Killer Whales in the Eastern North Pacific (*Orcinus orca*)

Killer whales occur in all oceans of the world but are more abundant in temperate and colder waters within 800 km (500 mi) of coasts. In the North Pacific, killer whales are divided into three nonassociating forms or ecotypes referred to as "resident," "transient," and "offshore." Resident and transient forms show distinctive differences in genetic composition, morphology, diet, ecology, distribution, movement patterns, and social structure. The offshore form is less well described, but appears to be more closely related to the resident form than to the transient form. One of the more notable differences among these forms is their diet. All killer whales are considered top-level predators, but the diet of resident killer whales appears to be composed of fish, whereas the transient form appears to prey primarily on marine mammals. The diet of the offshore form has not been characterized but is assumed to be fish.

Within each of these three ecotypes, killer whales in the eastern North Pacific (Fig. 12) are divided into various stocks, each of which also exhibits structure in the form of social groups. Resident whales occur in associations of matrilineal groups, which generally include fewer than 40 individuals, although large aggregations involving multiple pods may also occur. The social structure and reproductive behavior of transient killer whales appears to be more variable. They are generally found in small groups (fewer than 10 individuals) but also may occur as solitary animals or in temporary pairs. Offshore killer whales, on the other hand, tend to occur in large groups of 25 to 75 individuals. The reasons for these differences are not well understood but may reflect foraging-related natural selection over evolutionary time periods or adaptations to foraging conditions over shorter ecological time periods. For each ecotype, association in groups presumably facilitates cooperative behavior (e.g., hunting, calf-rearing). Group cohesion may be maintained by a range of behaviors, including the production of a number of different sounds that are presumably used by killer whales for communication, orientation, and foraging.

Stock Structure, Abundance, Trends, and Status

The National Marine Fisheries Service currently recognizes five killer whale stocks in the eastern North Pacific: (1) a northern resident stock (British Columbia through Alaska), (2) a southern resident stock (inland waters of Washington State and southern British Columbia), (3) a transient stock (Alaska to Cape Flattery, Washington), (4) a California/Oregon/Washington Pacific coast stock (Cape Flattery, Washington, through California),

Figure 12. Two resident killer whales near Harrow Strait in the Pacific Northwest. (Photo by Brad Hanson, courtesy of the National Marine Mammal Laboratory.)

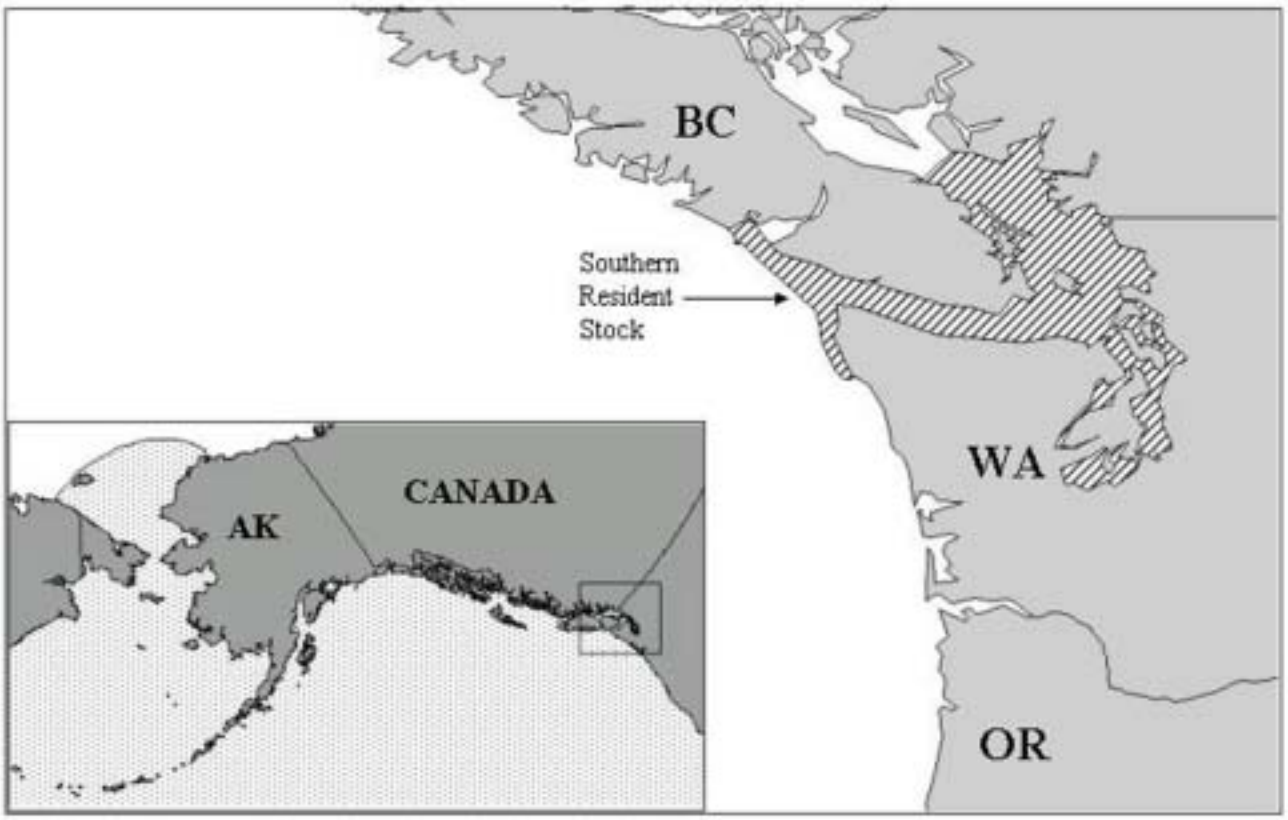

Figure 13. North Pacific killer whale distibution. Figure inset illustrates the wide distribution of killer whale stocks in the eastern North Pacific. The larger background figure shows distribution of the southern resident killer whale stock in Puget Sound, a larger view of the small square in the inset figure.

and (5) an offshore stock (southeastern Alaska through California). The Service's minimum population estimate for the northern resident stock is 723 animals. The minimum estimate for the southern resident stock is 78 animals, which is a decrease of 19 animals since 1995. The minimum estimate for the transient stock is 346 whales. Abundance has not been estimated for the California/Oregon/Washington coastal stock. The minimum abundance estimate for the offshore stock is 209. Trends for the northern resident stock, transient stock, California/Oregon/Washington coastal stock, and offshore stock cannot be described based on the available data. Trends for the southern resident stock are described below, as are trends for the AT1 population of transient killer whales from Prince William Sound area.

None of these recognized stocks is listed as threatened or endangered under the Endangered Species Act or designated as depleted under the Marine Mammal Protection Act. However, the status of killer whale stocks in the eastern North Pacific has become an issue of considerable concern in the past few years due to their potential role as predators and their interactions with, and vulnerability to, human activities. These issues have been confounded by the fact that scientists are now describing subgroups within these stocks based on genetic, geographic, social, morphological, ecological, or other characteristics, and the level of protection they should be afforded under the Marine Mammal Protection Act and the Endangered Species Act is a matter of debate.

Killer Whale Predation

Predation on Other Marine Mammals— Killer whale predation is the leading hypothesis for the decline of the northern sea otter in the central Aleutian Islands region. Such predation also may be a factor in other areas of decline (Alaska Peninsula west through the Aleutian Islands, Kodiak Archipelago, Pribilof Islands, and Bristol Bay area) although direct evidence is lacking. The hypothesis is that transient killer whales have increased

their predation of sea otters to compensate for declining availability of other prey, including Steller sea lions. Killer whale predation is also considered a possible contributing factor in the decline, or lack of recovery, of the western population of Steller sea lions in recent years. However, data required to confirm these hypotheses are not available in sufficient detail. The circumstantial evidence is stronger with respect to the decline of sea otters in the central Aleutian Islands although additional research is needed in both cases. In particular, data are needed on the rate of killer whale predation on sea lions and sea otters from direct observations or inferred from better information on killer whale abundance, trends, and diet. Research programs to address these questions are being initiated by the National Marine Fisheries Service (with respect to Steller sea lions) and the Fish and Wildlife Service (with respect to northern sea otters). Continued long-term support for these programs will be necessary if they are to provide the needed information.

Predation on Fishes Taken in Commercial Fisheries—In the southeastern Bering Sea and Prince William Sound, killer whales interact with longline fisheries for Pacific halibut, sablefish, and Greenland turbot. The whales sometimes damage or remove fish and damage gear. Studies of such depredation in the 1980s indicated that the killer whales tended to target the larger fish caught, that depredation occurred on at least 20 percent of bottom longline sets in the southeastern Bering Sea, and that an estimated 25 percent of the total catch was lost in Prince William Sound. A review of killer whale/longline interactions in the 1980s suggested that this phenomenon was spreading to the Aleutian Islands. Longline fisheries exist throughout the Aleutian Islands and along the continental shelf break (200-m isobath) in the Bering Sea. Such interactions may spread as killer whales learn to take advantage of the foraging opportunities presented by longlines with hooked fish.

In turn, the whales may be injured by ingestion of hooked fish, entangled in the longline gear, or shot by fishermen. The Service estimates that between 1995 and 1999 the average number of killer whale mortalities resulting annually from such interactions in the Bering Sea/Aleutian Islands region was about 0.8 whales. Estimated killer whale mortality due to groundfish fisheries during the same period was similar, suggesting an average total mortality rate of about 1.4 whales per year in the Bering Sea and Aleutian Island region. However, surveys conducted in 1992 by the Service also indicated that 8 of 182 killer whales observed in the Bering Sea and Gulf of Alaska exhibited evidence of gunshot wounds. The mortality rate from such wounds is unknown. In Prince William Sound, 8 of the 35 whales in the AB pod, which is involved in most fishery interactions, were lost between 1986 and 1988. Some of those losses may have been due to gunshot wounds although shooting was prohibited after 1986. An additional 13 whales were lost from this pod after the *Exxon Valdez* oil spill.

A variety of techniques has been tried to reduce or eliminate such interactions, including acoustic deterrents (e.g., "bang pipes" and seal bombs) and modified fishing procedures, such as operating vessels in teams that alternately retrieve lines so that one crew can keep animals away while the other retrieves hooked fish. To date, none of these techniques has proven to be particularly successful. As described in Chapter VIII, the Marine Mammal Commission provided support for a 2002 workshop to develop measures to mitigate interactions between cetaceans and longline fisheries.

Vulnerability to Human Activities

Southern Resident Killer Whale Stock— Southern resident killer whales occur primarily in the inland waters of Puget Sound and southern British Columbia, and occasionally range as far south as California (Fig. 13). Status of the stock before the 1960s is unknown, but it may well have been reduced at that time due to indiscriminate shooting, which was known to occur, and other human-related mortality. In the 1960s and early 1970s the stock was diminished by the live capture and removal of at least 48 whales for aquariums and display facilities. Abundance in 1974 was 71 whales (Fig. 14). The stock began to recover in the mid- and late 1970s, declined during the early 1980s, and then recovered to 97 whales in 1995. Since 1995 the stock has declined by about 20 percent, and abundance in 2001 was 78 whales. This recent decline appears to have resulted from decreases in both fecundity and survival although the change in survival appears to be the more significant factor. The decrease in survival is particularly worrisome because it has involved not only immature animals, but also mature females. Ma-

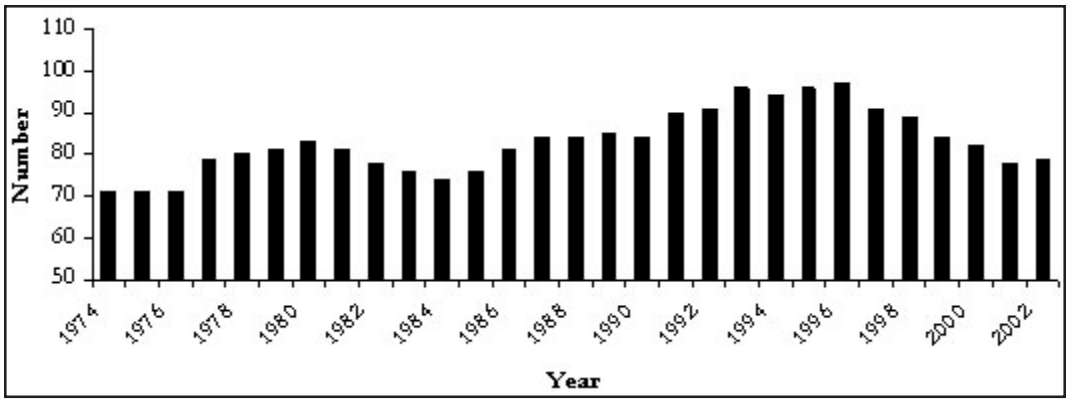

Figure 14. Southern resident killer whale abundance, 1974–2002.

ture females usually have a high probability of survival and are critical to the stock's ability to recover because of their role in reproduction.

Shortage of prey, exposure to contaminants, and disturbance have been identified as three human-related factors that may be contributing to the recent decline of the southern resident stock. Salmon, particularly chinook salmon, appear to be the major prey of these fish-eating resident killer whales. Comparisons of historical and current chinook salmon levels in this region suggest that their numbers have declined markedly, perhaps by 50 to 70 percent or more, throughout the range of the southern resident stock. As top-level predators, these whales also carry high levels of contaminants accumulated through the food chain. The manner and extent to which these contaminants affect the whales is unknown, but they may affect, among other things, immune system function and reproduction. In addition, southern resident killer whales are exposed to a variety of potential human-related disturbances from shipping, fishing, recreational boating, and whale-watching. Here, too, the manner and extent to which such potential forms of disturbance affects these whales are unknown, but such disturbance may affect their distribution and habitat use patterns, behavior, or ability to communicate using sound.

On 1 May 2001 the Center for Biological Diversity and other groups petitioned the National Marine Fisheries Service to list the southern resident stock as endangered or threatened under the Endangered Species Act and to designate critical habitat for the stock. On 13 August 2001 the Service published a notice in the *Federal Register*, finding that listing may be warranted. It convened a biological review team to assess killer whale stock structure and the probability of extinction of the southern resident stock. On 28 February 2002 the Service sent the draft report of the review team to the Marine Mammal Commission with a request for comments. The draft report indicated that the probability of extinction of the southern resident stock was greater than 10 percent over the next 100 years and greater than 85 percent over the next 300 years if the current trend continues. However the conclusion of the report hinged on the question of whether the southern resident stock constitutes a "distinct population segment," which it had previously interpreted (with the Fish and Wildlife Service *[Federal Register* 61:4722]) to be a segment that must be "discrete" from other populations and "significant" to the taxon (species or subspecies) to which it belongs. Ample evidence indicates that the stock is a discrete unit. Thus, the issue was whether it is significant to its taxon. The review team "could not identify with any certainty the true taxa for killer whales." Nonetheless, the team concluded that the southern resident stock was not significant and therefore did not constitute a distinct population segment.

In reaching its conclusion, the review team relied on four criteria established by the joint policy statement for determining significance:

(1) persistence of the discrete population segment in an ecological setting unusual or unique for the taxon;

(2) evidence that loss of the discrete population segment would result in a significant gap in the range of the taxon;

(3) evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range; and

(4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

The team also noted that other criteria may be used, as appropriate. The evaluation of these criteria depends heavily on the taxonomic status of killer whales.

In a 22 March 2002 letter to the Service, the Marine Mammal Commission commented that the outdated state of killer whale taxonomy appears to undermine the rationale for the preliminary conclusion that the southern resident stock is not significant. The Commission suggested that the Service consider additional information as to whether the stock is significant. In particular, the Commission recommended that the Service review the finding and purpose of the Endangered Species Act, wherein Congress recognizes the esthetic, ecological, educational, historical, recreational, and scientific value of various species to the nation and its people, and establishes as a purpose of the Act the conservation of the ecosystems upon which threatened and endangered species depend. In view of the uncertainty regarding the taxonomic status of killer whales and the importance of such information in the Service's rationale, the Commission also recommended that the Service act in a precautionary manner to ensure recovery and conservation of the southern resident killer whale stock.

On 1 July 2002 the Service published its final determination that listing of the southern resident killer whale stock was not warranted at this time and under its current taxonomic status because it does not constitute a species, subspecies, or distinct population segment under the Endangered Species Act. At the same time, the Service concurred that "the issue of classifying Southern Resident killer whales into a particular DPS cannot be resolved until the taxonomic structure of *O. orca* is clarified." Therefore, the Service committed to reconsider the taxonomy of killer whales within four years. On the same day the Service published a notice that it was anticipating that it would propose to designate the southern resident stock as depleted under the Marine Mammal Protection Act and was seeking comments on the proposed listing and potential conservation measures. On 6 August 2002 a group of environmental organizations and individuals informed the Service of their intent to sue the Service over its determination that listing under the Endangered Species Act was not warranted.

Representatives of the Service reviewed the status of eastern North Pacific killer whale stocks, including the decisionmaking process regarding the southern resident stock, at the Marine Mammal Commission's annual meeting on 8–10 October 2002. On 18 November 2002 the Commission wrote to the Service to provide additional comments and recommendations pertaining to the southern resident stock. The Commission again questioned the use of current taxonomy of killer whales as a basis for denying protection to the stock under the Endangered Species Act. With regard to the four criteria used to determine "significance," the Commission pointed out that it could be reasonably argued that the southern resident stock occupies an ecological setting unique for the species because it is the only resident stock along the entire Pacific coast of Washington, Oregon, and California.

The Commission also pointed out that the loss of this stock could result in a significant gap in the range of the taxon because transient, offshore, or other resident killer whales with overlapping or adjacent distributions may not expand into the range of the southern resident stock if it were absent. It is not clear, for example, that other ecotypes could replace southern residents because they differ significantly in behavior and ecological requirements. There is no evidence of such expansion to date, nor is there evidence that southern resident whales have excluded them from doing so. Because the Service committed to conduct a review of killer whale taxonomy within four years, the Commission also recommended that the Service develop a plan for carrying out this review and for ensuring that the information needed to make a more informed decision is available for the review.

With regard to the Service's notice of proposed rulemaking to designate the southern resident stock of killer whales as depleted under the Marine Mammal Protection Act, the Commission concurred that the available evidence is sufficient to demonstrate that the stock is below its optimum sustainable population range and warrants such designation. Because the same information used to determine that the stock is depleted may be used to determine when that designation is removed (i.e., the stock has recovered), the Commission rec-

ommended that the Service proceed with the designation but postpone a determination of the recovery level until it has had time to conduct an adequate review of the literature to provide the best science-based estimate of the recovery level.

Finally, the Commission commented on the similarities and distinctions between listing the stock under the Endangered Species Act and designating it as depleted under the Marine Mammal Protection Act. The foremost distinction is the consultation requirement under section 7 of the Endangered Species Act, which provides an explicit mechanism for identifying, evaluating, and modifying (if required) federal actions that may jeopardize a listed species or destroy or adversely modify its critical habitat. Section 7 consultation does not have a counterpart under the Marine Mammal Protection Act, and by declining to list the southern resident stock under the Endangered Species Act, the Service had failed to avail itself of this important tool for identifying and addressing threats to the stock and its habitat. The Commission also noted that designation of critical habitat and consultations on federal actions under the Endangered Species Act provide clear and direct mechanisms for protecting habitat of threatened and endangered species. The Marine Mammal Protection Act addresses habitat concerns more broadly and provides a mechanism under which the Service *may* develop and implement conservation and management measures for areas of ecological significance. The Commission therefore recommended that the Service use its authority to protect important habitat as it develops a conservation plan for the southern resident killer whale stock.

On 18 December 2002 the Center for Biological Diversity, Friends of the San Juans, People for Puget Sound, the Orca Conservancy, Ocean Advocates, Earth Island Institute, Ralph Munro, and Karen Munro filed suit against the National Marine Fisheries Service and the Department of Commerce. The plaintiffs challenged the Service's determination that listing under the Endangered Species Act was not warranted.

AT1 Group of Transient Whales—The AT1 group of transient killer whales occurs in Prince William Sound and the Kenai fjords. They feed on marine mammals, and Dall's porpoises and harbor seals are thought to be major prey. When first assessed in 1984, the group consisted of 22 animals. Currently, the group has declined to nine animals (five females and four males). The cause(s) of the decline have not been confirmed, but suspected causes include the *Exxon Valdez* oil spill, exposure to other contaminants, reduction in prey availability (see Chapter III, section on harbor seals in Alaska), and human-related disturbance.

On 14 November 2002 the Alaska Center for the Environment, Alaska Community Action on Toxics, Center for Biological Diversity, Coastal Coalition, Defenders of Wildlife, Eyak Preservation Council, and the National Wildlife Federation petitioned the National Marine Fisheries Service to designate the AT1 group of transient killer whales as depleted under the Marine Mammal Protection Act. On 22 November 2002 the Service published a notice of the availability of the petition and solicited comments on it.

In a 23 December 2002 letter to the Service the Marine Mammal Commission commented that the question of whether the AT1 group should be designated as depleted appears to hinge on two questions: Does the AT1 group constitute a stock and is the AT1 group below its optimum sustainable population level. The Marine Mammal Protection Act defines a "population stock" or "stock" as "a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature." The Alaska Scientific Review Group had previously reviewed evidence that AT1 is a separate stock and, in a 13 December 2001 letter, recommended that the Service recognize it as such. The Commission concurred with the scientific review group.

The limited information available to address the second question suggests that the AT1 group is below its optimum sustainable population level. The group consisted of 22 animals in 1984. Assuming that (1) 22 is a minimum indicator of the environmental carrying capacity for this group, and (2) the lower limit of the optimum sustainable population occurs at 60 percent of the carrying capacity (an assumption previously used by the Service for other marine mammals), then the current abundance of nine animals is less than the optimum sustainable population level.

The Commission's letter regarding the AT1 group recognized that the designation of such a small group of animals as a stock would require a new management approach with new challenges. The designation of the group as depleted and sub-

sequent management actions would also be confounded by a number of sources of uncertainty, including the relationships of the AT1 group to other killer whale groups, and the multiple factors that may have led to its decline. In view of these and other sources of uncertainty, the Marine Mammal Commission recommended to the Service that it take a precautionary approach to management of the AT1 group and designate it as depleted.

Future Research and Management

In its 18 November 2002 letter to the National Marine Fisheries Service, the Marine Mammal Commission emphasized the need for a sustained long-term research program on killer whales in the eastern North Pacific. The role of these animals as top predators and their vulnerability to human interactions had led to a number of significant concerns that are difficult to address in the absence of baseline life history and demographic information on these animals. In its letter, the Commission noted that future support is needed for studies of their biology, taxonomy, population dynamics, and ecology. Although these animals may have substantial influence on North Pacific ecosystems, they also may be vulnerable to changes occurring in these ecosystems as a result of natural factors or human activities. If, for example, the prey of transient killer whales in the Gulf of Alaska and Aleutian Islands region has declined significantly due to the removal of large numbers of large whales and the nearly 90 percent decline of Steller sea lions, then killer whales may have been forced to switch to secondary prey (e.g., sea otters) with significant effects on their foraging success (e.g., energy balance), reproduction, survival, and, ultimately, population trends. The evidence collected in recent surveys suggests far fewer transient killer whales than expected. The low number of sightings may indicate that transient killer whale numbers in this region are, in fact, depleted. For these and other reasons, the Marine Mammal Commission recommended to the Service that it develop a long-term research plan for North Pacific killer whales to provide the level of information needed to understand their population trends and their role in North Pacific ecosystems and to develop conservation programs needed to provide a suitable level of protection to ensure that they remain functioning elements of those ecosystems.

Rescue and Release of A73

A73 is a two-year-old female killer whale from the A pod of the northern resident stock in Canadian waters. In the summer of 2002 she was observed alone, and presumably orphaned, for several months in Puget Sound, where she had begun to interact with vessels and ferries. Out of concern for her health and poor prospects for her survival as a lone animal, the National Marine Fisheries Service decided in late May 2002 to capture her for rehabilitation and release back in her home waters. On 14 June 2002 she was captured and transported to a National Oceanic and Atmospheric Administration facility near Seattle, where she received medical care and was fed a diet of salmon. After treatment for parasites and bacterial infection, she was cleared for release. On 13 July she was transported by ferry to a facility in northern Vancouver. She began interacting almost immediately with killer whales in the area and was released the next day. Before release, the whale was tagged to allow tracking of her movements. Since then, she has been observed with other whales on numerous occasions and appears to be faring well. The rescue and release effort appears to have been a successful collaboration of the Service, Canada's Department of Fisheries and Oceans, the Vancouver Aquarium, and whale advocacy groups.