

reason to believe that disease will be a significant impediment to recovery of the Mexican wolf in the wild. Because the potential for disease and parasite transmission is much greater in captivity, especially in zoos, all captive Mexican wolves are vaccinated or treated for potential canine diseases and parasites that may exist in the captive environment.

As a result of captive disease and parasite prevention and treatment protocols, released wolves are in good health and physical condition when they enter the wild. Re-established Southwestern (Mexican) wolves will be monitored for disease or parasite-related problems, and all wild wolves captured for monitoring or management purposes will continue to be vaccinated indefinitely. To date, three Mexican wolf pups born in the wild have died from canine parvovirus. These pups were recaptured due to their parents killing livestock, and the pups subsequently died in captivity. This appears to be a limited occurrence and may have been associated with the pups being captured and placed in captivity.

**Predation.** There are no wild animals that habitually prey on gray wolves. Occasionally wolves will be killed by large prey such as deer or moose (Mech and Nelson 1989) or by a competing predator such as a mountain lion, but this has only been documented on rare occasions and is not believed to be a significant mortality factor. However, humans are highly effective predators of gray wolves.

**Eastern DPS.** Wolves are killed by other wolves, most commonly when a dispersing wolf encounters another pack and is attacked as an intruder, or when two packs encounter each other along their common territorial boundary. This form of mortality is likely to increase as more of the available wolf habitat becomes saturated with wolf pack territories, as is the case in northeastern Minnesota. Over the period from October 1979 through June 1998, 7 (13 percent) of the diagnosed mortalities of radio-collared Wisconsin wolves resulted from wolves being killed by other wolves (Wydeven 1998). However, this behavior is a normal part of the species' behavioral repertoire and should not be a cause for concern in healthy wolf populations, as it normally indicates that the wolf population is at, or approaching, the carrying capacity of the area.

Humans have functioned as highly effective predators of the gray wolf. We attempted to eliminate them from the landscape in earlier times: the United States Congress passed a wolf bounty that covered the Northwest Territories

in 1817. Bounties on wolves subsequently became the norm for States across the species' range. In Michigan, an 1838 wolf bounty became the ninth law passed by the First Michigan Legislature; this bounty remained in place until 1960. A Wisconsin bounty was instituted in 1865 and then repealed about the time wolves were extirpated from the State in 1957. Minnesota maintained a wolf bounty until 1965.

Subsequent to the gray wolf's listing as a federally endangered species, the Act and State endangered species statutes prohibited the killing of wolves except under extenuating circumstances, such as in defense of human life, for scientific or conservation purposes, or under several special regulations intended to reduce wolf depredations of livestock. This reduction in human-caused mortality is the main cause of the wolf's comeback in parts of its historical range. However, it is clear that illegal killing of wolves continues.

Illegal killing of wolves occurs for a number of reasons. Some of these killings are accidental (*e.g.*, wolves are hit by vehicles, mistaken for coyotes and shot, or caught in traps set for other animals), and some of these accidental killings are reported to State, tribal, and Federal authorities. However, it is likely that most illegal wolf killings are intentional and are never reported to authorities. Such killings may be done because of frustration over wolf depredations of livestock or pets, fear for the safety of pets or children, hatred of the species, opposition to wolf recovery, a desire to protest against the government, or for other reasons. The number of illegal killings is difficult to estimate and impossible to accurately determine, because they generally occur in isolated areas and the evidence is quickly concealed.

Two Minnesota studies provide insight into the extent of human-caused wolf mortality before and after the species' listing. On the basis of bounty data from a period that predated wolf protection under the Act by 20 years, Stenlund (1955) found an annual human-caused mortality rate of 41 percent. Fuller (1989) provided 1980–86 data from a north-central Minnesota study area and found an annual human-caused mortality rate of 29 percent, a figure which includes 2 percent mortality from legal depredation control actions. However, drawing conclusions from these two data sets is difficult due to the confounding effects of habitat quality, exposure to humans, prey density, differing time periods, and vast differences in study design. While these

figures provide support for the contention that human-caused mortality decreased subsequent to the wolf's protection under the Act, it is not possible at this time to determine if human-caused mortality (apart from mortalities from depredation control) has significantly changed over the 25-year period that the gray wolf has been listed as threatened or endangered.

Interestingly, when compared to his 1985 survey, Kellert's 1999 public attitudes survey showed an overall increase in the number of northern Minnesota residents who reported having killed, or knowing someone who had killed, a wolf. However, members of groups that are more likely to encounter wolves—farmers, hunters, and trappers—reported a decrease in the number of such incidents (Kellert 1985, 1999). Because of these apparently conflicting results, and differences in the methodology of the two surveys, drawing any clear conclusions on this issue is difficult.

It is important to note that despite the difficulty in measuring the extent of illegal killing of wolves, their population and range in the western Great Lakes States has continued to increase. During recent decades, all sources of wolf mortality, including legal (takings for research and depredation control activities) and illegal human-caused mortality, have not been of sufficient magnitude to stop the continuing growth of the wolf population, estimated at about 4 percent average annual increase in Minnesota, and about a 28 percent average annual increase in Wisconsin and Michigan since 1992–1993. This indicates that total gray wolf mortality continues to be exceeded by wolf recruitment (that is, reproduction and immigration) in these areas.

As the wolf population in Wisconsin and Michigan saturates the habitat or as the cultural carrying capacity is approached, the rapid population growth rates are expected to slow, and it is likely that growth will eventually stop. ("Cultural carrying capacity" differs from the biological or habitat carrying capacity in that it also incorporates the limits that will likely be imposed on the wolf population by human society, including both legal and illegal limiting measures.) At that time we should expect to see negative growth rates (that is, wolf population declines) in some years, due to short-term fluctuations in birth and mortality rates. However, adequate wolf monitoring programs, as identified in the Michigan, Wisconsin, and Minnesota wolf management plans, should be able to identify excessively high mortality rates