolla Shores Drive, La Jolla, CA 92037.

Barrett-Lennard, L. G. 2000. Population structure and mating patterns of killer whales (*Orcinus orca*) as revealed by DNA analysis. Ph.D. Dissertation, University of British Columbia, Vancouver, BC, Canada. 97 p.

Bigg, M. A., P. F. Olesiuk, G. M. Ellis, J. K. B. Ford, and K. C. Balcomb III. 1990. Social organization and genealogy of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Pp. 386-406 *in* P. S. Hammond, S. A. Mizroch, and G. P. Donovan (eds.), Individual Recognition of Cetaceans: Use of Photo-identification and Other Techniques to Estimate Population Parameters. Rep. Int. Whal. Comm. (Special Issue) 12.

Black, N. A., A. Schulman-Janiger, R. L. Ternullo, and M. Guerrero-Ruiz. 1997. Killer whales of California and western Mexico: a catalog of photo-identified individuals. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-247, 174 p.

Braham, H. W., and M. E. Dahlheim. 1982. Killer whales in Alaska documented in the Platforms of Opportunity Program. Rep. Int. Whal. Comm. 32:643-646.

Brault, S., and H. Caswell. 1993. Pod-specific demography of killer whales (*Orcinus orca*). Ecology 74(5):1444-1454.

Breiwick, J. M. 2013. North Pacific marine mammal bycatch estimation methodology and results, 2007-2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-260, 40 p.

Dahlheim, M. E. 1988. Killer whale (*Orcinus orca*) depredation on longline catches of sablefish (*Anoplopoma fimbria*) in Alaskan waters. NWAFC Processed Report 88-14, 31 p. Available online: https://apps-afsc.fisheries.noaa.gov/Publications/ProcRpt/PR%2088-14.pdf. Accessed May 2023.

Dahlheim, M. E., and C. O. Matkin. 1994. Assessment of injuries to Prince William Sound killer whales, p. 163-171. *In* T. R. Loughlin (ed.), Marine Mammals and the *Exxon Valdez*. Academic Press, Inc., San Diego, CA.

Dahlheim, M. E., and J. M. Waite. 1993. Abundance and distribution of killer whales (*Orcinus orca*) in Alaska in 1992. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Dahlheim, M. E., and P. A. White. 2010. Ecological aspects of transient killer whales (*Orcinus orca*) as predators in southeastern Alaska. Wildl. Biol. 16:308-322.

Dahlheim, M. E., D. Ellifrit, and J. Swenson. 1997. Killer Whales of Southeast Alaska: A Catalogue of Photoidentified Individuals. Day Moon Press, Seattle, WA. 82 p. + appendices.

Dahlheim, M. E., A. Schulman-Janiger, N. Black, R. Ternullo, D. Ellifrit, and K. C. Balcomb. 2008. Eastern temperate North Pacific offshore killer whales (*Orcinus orca*): occurrence, movements, and insights into feeding ecology. Mar. Mammal Sci. 24:719-729.

Fearnbach, H. 2012. Individual-based population assessment for cetaceans: using photographs to infer abundance, demography and individual quality. Ph.D. Dissertation. University of Aberdeen, Scotland.

Fearnbach, H., J. W. Durban, D. K. Ellifrit, J. M. Waite, C. O. Matkin, C. R. Lunsford, M. J. Peterson, J. Barlow, and P. R. Wade. 2014. Spatial and social connectivity of fish-eating "Resident" killer whales (*Orcinus orca*) in the northern North Pacific. Marine Biology 161:459-472. DOI: dx.doi.org/10.1007/s00227-013-2351-0

Ford, J. K. B. 1989. Acoustic behaviour of resident killer whales (*Orcinus orca*) off Vancouver Island, British Columbia. Can. J. Zool. 67(3):727-745.

Ford, J. K. B. 1991. Vocal traditions among resident killer whales (*Orcinus orca*) in coastal waters of British Columbia. Can. J. Zool. 69(6):1454-1483.

Ford, J. K. B. 2011. Killer whales of the Pacific Northwest coast: from pest to paragon. Whalewatcher 40(1):15-23.

Ford, J. K. B., and H. D. Fisher. 1982. Killer whale (*Orcinus orca*) dialects as an indicator of stocks in British Columbia. Rep. Int. Whal. Comm. 32:671-679.

Ford, J. K. B., G. Ellis, and K. C. Balcomb. 1994. Killer Whales: The Natural History and Genealogy of *Orcinus orca* in British Columbia and Washington State. University of British Columbia Press, Vancouver, BC, and University of Washington Press, Seattle. 102 p.

Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 2000. Killer Whales: The Natural History and Genealogy of *Orcinus orca* in British Columbia and Washington State. Second edition. University of British Columbia Press, Vancouver, BC, Canada. 104 p.

Forney, K. A., and P. R. Wade. 2006. World-wide abundance and density of killer whales. Pp. 145-162 *in* J. A. Estes, D. P. DeMaster, D. F. Doak, T. M. Williams, and R. L. Brownell, Jr. (eds.), Whales, Whaling, and Ocean Ecosystems. University of California Press.

Forney, K. A., J. Barlow, and J. V. Carretta. 1995. The abundance of cetaceans in California waters. Part II: Aerial surveys in winter and spring of 1991 and 1992. Fish. Bull., U.S. 93:15-26.

Freed, J. C., N. C. Young, B. J. Delean, V. T. Helker, M. M. Muto, K. M. Savage, S. S. Teerlink, L. A. Jemison, K. M. Wilkinson, and J. E. Jannot. 2022. Human-caused mortality and injury of NMFS-managed Alaska marine mammal stocks, 2016-2020. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-442, 116 p.

Goley, P. D., and J. M. Straley. 1994. Attack on gray whales (*Eschrichtius robustus*) in Monterey Bay, California, by killer whales (*Orcinus orca*) previously identified in Glacier Bay, Alaska. Can. J. Zool. 72:1528-1530.

Green, G. A., J. J. Brueggeman, R. A. Grotefendt, C. E. Bowlby, M. L. Bonnell, and K. C. Balcomb. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990, p. 1-100. *In* J. J. Brueggeman (ed.), Oregon and Washington marine mammal and seabird surveys. Final Report OCS Study MMS 91-0093.

Hoelzel, A. R., and G. A. Dover. 1991. Genetic differentiation between sympatric killer whale populations. Heredity 66:191-195.

Hoelzel, A. R., M. E. Dahlheim, and S. J. Stern. 1998. Low genetic variation among killer whales (*Orcinus orca*) in the eastern North Pacific, and genetic differentiation between foraging specialists. J. Hered. 89:121-128.

Hoelzel, A. R., A. Natoli, M. Dahlheim, C. Olavarria, R. Baird, and N. Black. 2002. Low worldwide genetic diversity in the killer whale (*Orcinus orca*): implications for demographic history. Proc. R. Soc. Lond. 269:1467-1473.

Leatherwood, J. S., and M. E. Dahlheim. 1978. Worldwide distribution of pilot whales and killer whales. Naval Ocean Systems Center, Tech. Rep. 443:1-39.

Leatherwood, S., C. O. Matkin, J. D. Hall, and G. M. Ellis. 1990. Killer whales, *Orcinus orca*, photo-identified in Prince William Sound, Alaska 1976 to 1987. Can. Field Nat. 104:362-371.

Martien, K.K., A.R. Lang, B.L. Taylor, S.E. Simmons, E.M. Oleson, P.L. Boveng, and M.B. Hanson. 2019. The DIP delineation handbook: a guide to using multiple lines of evidence to delineate demographically independent populations of marine mammals. NOAA-TM-NMFS-SWFSC-622.

Matkin, C. O., G. M. Ellis, M. E. Dahlheim, and J. Zeh. 1994. Status of killer whales in Prince William Sound, 1985-1992, p. 141-162. *In* T. R. Loughlin (ed.), Marine Mammals and the *Exxon Valdez*. Academic Press, Inc., San Diego, CA.

Matkin, C., G. Ellis, E. Saulitis, L. Barrett-Lennard, and D. Matkin. 1999. Killer Whales of Southern Alaska. North Gulf Oceanic Society. 96 p.

Matkin, C. O., G. Ellis, L. Barrett-Lennard, H. Yurk, E. Saulitis, D. Scheel, P. Olesiuk, and G. Ylitalo. 2003. Photographic and acoustic monitoring of killer whales in Prince William Sound and Kenai Fjords. *Exxon Valdez* Oil Spill Restoration Project 030012, Final Report, North Gulf Oceanic Society, 60920 Mary Allen Ave, Homer, AK 99603. 118 p.

Matkin, C. O., L. Barrett-Lennard, H. Yurk, D. Ellifrit, and A. Trites. 2007. Ecotypic variation and predatory behavior of killer whales *Orcinus orca* in the eastern Aleutian Islands, Alaska. Fish. Bull., U.S. 105:74-87.

Matkin, C. O., E. L. Saulitis, G. M. Ellis, P. Olesiuk, and S. D. Rice. 2008. Ongoing population-level impacts on killer whales *Orcinus orca* following the 'Exxon Valdez' oil spill in Prince William Sound, Alaska. Mar. Ecol. Prog. Ser. 356:269-281.

Matkin, C. O., G. Ellis, D. Herman, E. Saulitis, R. Andrews, A. Gaylord, and H. Yurk. 2010. Monitoring, tagging, acoustics, feeding habits and restoration of killer whales in Prince William Sound/Kenai Fjords 2003-2009. EVOS Trustee Council Restoration Project 090742 Final Report, North Gulf Oceanic Society, Homer, AK.

Matkin, C. O., G. Ellis, E. Saulitis, D. Herman, R. Andrews, and A. Gaylord. 2013. Monitoring, tagging, feeding habits, and restoration of killer whales in Prince William Sound/Kenai Fjords 2010-2012. *Exxon Valdez* Oil Spill Restoration Project Final Report, EVOS Project #10100742, North Gulf Oceanic Society, 3430 Main Street, Suite B1, Homer, Alaska 99603. 62 p.

Matkin, C. O., J. W. Testa, G. M. Ellis and E. L. Saulitis. 2014. Life history and population dynamics of southern Alaska resident killer whales (*Orcinus orca*). Mar. Mammal Sci. 30(2):460-479. DOI: dx.doi.org/10.1111/mms.12049

Mitchell, E. D. 1975. Report on the meeting on small cetaceans, Montreal, April 1-11, 1974. J. Fish. Res. Board Can. 32:914-916.

Morin, P. A., F. I. Archer, A. D. Foote, J. Vilstrup, E. E. Allen, P. Wade, J. Durban, K. Parsons, R. Pitman, L. Li, P. Bouffard, S. C. Abel Nielsen, M. Rasmussen, E. Willerslev, M. T. P. Gilbert, and T. Harkins. 2010. Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species. Genome Res. 20:908-916. DOI: dx.doi.org/10.1101/gr.102954.109

National Marine Fisheries Service (NMFS). 2019. Reviewing and designating stocks and issuing stock assessment reports under the Marine Mammal Protection Act. Protected Resources Policy 02-204-03. Available online: https://media.fisheries.noaa.gov/dam-migration/02-204-03.pdf. Accessed May 2023.

National Marine Fisheries Service (NMFS). 2023. Guidelines for preparing stock assessment reports pursuant to the Marine Mammal Protection Act. Protected Resources Policy 02-238-01. Available online: https://www.fisheries.noaa.gov/s3/2023-02/02-238-01%20Final%20SI%20Revisions%20clean_kdr.pdf. Accessed May 2023.

Olesiuk, P. F., M. A. Bigg, and G. M. Ellis. 1990. Life history and population dynamics of resident killer whales (*Orcinus orca*) in the coastal waters of British Columbia and Washington State. Rep. Int. Whal. Comm. (Special Issue 12):209-242.

Parsons, K. M., J. W. Durban, A. M. Burdin, V. N. Burkanov, R. L. Pitman, J. Barlow, L. G. Barrett-Lennard, R. G. LeDuc, K. M. Robertson, C. O. Matkin, and P. R. Wade. 2013. Geographic patterns of genetic differentiation among killer whales in the northern North Pacific. J. Hered. 104(6):737-754. DOI: dx.doi.org/10.1093/jhered/est037

Perez, M. A. 2003. Compilation of marine mammal-fisheries interaction data from the domestic and joint venture groundfish fisheries in the U.S. EEZ of the North Pacific, 1989-2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-138, 145 p.

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska, 1998-2004, defined by geographic area, gear type, and target groundfish catch species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167, 194 p.

Peterson, M. J. and D. Hanselman. 2017. Sablefish mortality associated with whale depredation in Alaska. ICES J. Mar. Sci. 74(5):1382-1394. DOI: dx.doi.org/10.1093/icesjms/fsw239

Riesch, R., L. G. Barrett-Lennard, G. M. Ellis, J. K. B. Ford, and V. B. Deecke. 2012. Cultural traditions and the evolution of reproductive isolation: ecological speciation in killer whales? Biol. J. Linn. Soc. 106:1-17.

Sigler, M. F., C. R. Lunsford, J. T. Fujioka, and S. A. Lowe. 2003. Alaska sablefish assessment for 2004. *In* Stock assessment and fishery evaluation report for the groundfish fisheries of the Bering Sea/Aleutian Islands regions. North Pacific Fishery Management Council, Anchorage, AK, Section 3:223-292.

Yano, K., and M. E. Dahlheim. 1995. Killer whale, *Orcinus orca*, depredation on longline catches of bottomfish in the southeastern Bering Sea and adjacent waters. Fish. Bull., U.S. 93:355-372.

Yurk, H., L. Barrett Lennard, J. K. B. Ford, and C. O. Matkin. 2002. Cultural transmission within maternal lineages: vocal clans in resident killer whales in southern Alaska. Anim. Behav. 63:1103-1119.

Zerbini, A. N., J. M. Waite, J. Durban, R. LeDuc, M. E. Dahlheim and P. R. Wade. 2007. Estimating abundance of killer whales in the nearshore waters of the Gulf of Alaska and Aleutian Islands using line-transect sampling. Mar. Biol. 150(5):1033-1045.