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 prefer the colder waters of both hemispheres, with greatest abundances found within 800 km of major continents (Mitchell 1975). In Alaska waters, killer whales occur along the entire Alaska coast from the Chukchi Sea, into the Bering Sea, along the Aleutian Islands, Gulf of Alaska, and into Southeast Alaska (Braham and Dahlheim 1982; Fig. 20). Their occurrence has been well documented throughout British Columbia and the inland waterways of Washington State (Bigg et al. 1990), as well as along the outer coasts of Washington, Oregon, and California (Green et al. 1992, Barlow 1995, Forney et al. 1995). Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Braham and Dahlheim 1982) and in the intracoastal waterways of British Columbia and Washington State (Bigg et al. 1990). 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 (Heise et al. 1991) 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).

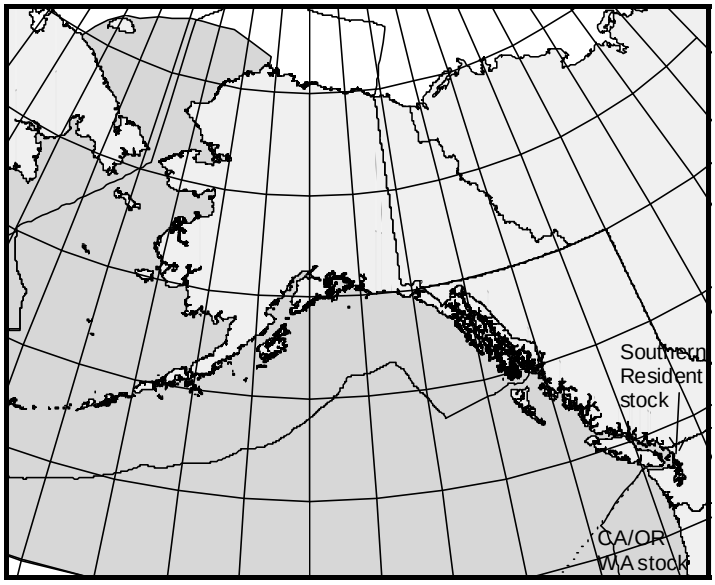

Figure 20. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the Eastern North Pacific Northern Resident and Transient stocks are largely overlapping (see text).

Killer whales along British Columbia and Washington State have been labeled as 'resident', 'transient', and 'offshore' (Bigg et al. 1990, Ford et al. 1994). Whales of a particular type have not been observed to associate with members of the other group types (Ford et al. 1994). Although less is known about killer whales in Alaska, it appears that all three types occur in Alaska waters (Dahlheim et al. 1997). The 'resident' and 'transient' types are believed to differ in several aspects of morphology, ecology, and behavior; that is, dorsal fin shape, saddle patch shape, pod size, home range size, diet, travel routes, dive duration, and social integrity of pods. For example, in Pacific Northwest waters, significant differences occur in call repertoires (Ford and Fisher 1982), saddle patch pigmentation (Baird and Stacey 1988), and diet (Baird et al. 1992). Studies on mtDNA restriction patterns provide evidence that the 'resident' and 'transient' types are genetically distinct (Stevens et al. 1989, Hoelzel 1991, Hoelzel and Dover 1991, Hoelzel et al. 1998).

Less is known about the 'offshore' type killer whales, which typically travel in pods of 25-75 individuals and have been encountered primarily off the coasts of California, Oregon, British Columbia and, rarely, in Southeast Alaska (Ford et al. 1994, Black et al. 1997, Dahlheim et al. 1997). Studies indicate the 'offshore' group type, although distinct from the other types ('resident' and 'transient'), appears to be more closely related genetically, morphologically, behaviorally, and vocally to the 'resident' type killer whales (Black et al. 1997, Hoelzel et al. 1998; J. Ford, pers. comm., Vancouver Aquarium, P. O. Box 3232, Vancouver, B.C. V6B3X8; L. Barrett-Lennard, pers. comm., Univ. of British Columbia, 6270 University Blvd., Vancouver, B.C. V6T1Z4).

Based primarily on data regarding association patterns, acoustics, movements, genetic differences and potential fishery interactions, five killer whale stocks are recognized along the west coast of North America from California to Alaska: 1) the Eastern North Pacific Northern Resident stock - occurring from British Columbia through Alaska, 2) the Eastern North Pacific Southern Resident stock - occurring within the inland waters of Washington state and southern British Columbia, 3) the Eastern North Pacific Transient stock - occurring from Alaska to Cape Flattery, WA, 4) the California/Oregon/Washington Pacific Coast stock - occurring from Cape Flattery through California (Fig. 20), and 5) the Eastern North Pacific Offshore stock - occurring from Southeast Alaska through California. Because the stock area for the Eastern North Pacific Northern Resident stock is defined as the waters from British Columbia through Alaska, 'resident' whales in Canadian waters are considered part of the Eastern North Pacific Northern Resident stock. The Stock Assessment Reports for the Pacific Region contain information concerning the Eastern North Pacific Southern Resident stock, the Eastern North Pacific Transient stock, the Eastern North Pacific Offshore stock, and the Hawaiian stock. The stock structure recommended in this report should be considered preliminary pending a joint review by the Alaska and Pacific Scientific Review Groups.

POPULATION SIZE

The Eastern North Pacific Northern Resident stock is a transboundary stock, including killer whales from British Columbia. Preliminary analysis of photographic data resulted in the following minimum counts for 'resident' killer whales belonging to the Eastern North Pacific Northern Resident stock (Note: individual whales have been matched between geographical regions and missing animals likely to be dead have been subtracted). In British Columbia, 216 'resident' whales have been identified as of 1998 (Ford et al. 2000; Table 1). In Southeast Alaska, 99 'resident' whales have been identified as of 1999 (M. Dahlheim, pers. comm., National Marine Mammal Laboratory, Seattle, WA 98125). In Prince William Sound and Kenai Fjords, another 362 'resident' whales have been identified as of 1998 (Matkin et al. 1999). Based on data collected from all Alaska waters west of Seward (Dahlheim and Waite 1993, Dahlheim 1994, Dahlheim 1997), 68 whales are considered 'residents' as they have been linked by association to 'resident' whales from Prince William Sound (M. Dahlheim, pers. comm., National Marine Mammal Laboratory, Seattle, WA, 98125; G. Ellis, pers. comm., Pacific Biological Station, Nanaimo, BC, V9R 5K6).

In addition to "known" resident pods, there are some animals which have been identified as "provisional" resident killer whales. Dahlheim (1997) documented 174 animals in Alaska waters west of Seward. Recent analyses of photographs collected by observers on commercial fishing vessels in the Bering Sea has resulted in an additional 67 animals which have been classified as "provisional" resident (M. Dahlheim and D. Ellifrit, pers. comm., National Marine Mammal Laboratory, Seattle, WA 98125). Provisional classifications were based primarily on morphological differences identified from the photographs. Accordingly, the numbers of 'residents' and 'transients' in Alaska waters west of Seward are considered preliminary at this time.

Combining the counts of known 'resident' whales gives a minimum number of 723 (BC + SEAK + PWS + Western; 216 + 99 + 341 + 68) killer whales belonging to the Eastern North Pacific Northern Resident stock (Table 18a).

Table 18a. Numbers of animals in each pod of killer whales belonging to the Eastern North Pacific Northern Resident stock of killer whales. A number followed by a "+" indicates a minimum count for that pod. Pods identified as "probable residents" by the authors are not included in the table.

Pod ID	**Previous Estimate in the SARs**	**1999/00 Estimate (and Source)**
Southeast Alaska	**Dahlheim et al., 1997**	
AF	42	49 (Matkin et al., 1999)
AG	24	27 (Matkin et al., 1999)

Pod ID	Previous Estimate in the SARs	1999/00 Estimate (and Source)
AZ	23+	23+ (Dahlheim, pers. comm.)
Total	**89+**	**99+**
Prince William Sound	**Matkin et al., 1998**	**Matkin et al., 1999**
AB	24	25
AD16	7	7
AD5	13	17
AE	15	16
AI	8	7
AJ	38	38
AK	10	12
AN10	19	20
AN20	9+	assume 9
AS	20	assume 20
AX	20 - 70	21
AY	11	assume 11
Unassigned to pods	88	138 (C. Matkin, pers. comm)

Pod ID	Previous Estimate in the SARs	1999/00 Estimate (and Source)
Total	**354+**	**341**
British Columbia	**Ford et al., 1994**	**Ford et al., 2000**
A1	15	16
A4	11	11
A5	12	13
B1	9	7
C1	13	14
D1	7	12
H1	8	7
I1	10	10
I2	7	2
I18	19	16
G1	28	37
G12	11	5
I11	18	22
I31	10	12
R1	23	29
W1	3	3
Total	**204**	**216**
Unassigned to pods	**68**	**68**
Total, all areas	**647**	**723**

Minimum Population Estimate

The survey technique utilized for obtaining the abundance estimate of killer whales is a direct count of individually identifiable animals. Given that researchers continue to identify new whales, the estimate of abundance based on the number of uniquely identified individuals known to be alive is likely conservative. However, the rate of discovering new whales within Southeast Alaska and Prince William Sound is relatively low. In addition, the abundance estimate does not include 241 unclassified whales from western Alaska that have been provisionally classified as 'residents'.

Other estimates of the overall population size (i.e., N_{BEST}) and associated CV(N) are not currently available. Thus, the minimum population estimate (N_{MIN}) for the Eastern North Pacific Northern Resident stock of killer whales is 723 animals, which includes animals found in Canadian waters (see PBR Guidelines regarding the status of migratory transboundary stocks, Wade and Angliss 1997). Information on the percentage of time animals 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 the recommendations of the Alaska Scientific Review Group (DeMaster 1996).

Current Population Trend

Mortality and recruitment rates for six 'resident' killer whale pods in Prince William Sound from 1985 to 1991 and for 16 pods in northern British Columbia from 1981 to 1986 indicate a 2% annual rate of increase for each region over the years examined (Matkin and Saulitis 1994). Although the current minimum population count of 723 is slightly higher than the last population count of 717, examination of only count data does not provide a direct indication of the net recruitment into the population. At present, reliable data on trends in population abundance for the entire Eastern North Pacific Northern Resident stock of killer whales are unavailable.

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% over the period from 1973 to 1987 (Olesiuk et al. 1990, Brault and Caswell 1993). Recent analyses indicate that some pods in the Eastern North Pacific Northern Resident population had increased at approximately 3% per year; one hypothesis for the reduction in the rate of increase is that the population may be apparently approaching carrying capacity (P. Olesiuk as reported in Dahlheim et al., 2000). However, a population increases at the maximum growth rate (R_{MAX}) only when the population is at extremely low levels; thus, the estimate of 2.92% is not a reliable estimate of R_{MAX}. Hence, until additional data become available, it is recommended that the cetacean maximum theoretical net productivity rate (R_{MAX}) of 4% be employed for this stock (Wade and Angliss 1997).

POTENTIAL BIOLOGICAL REMOVAL

Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the 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 (Wade and Angliss 1997). Thus, for the Eastern North Pacific Northern Resident killer whale stock, PBR = 7.2 animals ($723 \times 0.02 \times 0.5$).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fisheries Information

Six different commercial fisheries in Alaska that could have interacted with killer whales were monitored for incidental take by fishery observers from 1990 to 1999: Bering Sea (and Aleutian Islands) and Gulf of Alaska groundfish trawl, longline, and pot fisheries. Of the 6 observed fisheries, killer whale mortalities occurred only in the Bering Sea groundfish trawl and longline fisheries (Table 18b). For the fisheries with observed takes, the range of observer coverage over the 10-year period, as well as the annual observed and estimated mortalities are presented in Table 15. Both the 1991 and 1995 mortalities in the longline fishery occurred during unmonitored hauls and could not be used to estimate total mortality for the fishery in those years (80% and 28% observer coverage in 1991 and 1995, respectively). For computational purposes, the estimated mortality in 1991 and 1995 was set at 1, because at a minimum, one whale is known to have perished in each of those years. The 1993 mortality in the trawl fishery occurred under similar circumstances and was treated in the same manner (66% observer coverage in 1993). The mean annual (total) mortality for the most recent 5 years of observer coverage (1995-99) was 0.6 (CV = 0.67) for the Bering Sea groundfish trawl fishery and 0.8 (CV = 0.73) for the combined Bering Sea longline fishery, resulting in a mean annual mortality rate of 1.4 (CV = 0.51) killer whales per year from observed fisheries.

Table 18b. Summary of incidental mortality of killer whales (Eastern North Pacific Northern Resident stock) due to commercial fisheries from 1990 through 1999 and calculation of the mean annual mortality rate. Data from 1995 to 1999 are used in the mortality calculation when more than 5 years of data are provided for a particular fishery.

Fishery name	Years	Data type	Range of observer coverage	Observed mortality (in given yrs.)	Estimated mortality (in given yrs.)	Mean annual mortality
Bering Sea/Aleutian Is. (BSAI) groundfish trawl	90-99	obs data	53-75%	0, 1, 1, 1, 0, 0, 0, 1, 0, 1	1, 2, 2, 1, 0, 0, 0, 2, 0, 1	0.6 (CV = 0.67)
BSAI groundfish longline (incl. misc. finfish and sablefish fisheries)	90-99	obs data	27-80%	0, 1, 0, 0, 0, 1, 0, 0, 0, 1	0, 1, 0, 0, 0, 1, 0, 0, 0, 3	0.8 (CV = 0.73)
Estimated total annual mortality						1.4 (CV = 0.51)

An additional source of information on the number of killer whales killed or injured incidental to commercial fishery operations is the self-reported fisheries information required of vessel operators by the MMPA. During the period between 1990 and 1999, fisher self-reports from all Alaska fisheries indicated only one killer whale mortality, which occurred in the Bering Sea groundfish trawl fishery in 1990. That mortality has been included as an estimated mortality in Table 18b even though an observer program was in operation for that fishery (with 74% observer coverage) and did not report any killer whale mortalities during that year. However, because logbook records (fisher self-reports required during 1990-94) are most likely negatively biased (Credle et al. 1994), these are considered to be minimum estimates. Self-reported fisheries data are incomplete for 1994, not available for 1995, and considered unreliable for 1996 to the present (see Appendix 7).

The estimated minimum mortality rate incidental to U. S. commercial fisheries recently monitored is 1.4 animals per year, based exclusively on observer data. As the animals which were taken incidental to commercial fisheries have not been identified genetically, it is not possible to determine whether they belonged to the Eastern North Pacific Northern Resident or the Eastern North Pacific Transient killer whale stock. Accordingly, these same mortalities can be found in the stock assessment report for the transient stock (Forney et al., 2000).

Due to limited Canadian observer program coverage, there are few data on the mortality of marine mammals incidental to Canadian commercial fisheries (i.e., those similar to U.S. fisheries known to interact with killer whales). 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. Since 1990, there have been no reported fishery-related strandings of killer whales in Canadian waters. However, in 1994, one killer whale was reported to have contacted a salmon gillnet but did not entangle (Guenther et al. 1995). Data regarding the level of killer whale mortality related to commercial fisheries in Canadian waters, though thought to be small, are not readily available or reliable which results in an underestimate of the annual mortality for this stock.

Subsistence/Native Harvest Information

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

Other Mortality

Since 1986, research efforts have been made to assess the nature and magnitude of killer whale/blackcod (sablefish; *Anoplopoma fimbria*) interactions (Dahlheim 1988; Yano and Dahlheim 1995). Fishery interactions have occurred each year in the Bering Sea and Prince William Sound, with the number of annual reports varying considerably. Data collected from the Japan/U. S. cooperative longline research surveys operating in the Bering Sea indicate that interactions may be increasing and expanding into the Aleutian Islands region (Yano and Dahlheim 1995). Interactions between killer whales and commercial fisheries remain prevalent in the Bering Sea and Aleutian Islands

(M. Dahlheim, pers. comm., National Marine Mammal Laboratory, Seattle, WA). During the 1992 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 has experienced a high level of mortality: between 1986 and 1991, 22 whales out of a pod of 37 (59%) are missing and considered dead (Matkin et al. 1994). The cause of death for these whales is unknown, but it may related to gunshot wounds or effects of the *Exxon Valdez* oil spill (Dahlheim and Matkin 1994).

The shooting of killer whales in Canadian waters has also been a concern in the past. However, in recent years the Canadian portion of the stock has been researched so extensively that evidence of bullet wounds would have been noticed if shooting was prevalent (G. Ellis, pers. comm., Pacific Biological Station, Nanaimo, BC, V9R 5K6).

Other Issues

Although only small numbers of killer whales are taken in the Bering Sea fisheries, there is considerable interaction between the whales and the fisheries. Interactions between killer whales and longline vessels have been well documented (Dahlheim 1988, Yano and Dahlheim 1995). However, less has been documented regarding interactions with the trawl fishery. Recently several observers reported that large groups of killer whales in the Bering Sea have followed vessels for days at a time, actively consuming the processing waste (Fishery Observer Program, unpubl. data, NMFS, AFSC, 7600 Sand Point Way NE, Seattle, WA 98115).

STATUS OF STOCK

Killer whales are not listed as "depleted" under the MMPA or listed as "threatened" or "endangered" under the Endangered Species Act. In April 1999, the Committee on the Status of Endangered Wildlife in Canada voted to designate all resident killer whales in British Columbia as "threatened", and the designation appears to have been based on the fact that the resident population's small size and low potential growth rate makes it potentially at risk from immunotoxic effects of persistent toxic chemicals and a reduction in prey availability (Baird, 1999). Baird (1999) also indicates that the commercial and recreational whale watching industry may be having an impact. It is likely that both the human-caused mortality level and the population size for this stock are underestimated. The human-caused mortality has been underestimated due primarily to a lack of information on Canadian fisheries; however, a review of the status of killer whales in Canada indicates that the available evidence in Canada suggests that mortality incidental to commercial fisheries is rare and does not have the potential to cause substantial population reductions in the future (Baird, 1999). The minimum abundance estimate is likely underestimated because researchers continue to encounter new whales and because unclassified whales from western Alaska were not included. Because the population estimate is likely to be conservative, the PBR is also conservative.

Based on currently available data, the estimated annual fishery-related mortality level (1.4) exceeds 10% of the PBR, (i.e., 0.72) and therefore cannot be considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury (1.4 animals per year) is not known to exceed the PBR (7.2). Therefore, the Eastern North Pacific Northern 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 size are currently unknown.

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