KILLER WHALE (*Orcinus orca*): Eastern North Pacific Transient 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). 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). Movements of killer whales between the waters of Southeast Alaska and central California have also been documented (Goley and Straley 1994).

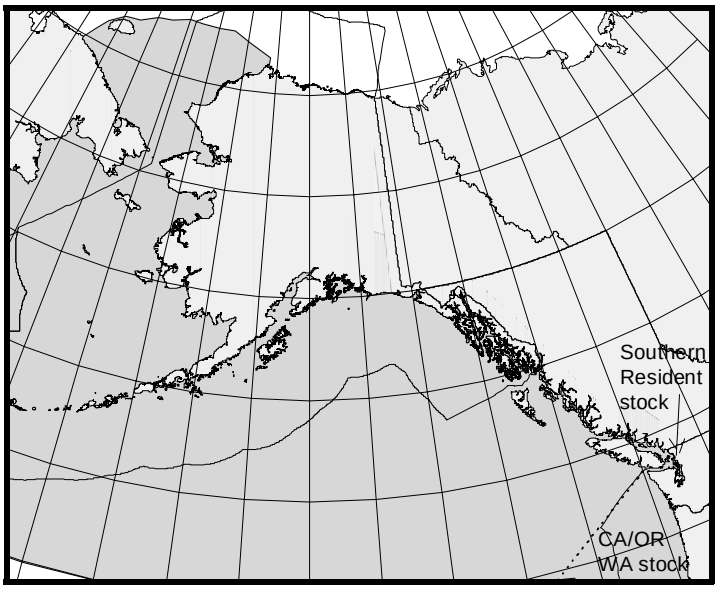

Figure 20. Approximate distribution of killer whales in the eastern North Pacific (shaded area). The distribution of the Eastern North Pacific Northern Resident and Transient stocks are largely overlapping (see text).

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 (Black et al. 1997, Dahlheim et al. 1997, Ford et al. 1994). 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 Transient stock is defined as the waters from Cape Flattery through Alaska, 'transient' whales in Canadian waters are considered part of the Eastern North Pacific Transient stock. The Stock Assessment Reports for the Pacific Region contain information concerning the Eastern North Pacific Southern Resident stock, the California/Oregon/Washington Pacific Coast stock, the Eastern North Pacific Offshore stock (to be included in the 1999 stock assessment revisions), and a 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 Transient stock is a transboundary 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 Eastern North Pacific Transient stock (Note: individual whales have been matched between geographical regions and missing animals likely to be dead have been subtracted). In British Columbia and southeastern Alaska, 170 'transient' whales have been identified (Ford et al. 1994). In the Gulf of Alaska, 17 'transient' killer whales have been identified genetically and acoustically (L. Barrett-Lennard, pers. comm., Univ. of British Columbia, 6270 University Blvd., Vancouver, B.C. V6T1Z4). The transient group AT1, commonly seen in Prince William Sound, was thought to have an additional 11 whales alive in 1997 (Matkin et al. 1998). 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 (G. Ellis, pers. comm., Pacific Biological Station, Nanaimo, BC, V9R 5K6), and an additional 174 are provisionally classified as 'residents' and 53 as 'transients.' 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 'transient' whales gives a minimum number of 198 (170 + 17 + 11) killer whales belonging to the Eastern North Pacific Transient stock.

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: 1) 53 unclassified whales from western Alaska that have been provisionally classified as 'transients', or 2) 105 'transients' encountered in California which have been linked by association and acoustic data to 'transient' whales in British Columbia (Black et al. 1997; G. Ellis, pers. comm., Pacific Biological Station, Nanaimo, BC, V9R 5K6). The California animals are currently accounted for in the abundance estimate for the California/Oregon/Washington Pacific Coast stock.

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 Transient stock of killer whales is 198 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

At present, reliable data on trends in population abundance for the Eastern North Pacific Transient 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). 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 re-authorized 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 Transient killer whale stock, PBR = 2.0 animals ($198 \times 0.02 \times 0.5$).

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 NMFS observers from 1990 to 1996 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. For the fisheries with observed takes, the range of observer coverage over the 7-year period, as well as the annual observed and estimated mortalities are presented in Table 16. 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 similarly circumstances and was treated in the same manner (66% observer coverage in 1993). The mean annual (total) mortality was 0.6 (CV=0.67) for the Bering Sea groundfish trawl fishery and 0.2 (CV=1.0) for the combined Bering Sea longline fishery, resulting in a mean annual mortality rate of 0.8 (CV=0.56) killer whales per year from observed fisheries.

Table 16. Summary of incidental mortality of killer whales (Eastern North Pacific Northern Transient stock) due to commercial fisheries from 1990 through 1996 and calculation of the mean annual mortality rate. Data from 1992 to 1996 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	90-96	obs data	53-74%	0, 1, 1, 1, 0, 0, 0	1, 2, 2, 1, 0, 0, 0	0.6 (CV=0.67)
BSAI groundfish longline (incl. misc. finfish and sablefish fisheries)	90-96	obs data	27-80%	0, 1, 0, 0, 0, 1, 0	0, 1, 0, 0, 0, 1, 0	0.2 (CV=1.0)
Estimated total annual mortality						0.8 (CV=0.56)

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 1996, 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 16 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 (see Appendix 4).

The estimated minimum mortality rate incidental to U. S. commercial fisheries recently monitored is 0.8 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 Resident stock.

Due to a lack of Canadian observer programs, there are few data concerning the mortality of marine mammals incidental to Canadian commercial fisheries, which are analogous to U.S. fisheries that are 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 Island region (Yano and Dahlheim 1995). 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 may be 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 there have been no reports of shooting incidents in Canadian waters. 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, 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. Recall, that the human-caused mortality has been underestimated primarily due to a lack of information on Canadian fisheries, and that the minimum abundance estimate is considered conservative (because researchers continue to encounter new whales and unclassified whales from western Alaska were not included), resulting in a conservative PBR estimate. Based on currently available data, the estimated annual fishery-related mortality level (0.8) exceeds 10% of the PBR (i.e., 0.20) and therefore can not be considered to be insignificant and approaching zero mortality and serious injury rate. The estimated annual level of human-caused mortality and serious injury (0.8 animals per year) is not known to exceed the PBR (2.0). Therefore, the Eastern North Pacific 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.

REFERENCES

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., Abrams, P. A., 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.

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. Commn. (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 pp.

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

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

Credle, V. R., D. P. DeMaster, M. M. Merklein, M. B. Hanson, W. A. Karp, and S. M. Fitzgerald (eds.). 1994. NMFS observer programs: minutes and recommendations from a workshop held in Galveston, Texas, November 10-11, 1993. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-94-1, 96 pp.

Dahlheim, M. E. 1988. Killer whale (*Orcinus orca*) depredation on longline catches of sablefish (*Anoplopoma fimbria*) in Alaskan waters. NWAFC Processed Rep. 88-14, 31 pp. (available upon request - Alaska Fisheries Science Center, 7600 Sand Point Way NE, Seattle, WA 98115).

Dahlheim, M. E. 1994. Abundance and distribution of killer whales (*Orcinus orca*) in Alaska in 1993. Annual report to the MMPA Assessment Program, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

Dahlheim, M. E. 1997. A photographic catalogue of killer whales (*Orcinus orca*) from the Central Gulf of Alaska to the southeastern Bering Sea. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 131, 54 pp.

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

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 pp. + appendices.

DeMaster, D. P. 1996. Minutes from the 11-13 September 1996 meeting of the Alaska Scientific Review Group, Anchorage, Alaska. 20 pp + appendices. (available upon request - D. P. DeMaster, National Marine Mammal Laboratory, 7600 Sand Point Way, NE, Seattle, WA 98115).

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. Commn. 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 and University of Washington Press. 102 pp.

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.

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. Bonnel, and K. C. Balcomb. 1992. Cetacean distribution and abundance of Oregon and Washington, 1989-1990. Pp. 1-100, *In* Brueggeman (ed.), Oregon and Washington Marine Mammal and Seabird Surveys. Final Rep. OCS Study MMS 91-0093.

Guenther, T. J., R. W. Baird, R. L. Bates, P. M. Willis, R. L. Hahn, and S. G. Wischniowski. 1995. Strandings and fishing gear entanglements of cetaceans of the west coast of Canada in 1994. Unpubl. doc. submitted to Int. Whal. Commn. (SC/47/O6). 7pp.

Heise, K., G. Ellis, and C. Matkin. 1991. A catalogue of Prince William Sound killer whales. North Gulf Oceanic Society, Homer, AK. Published for the National Marine Mammal Laboratory, 7600 Sand Point Way NE, Seattle, WA 98115.

Hoelzel, A. R. 1991. Analysis of regional mitochondrial DNA variation in the killer whale; implications for cetacean conservation. Rep. Int. Whal. Commn. (Special Issue 13): 225-233.

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. Heredity 89:121-128.

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 Naturalist 104: 362-371.

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

Matkin, C.O., D. Scheel, G. Ellis, L.Barrett-Lennard, H. Jurk, and E. Saulitis. 1998. Comprehensive Killer Whale Investigation, Exxon Valdez Oil Spill Restoration Project Annual Report (Restoration Project 97012), North Gulf Oceanic Society, Homer, Alaska. 58 pp.

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

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. Commn. (Special Issue 12):209-242.

Stevens, T. A., D. Duffield, E. Asper, K. Hewlett, A. Bolz, L. Gage, and G. Bossart. 1989. Preliminary findings of restriction fragment differences in mitochondrial DNA among killer whales (*Orcinus orca*). Can. J. Zool. 67:2592-2595.

Wade, P. R., and R. Angliss. 1997. Guidelines for assessing marine mammal stocks: report of the GAMMS workshop April 3-5, 1996, Seattle, Washington. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-12, 93 pp.

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.