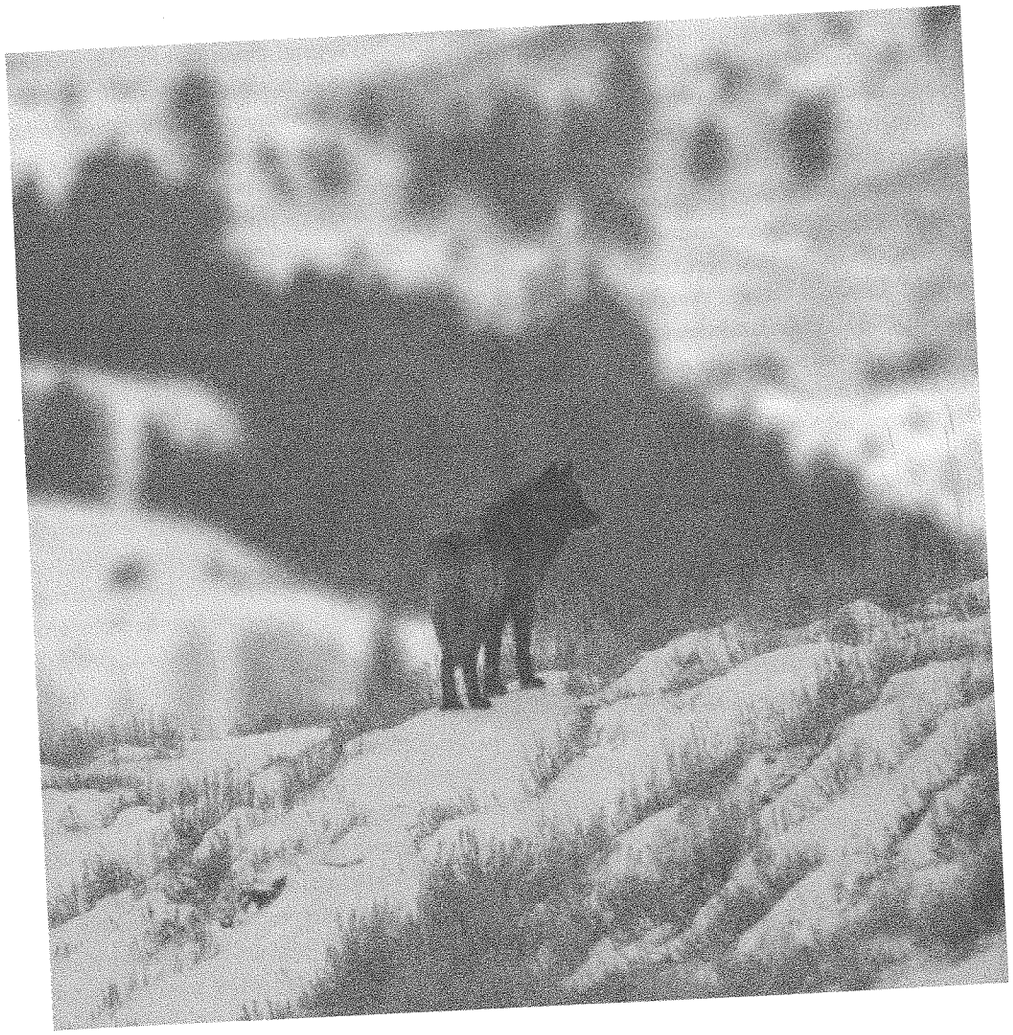


Chapter 2

Extermination and Recovery of the Red Wolf and Gray Wolf in the Conterminous United States

Michael K. Phillips and Brian Miller

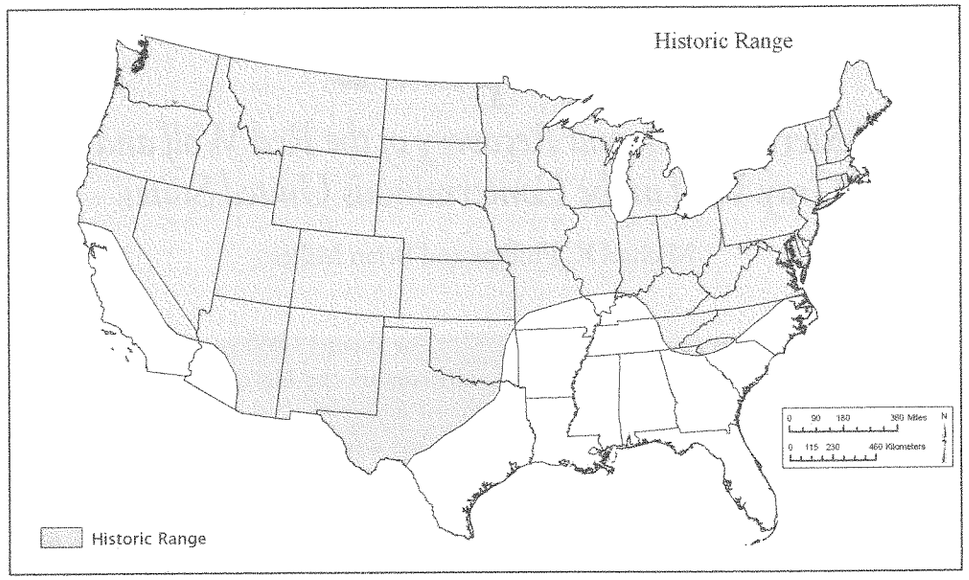
As recently as 150 years ago, the gray wolf (*Canis lupus*) lived throughout most of the conterminous United States, except for the Gulf Coast region east of Texas, where the red wolf (*Canis rufus*) occurred (Young and Goldman 1944; Nowak 1983) (figure 2.1). This wide distribution is especially noteworthy because conflict with agrarian interests resulted in government-supported wolf eradication campaigns as early as 1630, in the Massachusetts Bay Colony (Young and Goldman 1944; McIntyre 1995). Over the next three centuries, eradication campaigns were extended throughout the conterminous United States, resulting in the near extermination of both species there. In recent decades, there has been considerable effort to recover the red and gray wolf. Wolves are now more widely distributed than at any time since probably the 1920s. This chapter summarizes extermination and recovery efforts for wolf species in the conterminous United States.

EXTERMINATION OF THE RED WOLF AND GRAY WOLF

Historically, wolves were the most widely distributed large mammals in North America (figure 2.1). The species was likely represented by several hundred thousand individuals that occurred wherever large ungulates were found. Tolerant of environmental extremes, wolves inhabited areas from latitude 15° north in central Mexico to the Arctic (Hall 1981; Nowak 1995).

For about 13,000 years, the first peoples arriving on the North American continent lived with wolves as part of the landscape. Wolves were hunted, but Native Americans also imitated the wolf's style of hunting and viewed the species as a role model (Lopez 1978). The relationship between people in North America and wolves changed drastically when Europeans arrived 500 years ago with their culture, customs, and religion (Lopez 1978; McIntyre 1995). They came with attitudes about nature that were largely negative, dominating, and utilitarian (Kellert 1993). Thus, to understand the wolf's extermination in North America, it is important to understand the European history of attitudes toward the species (McIntyre 1995; see also chap. 1).

Religion played an integral role in the relationship between Europeans and wild places and wild things. Medieval religion held that wilderness was useless land inhabited by evil, whereas agricultural landscapes were godly, orderly, and subdued beneath human control (Primack 1998). By the fifth century AD, the Roman Catholic Church had adopted the view that the wolf was a dangerous predator, a symbol of religious heresy, and "deceitful and lascivious" (i.e., lustful) (Boitani 1995, 8). This view persisted for more than a thousand years and spawned the first version of "Little Red Riding Hood" in 1600. Boitani (1995, 8) writes, "This fable is a perfect example of a culture detaching itself from the biological reality of an animal in order to construct an image for its own use."



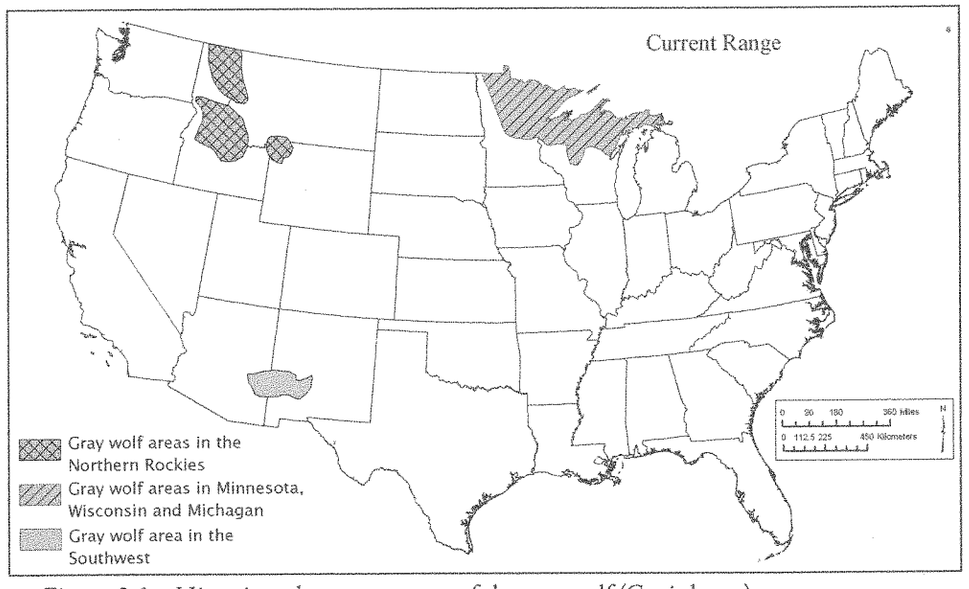


Figure 2.1—Historic and current ranges of the gray wolf (Canis lupus).
Source: US Fish and Wildlife Service

In central Europe, around AD 800, Charlemagne authorized and formed a special wolf hunting corps (Boitani 1995). Any member who killed a wolf had a legal right to collect money from all people living within two leagues (8 to 15 km or 5 to 9 mi.) of the spot where the wolf was captured and killed. In Sweden, killing predators was a public obligation after about 1350, and in 1442 all Swedish farmers were required by law to place and maintain wolf nets (Gilbert 1995). The last wolf disappeared from England during the early 1500s, although Celts had been hunting wolves intensively for the previous 1,800 years. Early kings of England allowed criminals to pay their fines in wolf heads or scalps if they were low on money. One Scottish king, James VI (1566–1625), declared that all men would join the organized wolf hunts (Boitani 1995). Age was not an issue in this decree, and young and old alike were mandated to participate. Wolves were eliminated in Scotland by 1684 and in Ireland by 1770.

With this history, colonists came to the New World. Don Juan de Oñate brought 7,000 head of livestock into what is now New Mexico in 1599, when he was searching for a channel linking the Atlantic and Pacific oceans (Dary 1974). The English brought livestock in 1609, two years after settling in Jamestown, Virginia. Livestock husbandry in both the West and East was lax, and domestic animals ranged freely (McIntyre 1995). Conflict between agrarian colonists and wolves thus began, and by 1630 the settlers in the Massachusetts Bay Colony proclaimed the first bounty (Matthiasson 1987; McIntyre 1995). McIntyre writes:

> Beginning in 1630, just 10 years after landing in the New World, the settlers in the Massachusetts Bay Colony passed a series of laws offering a cash reward to any resident who killed a wolf. The money to pay for those bounties initially came from assessments placed on livestock owners: one penny for every "beast (cow) and horse" and a half cent for each "swine and goat." In later laws, the colony paid bounties, as high as 40 shillings per wolf, directly out of the public treasury. A 1638 law fixed the minimum wage for a laborer at 18 cents per day, so 40 shillings (one shilling equaled 12 cents) was equivalent to 27 days of a laborer's wages. Such high prices tempted many to seek out and kill wolves. (1995, 29)

A utilitarian view of nature, religious philosophy, and livestock production all influenced the destruction of wolves and many other species of wildlife. For example, in 1638, King Charles I of England decreed that hats *had* to be manufactured from beaver (*Castor canadensis*), and by the early 1800s that species had disappeared from the eastern United States (Matthiasson 1987). The last bison (*Bison bison*) east of the Appalachian Mountains was killed in 1801 and the last one east of the Mississippi in 1825 (Matthiasson 1987). The last elk (*Cervus elaphus*) east of the Mississippi disappeared in 1867 (Matthiasson 1987). Eastern ungulates were soon reduced to one species, the white-tailed deer (*Odocoileus virginianus*), which could thrive on the edge of human civilization. The eastern United States were effectively "tamed" within a century. Afterward, settlers set their sights on the western United States.

Wolf persecution in the West reached a zenith in the late 1800s and early 1900s, a time when the wolf's natural prey of bison, elk, and deer had been greatly reduced due to unregulated exploitation by hunters striving to satisfy demand by East Coast consumers (Schmidt 1978; US Fish and Wildlife Service 1987a). Bison were also killed as part of federal efforts to force Indians to submit to the reservation system (Isenberg 1992; see also quote by General Sheridan, chap. 1, page 20). In response to reduced prey populations, wolves increasingly ate domestic livestock.

Consequently, the US government and private citizens intensified control efforts. Of this time, Barry Lopez (1978, 180) wrote, "The wolf was not the cattleman's only problem—there was weather, disease, rustling, fluctuating beef prices, hazards of trail drives...But the wolf became an object of pathologic hatred."

Some control was affected with religious fervor. In 1900, Benjamin Corbin, "boss wolf hunter" of North Dakota, wrote:

> In the New Testament, the parable of the Good Shepherd shines like a star. If Jesus did not disdain to call himself the

> Good Shepherd, why should any man in North Dakota not be proud to be called by that name, or be associated as I am, with the men who are feeding their flocks on the rich and abundant pastures of this great commonwealth? Largely, my life has been spent in protecting these flocks against the incursions of ravenous beasts of prey. I know it is but a step and the first step, which counts in the march of civilization...
>
> That's why I am here. The wolf is the enemy of civilization, and I want to exterminate him. (1900, 4)

Hatred for wolves was fueled by stories of individual wolves that performed great feats of destruction against the settlers' herds. Some of these animals were named, and they achieved celebrity status. The roster included Old Two Toes, Custer Wolf, Rags the Digger, Old Three Toes of the Apishapa, Blanca and her mate Lobo, the King of the Currumpaw (Caras 1966; McIntyre 1995, 144–147, 217–252). The stature of the most famous wolves was heightened because of their purported tendencies to kill large numbers of livestock and their supernatural abilities to avoid capture. For example, naturalist E. T. Seton wrote:

> Old Lobo, or the king, as the Mexicans called him, was the gigantic leader of a remarkable pack of gray wolves, that had ravaged the Currumpaw Valley for a number of years...Old Lobo was a giant among wolves, and was cunning and strong in proportion to his size...
>
> Old Lobo's band was but a small one... Several of the band, besides the two leaders, were especially noted. One of these was a beautiful white wolf, that the Mexicans called Blanca; this was supposed to be a female, possibly Lobo's mate...
>
> ...There was not a stockman on the Currumpaw who would not readily have given the value of many steers for the scalp of any one of Lobo's band, but they seemed to possess charmed lives, and defied all manner of devices to kill them. They scorned all hunters, derided all poisons, and continued, for at least five years, to exact their tribute from the Currumpaw ranchers to the extent, many said, of a cow each day. According to this estimate, therefore, the band had killed more than two thousand of the finest stock, for, as was only too well-known, they selected the best in every instance. (1898, 1–2)

In 1998, Gipson et al. (1998) evaluated the credibility of early literature about famous wolves. In the course of their research they calculated kill rates for fourteen such wolves and determined that, according to historical accounts, each wolf had an average of 48 kg (about 100 lbs.) of cattle flesh available per day. They considered several possible explanations for the extremely high kill rates that would be required to generate such a bounty and concluded that early authors fabricated information. Such misinformation continues today. Ron Gillett, a former outfitter and hunting guide who tried to start a ballot initiative for the 2008 election that, if passed, would have eliminated all wolves from Idaho, stated:

> Once you put wolves into an area, they kill everything that moves. They kill all of the prey first, whether that be squirrels, deer, elk, or mountain sheep. Then they kill other predators, and when they get down to wolves, they are cannibals. (Wilkerson 2007, 48)

Accuracy notwithstanding, stories about famous wolves fueled the country's desire to eradicate the species, and by the early 1900s the livestock industry had become a very effective advocate of the need for more government intervention in wildlife control (i.e., killing). In 1915, Congress began funding a federal wolf control program and assigned the mission of implementing it to the US Biological Survey. The early contributions made to this program by the livestock industry gave them considerable influence over policy (Leopold 1964; Dunlop 1988). Indeed, the Biological Survey's internal reports revealed that the goal of policy was the "absolute extermination" of the wolf, and poisoning was the main method used (McIntyre 1995, 18).

By 1929, this federal program was exterminating wolves and other species so extensively that the Biological Survey formed a new division to coordinate those activities, the Division of Predatory Animal and Rodent Control (DiSilvestro 1985; Dunlop 1988). In 1931, the Animal Damage Control Act authorized trapping, poisoning, and shooting of wildlife on federal or private lands (Dunlop 1988). It also indirectly sanctioned the partnership between this new division and the livestock industry (Bean 1983).

Eradication efforts were carried out everywhere, on private and public land alike. Wolf eradication efforts were even carried out in Yellowstone National Park from 1872, the year of the park's establishment, until the mid-1930s. Records indicate that from 1918 to 1935 government hunters killed 114 wolves in the park (Phillips and Smith 1996, 15).

Various and ingenious methods were used to kill wolves (Mech 1970, 325–333; McIntyre 1995). They were shot, trapped, poisoned, roped from horseback, and dismembered (Gilbert 1995). Puppies were dug from dens and clubbed to death. Steel traps usually had teeth to help hold the animal until the trapper arrived (Gilbert 1995). Some trappers welded nails to the jaws for a better grip on the leg (H. Rangel, former trapper from Mexico, pers. comm.). Strychnine and Compound 1080 were placed in meat and broadcast by horseback and later by airplane (Gilbert 1995). Like trapping, poisoning was indiscriminate, and the death of nontarget species was considered acceptable.

The "wolfers" (professional wolf killers) were effective and enjoyed widespread support. Even Aldo Leopold took an active part in wolf control early in his career, writing,

> In those days we had never heard of passing up a chance to kill a wolf. In a second we were pumping lead into the pack, but with more excitement than accuracy... When our rifles were empty, the old wolf was down, and a pup was dragging a leg into impassable slide-rocks. (1966, 138)

CONSERVATION OF THE RED WOLF AND THE GRAY WOLF

During the 1930s, concern arose among biologists about the wholesale slaughter of wolves. In the late 1930s and early 1940s, some biologists conducted field studies on the gray wolf (Olson 1938; Murie 1944). These studies sparked significant interest in the ecology and conservation of the wolf. For example, in 1944 Stanley Young and E. A. Goldman wrote, "There still remain, even in the United States, some areas of considerable size in which we feel that both the red and the gray wolf should be allowed to continue their existence without molestation." (1944, 385)

Aldo Leopold (1944) stated that, unless government agencies did something to protect the wolf in at least some areas, the species would disappear from the United States.

Later he articulated an important ecological insight:

> We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then and have known ever since that there was something new to me in those eyes—something known only to her and the mountain. I was young then and full of trigger itch. I thought that less wolves would mean more deer,

> and that no wolves would mean hunters' paradise. But after seeing the green fire die, I sensed that neither the wolf nor the mountain would agree with such a view. (1966, 138–139)

Despite credible scientific evidence and changing public attitudes toward wildlife control (in general) and wolves (in particular), the policy of extermination continued, probably because the viability of any policy is determined by the momentum of the status quo, access to funding and internal resources, and the preferences of key individuals in the decision-making process (Miller et al. 1996). Consequently, the entrenched policy of wolf control that generated jobs, funding, and power was not to be abandoned simply because of new and contradictory information.

By the 1940s, wolves were essentially absent from the conterminous United States (Young and Goldman 1944; Young 1970; Brown 1983; Nowak 1983). In the early 1950s, government trappers turned efforts to northern Mexico and the few wolves from there that dispersed to the United States. This influx was eliminated by the end of the decade, when wolf numbers were at an all-time low (McIntyre 1995). Then, fewer than 1,000 wolves persisted in the remote regions of the Gulf Coast (red wolves) and the forests of northeastern Minnesota (gray wolves). Additionally, probably fewer than twenty wolves inhabited Isle Royale National Park, a 546 sq. km (210 sq. mi.) island in Lake Superior located about 32 km (20 mi.) from the Minnesota mainland (Stenlund 1955; Mech 1966; Peterson 1977; Fuller et al. 1992; Thiel 1993). In addition to being persecuted by humans, remnant red wolf populations were threatened with extinction because of hybridization with coyotes (*Canis latrans*) (McCarley 1962; Nowak 1972, 1979). By 1980, the red wolf was considered extinct in the wild (McCarley and Carley 1979; US Fish and Wildlife Service 1984).

From the 1950s through the 1970s, studies provided insights into gray wolf ecology (Stenlund 1955; Mech 1966, 1970; Mech and Frenzel 1971; Pimlott 1966, 1967; Peterson 1977; Rabb et al. 1967; Van Ballenberghe 1972) and fostered a growing public desire to conserve the species. Those advocating wolf conservation rather than eradication were pioneers of a new paradigm. Quite simply, advocating for wolf conservation represented a significant change in how Americans viewed themselves in relation to nature. Nothing less than a major shift in public attitude was required before one could imagine wolves persisting in the wildlands of the conterminous United States.

In the conclusion of his seminal book *The Wolf*, L. David Mech wrote:

> Once blinded emotionally by such hate, the anti-wolf people fail to see that the wolf has no choice about the way it lives: that it cannot thrive on grass or twigs any more than a man can. To them the wolf pack is a cowardly assemblage of wanton slayers, the animal's howl a bloodcurdling condemnation of all the innocent big game of the country. These people cannot be changed. If the wolf is to survive, the wolf haters must be outnumbered. They must be out-shouted, out-financed, and out-voted. Their narrow and biased attitude must be outweighed by an attitude based on an understanding of natural processes. Finally their hate must be outdone by a love for the whole of nature, for the unspoiled wilderness, and for the wolf as a beautiful, interesting, and integral part of both. (1970, 348)

EFFORTS TO RECOVER THE RED WOLF AND GRAY WOLF

By the early 1970s, the environmental movement was real and had significant momentum. The Endangered Species Act (ESA) of 1973 (Public Law No. 93–205, as amended) provided significant protection for the wolf. In response, nongovernmental conservation organizations such as the National Wildlife Federation and Defenders of Wildlife launched efforts to recover wolves. Such efforts were opposed by agribusiness, led by the American Farm Bureau, stockgrower associations, and their state affiliates.

Shortly after passage, the US Department of the Interior's US Fish and Wildlife Service, charged with administering the ESA, initiated efforts to recover wolves. The first list of endangered species included the red wolf, eastern timber wolf (*C. l. lycaon*), and the northern Rocky Mountain wolf (*C. l. irremotus*) (US Fish and Wildlife Service 1974). In April 1976, the Mexican wolf (*C. l. baileyi*) was listed as endangered (*Federal Register* 41, 17740), and in June of that year, the Texas wolf (*C. l. monstrabilis*) was listed as endangered (*Federal Register* 41, 24064). At this time, the red wolf was probably extinct in the wild, and gray wolves were only represented by a remnant population in northeastern Minnesota and a few animals on Isle Royale National Park.

Because listing several subspecies created myriad problems, and because the trend among taxonomists was to recognize fewer subspecies of wolves, in 1978 the US Fish and Wildlife Service combined the subspecific listings for the gray wolf and reclassified it at the species level (i.e., *Canis lupus*) as endangered throughout the conterminous United States and Mexico, except for Minnesota, where the gray wolf was reclassified to threatened (Nowak 1978). As the service finalized this reclassification, some voiced concern that eliminating subspecific differentiation could jeopardize efforts to locate and maintain subspecific stocks. In response, the service indicated that efforts would continue to recognize valid subspecies for purposes of research and conservation (Nowak 1978). Shortly after the listing action was completed, the service formed recovery teams charged with developing and implementing plans for recovering wolves. The red wolf has a recovery plan, and the gray wolf has three plans that cover three separate geographic areas: the Great Lakes, the Northern Rockies, and the southwestern United States. There is no recovery goal for wolf numbers throughout the entire Lower 48.

Recovery planning and implementation are critically important components of the ESA. Unlike some of the act's other provisions, recovery planning and implementation are intended to promote increases in the populations of listed species, rather than simply limiting further declines. Section 4(f) of the ESA clearly indicates that the objective of recovery plans is to identify and catalyze activities necessary to restore listed species to a point where they are secure, self-sustaining components of their ecosystem and, thus, to allow delisting (US Fish and Wildlife Service 1996a; see chap. 7). The courts have determined that development and implementation of recovery plans are mandatory under the ESA, unless the secretary of the interior determines that such plans would not promote conservation of the species (see chap. 7).

THE RED WOLF

By the time the ESA was passed and a red wolf recovery program launched in 1984, the species was nearly extinct in the wild. Consequently, recovery had to rely on captive breeding and reintroductions. In 1973, a federally supported captive-breeding program was established at the Point Defiance Zoological Gardens in Tacoma, Washington. By November 2001, the founding stock of 14 wolves had spawned a captive population that included 160 animals maintained at 32 facilities. Management of captive breeding is guided by a Species Survival Plan (SSP) initiated in 1984 and implemented by the Association of Zoos and Aquariums.

The origins of the red wolf are enigmatic and have been debated since persistence of the species became a conservation concern nearly forty years ago. Some authorities have considered the red wolf to be a full species (Nowak 1992), while others have considered that it might be a subspecies of the gray wolf (Lawrence and Bossert 1967; Phillips and Henry 1992) or a hybrid resulting from interbreedings of gray wolves and coyotes (Mech 1970; Wayne and Jenks 1991; Roy et al. 1996). The debate harmed the red wolf recovery program and served as rationale for the American Sheep Industry to petition the secretary of the interior to remove the red wolf from the list of endangered and threatened species (Gittleman and Pimm 1991). The service denied the petition (Henry 1997).

Recent genetics work suggests that the red wolf and eastern timber wolf share a close taxonomic relationship and both evolved in North America, sharing a common lineage with the coyote until 150,000 to 300,000 years ago (Wilson et al. 2000). The service continues to recognize the red wolf as a valid species distinct from the gray wolf and coyote. However, based on historical taxonomic classifications, Wilson et al. (2000) contend that the red wolf and the eastern timber wolf require the classification *Canis lycaon*.

A red wolf recovery plan was finalized in 1984 (US Fish and Wildlife Service 1984), but it did not present criteria for removing the species from the list of endangered and threatened species (i.e., delisting). The plan did establish the foundation for reintroducing up to fifteen wolves for five consecutive years to the Alligator River National Wildlife Refuge in northeastern North Carolina (US Fish and Wildlife Service 1984). The released wolves and their offspring were to be designated as members of an experimental-nonessential population per Section 10(j) of the ESA (Parker et al. 1986; see chap. 7). The designation allows the service to relax the restrictions of the act to facilitate wolf management (Parker and Phillips 1991).

The Alligator River National Wildlife Refuge reintroduction is notable for several reasons, including being the first attempt ever to restore an extinct-in-the-wild carnivore species. From 1987 through 2001, eighty-three red wolves were released on thirty-eight occasions. These animals gave birth to at least 214 pups in the wild. By December 2001, the population included approximately 100 red wolves distributed in 20 packs across a 6,912 sq. km (2,668 sq. mi.) recovery area that was 60 percent private land and 40 percent public land, mostly comprised of three national wildlife refuges (Bud Fazio, red wolf recovery coordinator, pers. comm.). By 2008, the numbers of individuals and packs remained approximately the same; recovery requires 550 wolves with at least 220 in the wild (US Fish and Wildlife Service 2009a).

In 1989, a revised red wolf recovery plan called for additional reintroduction projects and indicated that for the foreseeable future it would not be feasible to down-list (change species' classification from endangered to threatened) or delist (remove species from the list of threatened and endangered species) the red wolf (US Fish and Wildlife Service 1989). In 1991, a second reintroduction project was initiated in Great Smoky Mountains National Park with the experimental release of one family (US Fish and Wildlife Service 1992a). Results suggested that restoration was feasible. Consequently, the service released thirty-seven wolves there from 1992 through 1996 to establish a second experimental-nonessential population. Of the released animals, twenty-six died or were recaptured after traveling outside the park. Of twenty-eight pups born in the wild and not removed, none survived its first year. In 1998, the service terminated that project because the wolves tended to establish home ranges that included nonpark lands, had a low pup survival rate, and experienced low winter prey availability (Henry 1998).

From 1987 through 1994, it seemed that the red wolf reintroduction project at Alligator River National Wildlife Refuge was succeeding (Phillips et al. 1996). During the mid-1990s, the situation changed because hybridization between red wolves and coyotes became increasingly common (Kelly and Phillips 2000). A comprehensive population and habitat viability assessment in April 1999 generated a management plan to reduce hybridization (Kelly et al. 1999). By November 2001, the plan, which called for very intensive fieldwork to prevent or significantly limit red wolf–coyote interbreeding by removing or sterilizing coyotes, promoting the formation and maintenance of wolf breeding pairs, and euthanizing known and suspected hybrids, was beginning to show progress.

Few conflicts with humans have arisen since red wolves were released at Alligator River National Wildlife Refuge. White-tailed deer are abundant in northeastern North Carolina, and hunter harvest has remained heavy despite the presence of red wolves. Very few depredations from red wolves have been reported or documented. Through November 2001, only three depredations were documented, and every complaint was investigated exhaustively; the three confirmed cases involved one chicken, one hunting dog, and a few domestic ducks. No cases of livestock depredations have been reported for the recovery area.

Despite the chronic challenge of hybridization, the Alligator River National Wildlife Refuge restoration project is showing limited success due to intensive wolf and coyote management. Overall, the project illustrates that the values and successes of reintroduction efforts often have the potential to extend beyond the immediate preservation of the reintroduced species to positively affect local citizens and communities, larger conservation efforts, and other imperiled species (Phillips 1990).

A Cornell University study concluded that on average the Alligator River National Wildlife Refuge red wolf project generates an annual regional economic impact of about $37.5 million (Rosen 1997). Public opinion polls conducted as part of the Cornell study and by North Carolina State University revealed that the majority of local residents strongly favor red wolf recovery in northeastern North Carolina (Quintal 1995). Such support derives partly from the ecological effects generated by red wolves. Local landowners credit red wolf predation on raccoons (*Procyon lotor*) as benefiting populations of bobwhite quail (*Colinus virginianus*) and turkey (*Meleagris gallopavo*). Food habits data and observations by local landowners reveal that red wolf predation on nutria (*Coypu myocaster*) reduces damage to water-control levees. Rosen (1997) predicted that because of such benefits the public would strongly support and materially benefit from efforts to reestablish red wolves elsewhere.

It seems likely that the red wolf could be recovered via reintroduction of captive-born animals were it not for the species' predilection to hybridize with coyotes. Data collected during intensive fieldwork are beginning to suggest that coyotes and red wolves can be managed to greatly reduce the frequency of hybridization. Confirmation of these preliminary results will, however, require several more years of work. Of course, hybridization would not be a problem if red wolves could be reintroduced to areas that were not inhabited by coyotes. Historically, coyotes were not in the red wolf's range, but they have now moved in. Consequently, long-term prospects are bleak for the species to be restored to a significant portion of the southeastern United States.

THE GRAY WOLF IN THE GREAT LAKES REGION

The gray wolf recovery plan was written for the Great Lakes region and approved by the service in May 1978 (US Fish and Wildlife Service 1978). However, the plan does not include goals or criteria for the wolf population on Isle Royale, because it is not considered an important factor in the long-term survival of the species. The population on the island is small (usually including twelve to twenty-five wolves and never more than fifty) and almost completely isolated from other wolf populations (Peterson et al. 1998). While assigning no "recovery value" to the Isle Royale population, the service recognized the population's importance as the focus of long-term research and recommended that it be completely protected (US Fish and Wildlife Service 1992b).

A revised plan, approved in January 1992 (US Fish and Wildlife Service 1992b), included two delisting criteria. The service considered wolves in the Great Lakes region as a single population that would be considered recovered once the survival of the Minnesota population was secure and an additional viable population lived outside of Minnesota.* Although these criteria had (arguably) been met by 2001, as of this writing, attempts to delist the species in the region have been defeated twice in federal court. The effort to delist the species in the Great Lakes region continued in early 2009, when the US Fish and Wildlife Service again attempted to delist the species (US Fish and Wildilfe Service 2009b). However, conservation groups again have threatened to sue.

Prior to the ESA, wolves in Minnesota were not protected and could be hunted and trapped. The state sponsored a control program that included aerial gunning until 1956 and bounty payments until 1965 (Minnesota Department of Natural Resources 2001). Until 1973, the year the ESA was enacted, some wolves were killed for fur, while others were killed under the state's predator control program. Various surveys conducted from the late 1950s to 1973 indicated that the Minnesota wolf population did not exceed 1,000 animals and dropped as low as 350 to 700 individuals. Wolves that have since populated the region originated in Minnesota.

After wolves were included on the list of threatened and endangered species, the population in Minnesota began to grow and expand into Wisconsin and Michigan. Historically, Wisconsin held about 3,000 to 5,000 wolves, but from about 1830 to 1960 that number dropped to zero (Thiel 1993; Wydeven et al. 1995). Until the mid-1970s, occasional sightings were reported, but there was no evidence of reproduction (Wisconsin Department of Natural Resources 1999). By the mid-1980s, Wisconsin's wolf population numbered fifteen to twenty-five animals (Wydeven et al. 1995). By 1997, the wolf population had exceeded the state's endangered criteria, and its status was changed to threatened, meaning there were eighty or more wolves for three successive years.

In Michigan, the last known breeding population of wolves (outside of Isle Royale) was reported in the mid-1950s. While numbers continued to decline through the 1970s, it is possible that wolves were never completely extirpated from the state (Michigan Department of Natural Resources 1997). During the 1980s, reports of wolves in the Upper Peninsula increased, and a pair produced pups there in 1991. In 1997, the Department of Natural Resources finalized a comprehensive management plan for Michigan's wolf population. In 1999 and 2001, Wisconsin's and Minnesota's natural resources departments did the same (respectively). Together, those three state plans should ensure the long-term survival of wolves in the Great Lakes region.

By 2001, the wolf population in Minnesota included more than 2,500 animals distributed over about 40 percent of the state, Wisconsin's wolves numbered 251 animals over about 40 percent of the state, and Michigan had 249 animals distributed over about 30 percent of the state. As of 2006, there were 3,020 wolves in Minnesota, 465 in Wisconsin, and 434 in Michigan, not counting Isle Royale's 30 wolves (US Fish and Wildlife Service 2007a). In general, the rural people of the Great Lakes region have been more tolerant of wolves than the rural people of the Northern Rockies and the southwestern United States.

THE GRAY WOLF IN THE NORTHERN ROCKY MOUNTAINS

In 1974, the US Fish and Wildlife Service started an interagency wolf recovery team, which compiled the Northern Rocky Mountain Wolf Recovery Plan (US Fish and Wildlife Service 1980). A revised plan in 1987 focused recovery on northwestern Wyoming, western Montana, and central Idaho, an area characterized by large tracts of public land, healthy populations of native ungulates, and relatively little livestock (US Fish and Wildlife Service 1987a). The 1987 plan identified several criteria for downlisting and delisting the species and predicted that about 300 wolves in 30 packs would inhabit the region at the time of recovery. The plan promoted natural recovery for Montana and Idaho if two packs had become established in Idaho by 1992. If two Idaho packs did not exist by 1992, then reintroduction would become a tool for Idaho and Yellowstone National Park. The plan recognized that reintroduction was the surest way to restore wolves to the Greater Yellowstone Ecosystem.

During the 1960s, the stage was set for wolves to naturally recolonize northwestern Montana as the Canadian government greatly reduced human-caused mortality in southwestern Canada (Carbyn 1983). By the 1970s, dispersing wolves were traveling through northwestern Montana, and by 1982 a pack inhabited Glacier National Park (Ream and Mattson 1982). In 1986, the first litter of pups in more than fifty years was born there (Ream et al. 1985; Ream et al. 1989). By 1993, the number of wolves in northwestern Montana had increased to fifty-five (Fritts et al. 1995). By December 2001, the population included eighty-four wolves (US Fish and Wildlife Service et al. 2002). By 2003, there were 183 wolves and the population essentially stopped growing; by 2006, there were 159 individuals in Montana (US Fish and Wildlife Service 2007b). Northwestern Montana has lower ungulate densities and higher levels of livestock than central Idaho and Yellowstone, thus wolves may be closer to their carrying capacity there—particularly the capacity of human tolerance (Bangs et al. 2001; US Fish and Wildlife Service 2009b).

By the early 1990s, two naturally occurring packs had not materialized in Idaho, and interest in restoring wolves to Yellowstone National Park had intensified. While Leopold (1944) had first discussed wolf restoration to the park in the 1940s, it was not until 1972 that the Department of the Interior officially considered the idea. That stimulated a study to determine if any wolves remained in Yellowstone; infrequent

* In 1996, the US Fish and Wildlife Service and the National Marine Fisheries Service adopted a policy for recognizing distinct population segments (DPS) for purposes of listing, reclassifying, and delisting vertebrate species (Fay and Nammach 1996). This policy may allow the service to protect and conserve species and the ecosystems upon which they depend before large-scale declines occur that would necessitate listing a species or subspecies throughout its entire range. For a group of vertebrates to be recognized as a DPS, they must be "discrete" and "significant." Discreteness requires that the population segment be delimited by physical, physiological, ecological, or behavioral barriers or by an international boundary that coincides with differences in the degree of protection. Significance requires that the population segment inhabit an unusual or unique ecological setting, exhibit marked genetic differences from other populations of the parent taxon, or inhabit an area that, if devoid of the species, would result in a significant gap in the range of the taxon.

sightings were occasionally reported to park officials. The study concluded that wolves were absent from the park and recommended that the species be restored through reintroductions (Weaver 1978).

In 1989, Congressman Wayne Owens (D-UT) introduced a bill in the US Congress that required the service to prepare an Environmental Impact Statement (EIS) on wolf reintroduction to Yellowstone National Park. The bill prompted numerous discussions, but Congress did not authorize an EIS. Congress did, however, fund two reports aimed at answering the many questions surrounding wolf restoration (Yellowstone National Park et al. 1990; Varley and Brewster 1992). In 1992, Congress directed the service to prepare an EIS on wolf reintroduction to Yellowstone and central Idaho.

The reintroduction EIS initiated what would become one of the most extensive public processes ever conducted for a national environmental issue. The EIS took two and a half years to complete and covered all aspects of reintroducing wolves to Yellowstone and central Idaho. After releasing the draft EIS, government officials held more than 130 public hearings and meetings and considered 160,000 public comments from all 50 states and 40 foreign countries (US Fish and Wildlife 1994). The final EIS was published in April 1994, and by July 1994 the secretaries of the interior and agriculture had signed a Record of Decision and Statement of Findings on the Environmental Impact Statement, effecting the final EIS as the federal government's official policy.

The final EIS recommended reintroducing about fifteen wolves annually to both Yellowstone and Idaho. This would continue for three to five years, and the wolves would come from Canada. It also recommended that released wolves and their offspring be designated as members of experimental-nonessential populations per Section 10(j) of the ESA (Bangs 1994). Such a designation, as with the red wolves in North Carolina, allows the service to relax the restrictions of the act when managing wolves (Parker and Phillips 1991; Bangs 1994; see also chap. 7).

The restoration plan called for releasing wolves in Idaho immediately after they were moved from Canada (a "hard" release), whereas in Yellowstone the wolves would be acclimated for several weeks in large pens at the site of release before being set free (a more labor-intensive, "soft" release). Because hard releases are easier, they have been commonly used to reintroduce wildlife throughout North America (Griffith et al. 1989). While the overarching objective was to establish populations of wolves in the Greater Yellowstone Area and central Idaho as quickly and cost effectively as possible, the service did decide to test hard releases versus soft releases to refine and optimize subsequent releases and to gain information to benefit future wolf reintroductions (Fritts et al. 1997).

In January 1995, fifteen wolves from Alberta, Canada, were released in Idaho, and a year later twenty wolves from British Columbia, Canada, were released (Bangs and Fritts 1996; Fritts et al. 1997). In March 1995, the Nez Perce signed a cooperative agreement with the service (Agreement No. 14-48-0001-95-538) authorizing the tribe to assume responsibility for recovery and management of the Idaho gray wolves. By September 1995, the tribe completed a plan to guide such activities (Jimenez et al. 1995). The overall goal of the plan was to establish a wolf population in central Idaho that would contribute to the recovery of the species in the Northern Rocky Mountains.

During March 1995, fourteen wolves from Alberta were released in Yellowstone National Park, and in January 1996, seventeen wolves from British Columbia were released (Phillips and Smith 1996). Furthermore, as part of wolf population control activities, ten pups were transferred from northwestern Montana to an acclimation pen in the park in late 1996. These wolves were under the jurisdiction of the National Park Service and the US Fish and Wildlife Service.

Both wolf opponents and proponents filed several lawsuits over the experimental-nonessential designation for reintroduced wolves. Wolf proponents claimed that the designation illegally reduced ESA protection for naturally occurring wolves inhabiting northwestern Montana and possibly central Idaho. In December 1997, wolf opponents won the day when a Wyoming federal judge in the US District Court of Wyoming determined that the designation had been illegally applied and ordered the service to remove the already reintroduced wolves and their offspring. Given the ramifications of his determination, the order was stayed pending appeal. The appeal was settled in January 2000 when the Tenth Circuit Court of Appeals (Denver, Colorado) reversed the Wyoming court order. The losing parties did not appeal to the US Supreme Court.

The reintroduced wolves adapted better than predicted, establishing their population two years after reintroduction rather than the predicted three to five years (Fritts et al. 1997). Compared to predictions in the EIS, the wolves produced more pups, survived at a higher rate, and had fewer conflicts with humans (Phillips and Smith 1996; Bangs et al. 1998; Smith et al. 1999; Fritts et al. 2001).* Additionally, by 2001 more than 70,000 visitors to Yellowstone had observed wolves (Fritts et al. 2003), and public interest in recovery remains high.†

Both hard- and soft-release techniques established wolf populations. Fritts et al. concluded:

> It appears that if landscape conditions, prey availability, wolf restoration stock, and early release management are suitable...the choice of hard versus soft release seems to matter little. Nonetheless, hard releases may be advantageous if the size of the area can accommodate wolves wandering without encountering people or killing livestock. The technique is relatively inexpensive as well, and involves less husbandry. If the size of the area is restricted, however, then a soft release should be used to limit post-release movements. Because few areas are as extensive as central Idaho, soft releases are likely to be preferred in future wolf restoration efforts. (2001, 144)

From the original 31 Canadian wolves of 1995 and 1996 (plus the 10 pups from northwestern Montana in 1996), the wolf population inhabiting the Greater Yellowstone Area grew to 189 individuals by December 2001; by 2006, the number was 371 (US Fish and Wildlife Service 2007a). Under Nez Perce management, there were 251 wolves in Idaho by the end of 2001 and 713 by 2006 (US Fish and Wildlife Service 2007a). By mid-September 2008, the service estimated that there were 360 wolves in Montana, 771 in

* The frequency of wolf control belies the actual magnitude of the wolf-livestock problem. For example, only about 1 percent of farms in wolf range in Minnesota suffer verified wolf depredations (W. J. Paul, unpublished report, 1998, as cited by Mech et al. 2000). Similarly, average annual confirmed losses in the Northern Rockies have been slight: four cattle and twenty-eight sheep (and four dogs) in the Greater Yellowstone Area and nine cattle and twenty-nine sheep (and two dogs) in Idaho during the first five years. These rates are one-third to one-half of the rates predicted in the EIS. In contrast, livestock producers in Montana annually report losing about 80,000 cattle and 90,000 sheep (Bangs 1998). Financial compensation for livestock losses has proven useful for minimizing animosity toward wolves (Fischer 1989; Fischer et al. 1994). In North America, encounters that have ended in contact between wolves and humans have been rare.

† The above summary of the Yellowstone project is complemented well by several books that provide additional details, including Fischer (1995), Ferguson (1996), Phillips and Smith (1996), Schullery (1996), McNamee (1997), and Smith and Ferguson (2005).

Idaho, and 332 in Wyoming, for a total of 1,463 wolves in the Northern Rockies (US Fish and Wildlife Service 2008a).

The recovery goal set in 1987 was for ten or more breeding pairs in each of the three recovery areas for three consecutive years, for a total of more than 300 wolves throughout the region (Refsnider 2000, 43454, 43457). By 1999, the service indicated that they might change the objectives for recovery, likely due to ceaseless political controversy, early rapid growth of wolf populations in the Greater Yellowstone Area and central Idaho, and the relatively slow growth of the wolf population in Montana. The new objective for recovery came from Appendix 9 of the EIS for the reintroductions (USFWS 1994, 6–75). It stated: "Thirty or more breeding pairs comprising some 300+ wolves in a metapopulation with genetic exchange between subpopulations should have a long-term probability of persistence."

In November 2001, the service queried dozens of professionals familiar with wolf recovery about population viability. By February 2002, the service had determined that the official recovery goal for the Northern Rockies would be maintaining a viable wolf population for three consecutive years, defining a viable population as "Thirty or more breeding pairs (an adult male and an adult female wolf that have produced at least 2 pups that survived until December 31 of the year of their birth, during the previous breeding season), comprising some 300+ wolves in a metapopulation with genetic exchange between subpopulations" (Bangs 2002, 1).

The wolf population no longer had to be distributed equally, and the recovery objective was reached by December 31, 2002. So the service proposed that the gray wolf in the distinct population segment for the Northern Rocky Mountains should be removed from the list of threatened and endangered species. In addition to the Greater Yellowstone Ecosystem, northwestern Montana, and central Idaho (areas having wolves), this distinct population segment included the eastern parts of Washington and Oregon, north-central Utah, and the rest of Montana, Idaho, and Wyoming—areas of former range where wolves no longer exist (US Fish and Wildlife Service 2007a).

One hurdle remained. Wolves could not be delisted in the Northern Rockies' distinct population segment until the state governments of Wyoming, Idaho, and Montana each submitted management plans assuring that adequate regulatory mechanisms existed to protect wolves at or above recovery levels after federal protection was removed; the plans had to be approved by the US Fish and Wildlife Service (US Fish and Wildlife Service 2007a). There was no point in removing federal protection from a threatened or endangered species if the subsequent local management would then mismanage the species to the point that it was again threatened.

In January 2002, the US Fish and Wildlife Service accepted the Montana Fish, Wildlife, and Parks Department's conservation and management plan. In March 2002, the Idaho Legislative Wolf Oversight Committee finalized its plan (Idaho Legislative Wolf Oversight Committee 2002). This plan was developed and approved by the state legislature and the US Fish and Wildlife Service. After delisting, the Nez Perce would turn management responsibilities over to the Idaho Department of Fish and Game. Because of the tribe's expertise, the Idaho Department of Fish and Game intended to consult with the tribe when the state assumed management authority.

Even though the 2002 Idaho legislature's wolf management plan was acceptable to the US Fish and Wildlife Service, the 2001 legislature previously had passed House Joint Memorial No. 5, which demanded "that wolf recovery efforts in Idaho be discontinued immediately and wolves be removed by whatever means necessary" (Legislature of the State of Idaho 2005). As indicated in the 2002 management plan, House Joint Memorial No. 5 continues to be the state's official position. The official position notwithstanding, Memorial No. 5 does not carry the weight of law. Nevertheless, Idaho governor Butch Otto spoke at Idaho Sportsman's Day on January 11, 2007, and vowed to kill more than 80 percent of Idaho's wolves, perhaps shooting the first one himself; he promised to begin the moment wolves were removed from the federal endangered species list (Woodruff 2007). Montana's plan for wolf management is much more sensible than the Idaho governor's.

Wyoming did not complete a wolf management plan until 2004, and the US Fish and Wildlife Service rejected it because it was inadequate to maintain wolves at recovery level (US Fish and Wildlife Service 2007b). Wyoming litigated this decision in the Wyoming federal district court, but the case was dismissed on procedural grounds (US Fish and Wildlife Service 2007b). Wyoming appealed, but in April 2006 the Tenth Circuit Court of Appeals (in Denver, Colorado) agreed with the Wyoming federal district court. Thus, on August 1, 2006, the US Fish and Wildlife Service determined that wolves in the Northern Rockies could not be delisted, because Wyoming did not provide the necessary regulatory mechanisms to conserve their share of the wolf population (US Fish and Wildlife Service 2006). In short, Wyoming declared the wolf a predator if it ranged outside of the northwestern section of the state; this meant that a wolf could be shot on sight, and the US Fish and Wildlife Service thought that was a threat to the species (Smith and Ferguson 2005).

At the time of this writing, the US Fish and Wildlife Service had unsuccessfully attempted, for the second time, to remove the gray wolf in the Northern Rocky Mountains from the list of threatened and endangered species and continued to try to delist the species (US Fish and Wildlife Service 2008a). In October 2008, the service abandoned trying to delist wolves regionally and adopted a new tactic by delisting the wolf only in Montana and Idaho because federal courts repeatedly rejected Wyoming's management plan (US Fish and Wildlife Service 2009b). Conservation groups and the state of Wyoming have already threatened to sue the service again.

One of the primary arguments against wolf delisting in the Northern Rocky Mountains and the Great Lakes region is that the species presently occupies less than 5 percent of its range. Conservationists argue that such a wide-ranging species must occupy a significant portion of its range in order to meet the definition of recovery as defined by Congress.

THE MEXICAN GRAY WOLF IN THE SOUTHWEST

The Mexican wolf, a subspecies of the gray wolf, was extirpated from the southwestern United States by the 1940s. Between 1977 and 1980, under an agreement between the United States and Mexico, five Mexican wolves were captured in the Mexican states of Durango and Chihuahua. These four males and one pregnant female were transported to the Arizona-Sonora Desert Museum in Tucson, Arizona, to establish a captive-breeding program. In 1979, the service formed a Mexican Wolf Recovery Team; the team finalized a binational recovery plan with Mexico in 1982. The prime objective of the plan was to maintain a captive-breeding program and to reestablish a population of at least 100 Mexican wolves within their historic range (US Fish and Wildlife Service 1982). The plan called for reestablishing at least two wild populations, but it did not specify a population goal for the second one. The recovery team considered the objective to be necessary for the survival of the Mexican wolf, but did not propose a numerical objective for full recovery and delisting (from

the ESA) of the Mexican wolf (US Fish and Wildlife Service 1982).

Given the absence of wild Mexican wolves, captive breeding is essential to recovery. In the mid-1990s, two captive lineages of Mexican wolves were found to be of pure wild strains and were included in the captive-breeding program. This increased the number of founders of the captive-bred population to seven. Thus, all known Mexican wolves in existence today stem from just these seven animals, a true brush with extinction. By July 31, 2008, the captive-breeding program included 327 animals maintained at 47 facilities in the United States and Mexico (Siminski 2008a). The Mexican Wolf Species Survival Plan guides the captive-breeding program, and its goal is to retain at least 300 Mexican gray wolves in captivity to protect the subspecies from extinction while producing additional animals for reintroduction (Siminski 2008b). Wolves are bred and managed for reintroduction at three US facilities: the Sevilleta National Wildlife Refuge and Ladder Ranch (owned by Ted Turner) wolf management facilities, both in New Mexico, and Wolf Haven International, in Tenino, Washington.

Wolves with potential for reintroduction are managed with minimal human contact to promote behavior to avoid humans and maximize pair bonding, breeding, pup rearing, and pack formation. Wolves are selected for reintroduction by genetic makeup, reproductive performance, behavior, and physical prowess (US Fish and Wildlife Service 2006).

In the early 1990s, as the species became increasingly secure in captivity, the US Fish and Wildlife Service began to develop an EIS for reestablishing a wild population. After considering nearly 18,000 comments on the draft EIS, the service recommended reintroducing Mexican gray wolves to the Blue Range Wolf Recovery Area on the Arizona–New Mexico border (US Fish and Wildlife Service 1996b). The record of decision was signed in March 1997, and the specifics for reintroduction and management were published shortly thereafter (Parsons 1998). Similarly, the Arizona Game and Fish Department (AGFD) concluded that the Arizona portion of the Blue Range Wolf Recovery Area was best suited for a reintroduction project; in 1995, AGFD developed a reintroduction plan for this area (Groebner et al. 1995).

The Blue Range Wolf Recovery Area encompasses 17,752 sq. km (6,852 sq. mi.) of the Gila National Forest in New Mexico and the Apache National Forest in Arizona and New Mexico. The service's final administrative rule authorizes them to reintroduce wolves only in the "primary recovery zone" of the Blue Range Wolf Recovery Area, an area that encompasses 2,664 sq. km (1,028 sq. mi.) of the Apache National Forest (Parsons 1998). The remainder of the Blue Range Wolf Recovery Area comprises the "secondary recovery zone," and the service is authorized only to conduct rereleases in the secondary recovery zone. Wolves travelling from the primary recovery zone can inhabit the secondary zone, but wolves living entirely outside the boundaries of the Blue Range Wolf Recovery Area are required to be captured and brought back to the primary zones or returned to captivity (US Fish and Wildlife Service 1998b).

This is the only endangered species reintroduction project we are aware of where hard boundaries legally limit the area that can be occupied by the species in the wild, even though suitable areas exist on public lands outside the boundary.

At the beginning of the project, the New Mexico Game Commission officially opposed the Blue Range Wolf Recovery Area project. On March 29, 2002, the commission unanimously reaffirmed its opposition to the reintroduction of wolves in the Gila National Forest portion of the Blue Range Wolf Recovery Area. Citing a study by the state's game and fish department, the commission claimed that no potential wolf release sites in the Gila National Forest would provide the biological and societal characteristics necessary for success. A new game commission, appointed by incoming governor Bill Richardson, reversed the position, deciding at a meeting on April 4, 2004, to support wolf reintroduction and recovery. Early opposition to the Blue Range Wolf Recovery Area project notwithstanding, New Mexico Game and Fish (NMGF) has provided a field biologist to serve on the Interagency Field Team since 1999, and it is now one of six coleading agencies. In addition, although the White Mountain Apache and San Carlos Apache initially showed little interest in the reintroduction, the White Mountain Apache became a member of the six coleading agencies in 2002 and began allowing wolves to occupy tribal lands in 2003.

In contrast, the Arizona Game Commission has never opposed the Blue Range reintroduction project, and the AGFD has become a leader in managing the wild population and in the decision-making process. The AGFD promoted a 2003 memorandum of understanding that formed the multiagency Adaptive Management Oversight Committee, which it leads. The AGFD has a much larger budget (from lottery proceeds) than does NMGF.

Ninety-nine Mexican gray wolves were released from 1998 through 2006—four years beyond the anticipated need to release wolves. The US Fish and Wildlife Service (1996b) estimated that it would take nine years (1997 to 2005) to reach a population of 100 wolves with 18 breeding pairs. Although the reintroduction did not actually begin until 1998, the 100-wolf prime objective was not met in nine years—by 2006—as planned. By the end of 2006, just fifty-nine wolves and six breeding pairs (using the definition of "breeding pair" from the 1998 final rule) survived in the wild. By the end of 2008, those numbers had fallen to fifty-two wolves and just two breeding pairs. Importantly, the 2008 official population count showed that fewer individual wolves and fewer breeding pairs existed in the wild than did at the end of 2003.

Despite encouraging first efforts in captive breeding and reintroduction, the service has failed to reach any basic benchmark for recovery in the wild since the Mexican gray wolf reintroduction project began. Instead, the population of Mexican gray wolves in the Blue Range Wolf Recovery Area has suffered significant human-caused losses from both illegal killings and authorized removal actions by the service. Average litter size for the reintroduced population during its first five years was 2.1, compared to 4.2 to 6.9 elsewhere, and the average pack size was 4.8 (Fuller 2003).

A telling finding in the five-year review from 1998 to 2003 was an average annual failure rate of 64 percent (Mexican Wolf Blue Range Adaptive Management Oversight Committee and Interagency Field Team 2005). The failure rate is the sum of wolf mortalities plus wolves killed or removed from the wild by deliberate management actions carried out by the agencies (e.g., because a wolf preyed on livestock three times). Such a high failure rate is unsustainable without continually supplementing the population through releases, especially given the lower than average litter sizes. This explains why releases have been continued beyond what was initially anticipated.

Most Mexican wolf deaths have been caused by humans. From March 1998 through January 2009, there have been thirty-one illegal shootings, twelve wolves killed by vehicles, and nineteen deaths from natural or unknown causes (US Fish and Wildlife Service 2009c). An additional 144 wolves were lethally and nonlethally removed from the wild from 1998 to 2008 (US Fish and Wildlife Service 2008b); from

a population dynamics perspective, nonlethal removal is equivalent to mortality (Paquet et al. 2001).

Rather than redouble its wolf conservation efforts in light of this daunting record, in 2003 the service delegated authority over wolf recovery to the Mexican Wolf Management Oversight Committee, directed by the AGFD. Since then, control issues have surfaced resulting in unproductive conflict.

The Management Oversight Committee adopted Standard Operating Procedure 13 (SOP 13) in 2005, which requires the service to permanently remove every Mexican wolf that preys on livestock three times or more within 365 days. This caused permanent wolf removals to spike: of the seventy Mexican wolves removed by the service for conflicts with livestock since reintroduction began, forty-five were removed under the SOP 13 mandate between 2005 and 2008. As a result, the Mexican gray wolf is not currently on a positive trajectory toward recovery. Wild Mexican gray wolves declined by 12 percent from 2006 to 2007, despite a goal of a 10 percent population increase. Thus, the service fell 22 percent short of its most recent goal. More seriously, the number of breeding pairs as defined in the final rule declined from six at the end of 2006 to only three at the end of 2007. This reverse population trend may portend the Mexican gray wolf's second extinction in the wild.

The EIS predicted livestock depredation rates of 1 to 34 head per 100 wolves. Between 1998 and 2004, confirmed kills of livestock (cattle) by Mexican wolves averaged 14 per an adjusted population of 100 wolves (Mexican Wolf Blue Range Adaptive Management Oversight Committee and Interagency Field Team 2005; US Fish and Wildlife Service 2006). In 2005, the rate increased to 45 head per 100 wolves. One factor contributing to livestock depredation in the Blue Range Wolf Recovery Area is the practice of year-round grazing with open range calving on a significant portion of the area.

The Mexican Wolf Recovery Plan, approved and adopted in 1982, is, according to the service's policy, supposed to be updated or revised every five years if it is out of date or not in compliance with the ESA. The Mexican Wolf Recovery Plan has never been updated or revised, even though it does not contain "objective, measurable criteria which, when met, would result in a determination...that the species be removed from the list" (ESA Section 4(f)(2)(B)(ii)) nor a detailed plan for fully recovering Mexican wolves throughout a significant portion of their historic range to a population status that warrants delisting from the ESA. The current Mexican Wolf Recovery Plan has been in effect, in its original form, for twenty-five years and needs revision. Following the listing of a southwestern gray wolf distinct population segment, the service initiated a process for revising the recovery plan in October 2003, but it suspended that effort in January 2005 after a federal court ruling vacated the distinct population segment listing (*Defenders of Wildlife v. Norton*, 03-1348-JO).

Though the Mexican wolf remains listed as endangered in the Southwest under the 1978 listing rule for the entire gray wolf species, the service has not reinitiated the recovery planning process for the critically endangered Mexican gray wolf subspecies. As such, in late 2008 conservationists filed a petition to compel the US Fish and Wildlife Service to expedite revision of the Mexican Wolf Recovery Plan.

The final rule for the reintroduction project required the service to conduct a comprehensive review of the project at the end of three years, in March 2001, and after five years, in March 2003 (Parsons 1998). The service contracted the 2001 review to the Conservation Breeding Specialist Group (CBSG) from the International Union for Conservation of Nature–Species Survival Commission (IUCN-SSC), and the 2003 review was conducted internally (Mexican Wolf Blue Range Adaptive Management Oversight Committee and Interagency Field Team 2005).

The 2001 review was conducted by a team of scientists led by renowned wolf ecologist Dr. Paul C. Paquet. They found that (1) survival and recruitment rates were far too low to ensure population growth and persistence; (2) livestock producers using public lands could make a substantive contribution to reducing conflicts with wolves through improved husbandry and better management of carcasses; and (3) dispersal of wolves outside the recovery area boundaries is required if the regional population is to be viable (Paquet et al. 2001). They recommended that regulations for the Blue Range reintroduction project be modified to allow wolves that are not management problems to establish territories outside the Blue Range Wolf Recovery Area boundary, and that livestock operators on public land be required to take some responsibility for carcass management or disposal to reduce the likelihood of wolves becoming habituated to feeding on livestock. None of the substantive recommendations in the Paquet report has yet been implemented or initiated.

The internal five-year review completed in 2003 made thirty-seven recommendations, many of which are burdened by required bureaucratic processes of government agencies (Mexican Wolf Blue Range Adaptive Management Oversight Committee and Interagency Field Team 2005). While some recommendations could improve the status of the Blue Range reintroduction project in the next two to five years, four provisions are worrisome from a conservation perspective. These four would (1) specify that new regulations will not address wolf habituation to livestock or attraction to the vicinity of livestock through scavenging on untended livestock carcasses, one of the principal reasons wolves are trapped or shot (Recommendations 12.b. and 29); (2) allow private individuals to kill wolves in broader circumstances than presently permitted (Recommendation 10); (3) mandate that current management protocols apply to all new areas made available for wolf occupation, even though those protocols result in an unsustainable failure rate (Recommendation 5.c); and (4) allow Arizona, New Mexico, and tribal authorities to cap the wolf population in the bistate area at 125 individuals and permit wolves in excess of that number to be killed (Recommendation 11). The population figure of 125 as an adequate recovered population has no scientific justification and no relationship to the recovery of wolves in the Southwest. The Mexican gray wolf is not currently on a firm trajectory toward recovery.

WHAT IS RECOVERY?

Unfortunately, the ESA provides no clear answer to a question of great importance: What is recovery? Service policy states, "The goal of this process [recovery] is to restore listed species to a point where they are secure, self-sustaining components of their ecosystem and, thus, to allow delisting" (US Fish and Wildlife Service 1996b, 2).

Recent developments in conservation biology show that species interactions contribute greatly to ecosystem health, and the loss of species that are highly interactive degrades composition, structure, and diversity in ecosystems (Soulé et al. 2005). Thus, increasing understanding of interactions and webs means that the older definitions of recovery based on taxonomic representation and population viability are outdated. For highly interactive species, species that play driving roles in their ecosystems, achieving functional (ecological and evolutionary) densities over a significant portion of range is particularly important. Without functional

densities and distributions of species that are ecological drivers, biodiversity will continue to decline despite the best of intentions (Soulé et al. 2003a, 2005). Examples of such species include prairie dogs (*Cynomys* spp.), beavers, elephants, and wolves.

The concept of restoring functional densities of a species over a significant portion of suitable habitat within a species' historic range means recovery must strive for numbers that are higher than what is deemed taxonomically viable (Tear et al. 1993; Rohlf 1991; Shaffer and Stein 2000; Miller et al. 2000; Soulé et al. 2003b, 2005). For example, wolves in the Greater Yellowstone Ecosystem may exist in viable numbers, but they do not affect elk numbers and behavior in Colorado. A complex of prairie dog colonies covering 1,000 hectares (2,471 acres) may hold 10,000 or more prairie dogs, enough to be considered viable, but that complex may only hold 15 black-footed ferrets, a population at risk. Minimal recovery goals may keep a taxonomic representation, but such minimal goals for highly interactive species will continue to erode biodiversity.

The ESA does not discuss the role of highly interactive species in endangerment or recovery, probably because the act was written and last revised before much was known of these complexities. But, the act does state that decisions need to be based on the best scientific knowledge available, and there is enough flexibility to incorporate knowledge about how a species affects the broader ecosystem (Soulé et al. 2005).

Goals to restore a species' density and distribution across as much of its former range that holds suitable habitat as possible seem consistent with the act's definitions of *endangered species* (any species which is in danger of extinction throughout all or a significant portion of its range) and *threatened species* (any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range). Vucetich et al. (2006) argued that such an approach would mean that the species should be recovered to at least 75 percent of its range, where *range* is defined as "historic range that is currently suitable or can be made suitable by removing or sufficiently mitigating threats to the species." In 2001, the Ninth Circuit Court of Appeals reinforced these definitions when it implied that recovery must consider a significant portion of a species' historic range, at least where suitable habitat exists (*Defenders of Wildlife v. Norton*, 258 F.3d 1136, 1145).

Since passage of the ESA, conservation measures initiated by the service and other federal and state agencies have led to thirteen delisting actions involving nine species, two subspecies, and two distinct population segments (Enbring 1985; Jacobs 1985; Neal 1987a, 1987b; Swem 1994; Mesta 1999; Anderson and DeGange 2001). In each of the thirteen cases, the service emphasized that delisting was justified because evidence indicated that the species was distributed throughout its former range at near original abundance and was faced with no foreseeable threats.

In these cases, decisions on delisting seemed to be guided by Aldo Leopold's maxim:

> There seems to be a tacit assumption that if grizzlies survive in Canada and Alaska, that is good enough. It is not good enough for me...Relegating grizzlies to Alaska is about like relegating happiness to heaven; one may never get there (1966, 277).

CONCLUSIONS

As recently as 1850, the gray wolf and the red wolf lived throughout most of the conterminous United States (Young and Goldman 1944; Nowak 1983). Conflict with agrarian interests resulted in government-supported wolf eradication campaigns as early as 1630 in the Massachusetts Bay Colony, which then expanded throughout the conterminous United States, resulting in the near extermination of red and gray wolves (Young and Goldman 1944; McIntyre 1995).

The conservation status of red and gray wolves has greatly improved since the 1950s, when both species approached extinction in the Lower 48. This improvement is a direct result of a rising conservation consciousness in the public and implementation of recovery activities under the ESA. The status of each species would not have improved if not for the ESA.

At present, the red wolf is limited to North Carolina, and its future is threatened because of hybridization with coyotes—a species formerly not present in the southeastern United States. Gray wolf recovery efforts are centered in three regions: the Great Lakes states, the Northern Rockies, and the Southwest. The Great Lakes population of wolves has responded very well and now holds around 4,000 wolves. The Great Lakes area once held a population of wild wolves, and changing management practices allowed them to expand. The Northern Rockies population holds around 1,200 individuals, with all but about 150 of those wolves in Yellowstone and Idaho, and with both populations started by reintroducing wolves from Canada. The population in northern Montana came from colonizing wild wolves. The Mexican wolf population in Arizona and New Mexico holds only about fifty individuals and was started by the release of animals raised in captivity.

In the Northern Rockies and the southwestern United States, there has been significant opposition to wolf recovery, largely from agrarian interests. Farmers and livestock producers of the Great Lakes region, however, have lived with increasing wolf numbers for forty years and are much more tolerant.

The US Fish and Wildlife Service has attempted to remove protections from wolves despite repeated legal defeats and despite the fact that wolves occupy only about 5 percent of their original range in the Lower 48. There are several areas of former range in the Lower 48 that could provide excellent habitat for wolves, but where wolves are absent. Expanding recovery efforts to include presently unoccupied wolf habitat, such as the Southern Rocky Mountains, would contribute mightily toward recovery of the species. (See Vucetich et al. 2006 for a robust discussion of this subject.)

There are presently no efforts by the US Fish and Wildlife Service to restore wolves to areas with good habitat that lack wolves, despite a scientific, ESA, and court emphasis interpreting recovery as occurring in a "significant portion of the former range" (*Defenders of Wildlife v. Norton*, 258 F.3d 1136, 1145). Recent studies show that habitat could support 1,000 or more wolves in the northeastern United States, from New York to Maine (Harrison and Chapin 1998; Mladenoff and Sickley 1999). The Southern Rockies Ecoregion contains almost 1.5 to 1.8 times more public land than is available to wolves in the Yellowstone area and central Idaho, and 6 times the amount of public land available to Mexican wolves in the Blue Range Wolf Recovery Area. A 1994 congressionally mandated study concluded that the Colorado portion of the ecoregion could support more than 1,000 wolves, mostly on public land (Bennett 1994). Mech (2000) proposed that because the ecoregion is nearly equidistant from the Northern Rockies and the Blue Range Wolf Recovery Area, it is possible that a Southern Rockies population, through the production and movement of dispersers, would contribute to establishing and maintaining a metapopulation of wolves extending from the Arctic to Mexico. Carroll et al. (2004) rate the Grand Canyon area (Arizona into southern Utah) as potentially able to support the largest regional population in the southwestern United States; the

area offers a low probability of extinction and high resilience to potential change.

By not trying to place wolves in such high-quality habitats, the US Fish and Wildlife Service is allowing de facto no-wolf zones. Such a policy prevents wolves from connecting across a landscape and fulfilling their ecological function. While wolves may persist in a few locations, they will remain at higher risk because opportunities to disperse and colonize new habitat will be artificially limited. That will affect not just ecological function but also evolutionary potential. There are, however, local efforts by nongovernmental organizations to return wolves to these and other areas.

Significant credit for gains in wolf conservation is due to citizens, members of nongovernmental conservation organizations, elected and appointed officials, and individuals working for state, tribal, and federal governments who, despite political controversy, recognize the key role wolves play in ecosystems and in our nation's natural heritage.