The Biology and Conservation of Wild Canids

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CHAPTER 19

Grey wolves—Yellowstone

Extermination and recovery of red wolf and grey wolf in the contiguous United States

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Grey wolf *Canis lupus* in snow © M. K. Phillips. Black wolf reintroduced to Yellowstone National Park © National Park Service.

As recently as 150 years ago, the grey wolf (*Canis lupus*) was distributed throughout the contiguous United States (US), except for the southeastern US from central Texas to the Atlantic coast where the red wolf (*Canis rufus*) occurred (Young and Goldman 1944; Nowak 1983). Conflict with agricultural interests resulted in government-supported eradication campaigns beginning in colonial Massachusetts in 1630 (Young and Goldman 1944; McIntyre 1995). Over the next 300 years, the campaigns were extended throughout the US resulting in the near extermination of both species. In recent decades, efforts to recover the red and grey wolf were carried out. This case study summarizes extermination and recovery efforts for both species in the contiguous US.

Wolf extermination

Historically, wolves were the most widely distributed large mammals in North America (Fig. 19.1). Together the two species probably numbered several hundred thousand individuals, and they occurred wherever large ungulates were found. Tolerant of environmental extremes, wolves inhabited areas from 15°N latitude (i.e. central Mexico) to the North Pole (Hall 1981; Nowak 1995). Wolf distribution was greatly reduced as a result of long-term extermination efforts that began as Europeans settled in North America. Conflict between the agrarian colonists and wolves prompted the establishment of bounties as early as 1630 (McIntyre 1995). Eventually wolf extermination became the policy of the federal government. Persecution reached a zenith in the late 1800s and early 1900s when the wolf's natural prey (i.e. bison (*Bison bison*), elk (*Cervus elaphus*), and deer (*Odocoileus* spp.)) had been greatly reduced due to unregulated exploitation (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).

In the presence of reduced prey populations and expanded production of livestock, wolves increasingly depredated on the latter. In response the federal government and private citizens intensified control efforts. In 1915, the US Congress began funding a wolf control programme and assigned the mission of implementing it to the US Biological Survey. The goal was the 'absolute extermination' of the wolf, and poisoning was the main method used (McIntyre 1995).

By the 1930s, the numbers and distribution of wolves were reduced throughout the contiguous US, and by the 1940s wolves were almost absent (Young and Goldman 1944; Young 1970; Brown 1983; Nowak 1983). In the early 1950s, government trappers turned to northern Mexico and the few wolves from there that dispersed to the US. This influx was eliminated by the end of that decade (McIntyre 1995) when wolf numbers were at an all-time low. Then, less than 1000 wolves persisted in the remote regions of the Gulf Coast (red wolves) and the forests of northeastern Minnesota (grey wolves) (Fig. 19.1). Additionally, probably less than 20 grey wolves inhabited Isle Royale National Park, a 546 km^2 (210 $miles^2$) island in Lake Superior located about 32 km (20 miles) from the Minnesota mainland (Fig.19.1) (Stenlund 1955; Mech 1966; Peterson 1977; Fuller *et al.* 1992a; Thiel 1993). From the 1950s through the 1970s, studies provided insights into wolf ecology (Stenlund 1955; Pimlott 1967; Mech 1966; Mech and Frenzel 1971; Van Ballenberghe 1972; Peterson 1977) and helped foster a public desire to conserve the species.

Wolf recovery

In 1973, the Endangered Species Act (ESA) was passed (Public Law No. 93-205, as amended). This law provided significant protection for wolves and mechanisms for recovering both species. The first list of endangered species under this law included the red wolf, eastern timber wolf (*C. lupus lycaon*) and the Northern Rocky Mountain wolf (*C. lupus irremotus*) (US Fish and Wildlife Service 1974). In April 1976, the Mexican wolf (*C. lupus baileyi*) was listed as endangered (US Fish and Wildlife Service 1976a). In June 1976, *C. lupus monstrabilis* was listed as endangered (US Fish and Wildlife Service 1976b). In 1978, the US Fish and Wildlife Service (Service) combined the subspecific listings for the grey wolf and reclassified it at the species level (i.e. *C. lupus*) as 'endangered' throughout the contiguous US and Mexico, except for Minnesota where the species was reclassified to 'threatened' (Nowak 1978). Shortly after the wolves were listed, the Service began developing recovery plans.

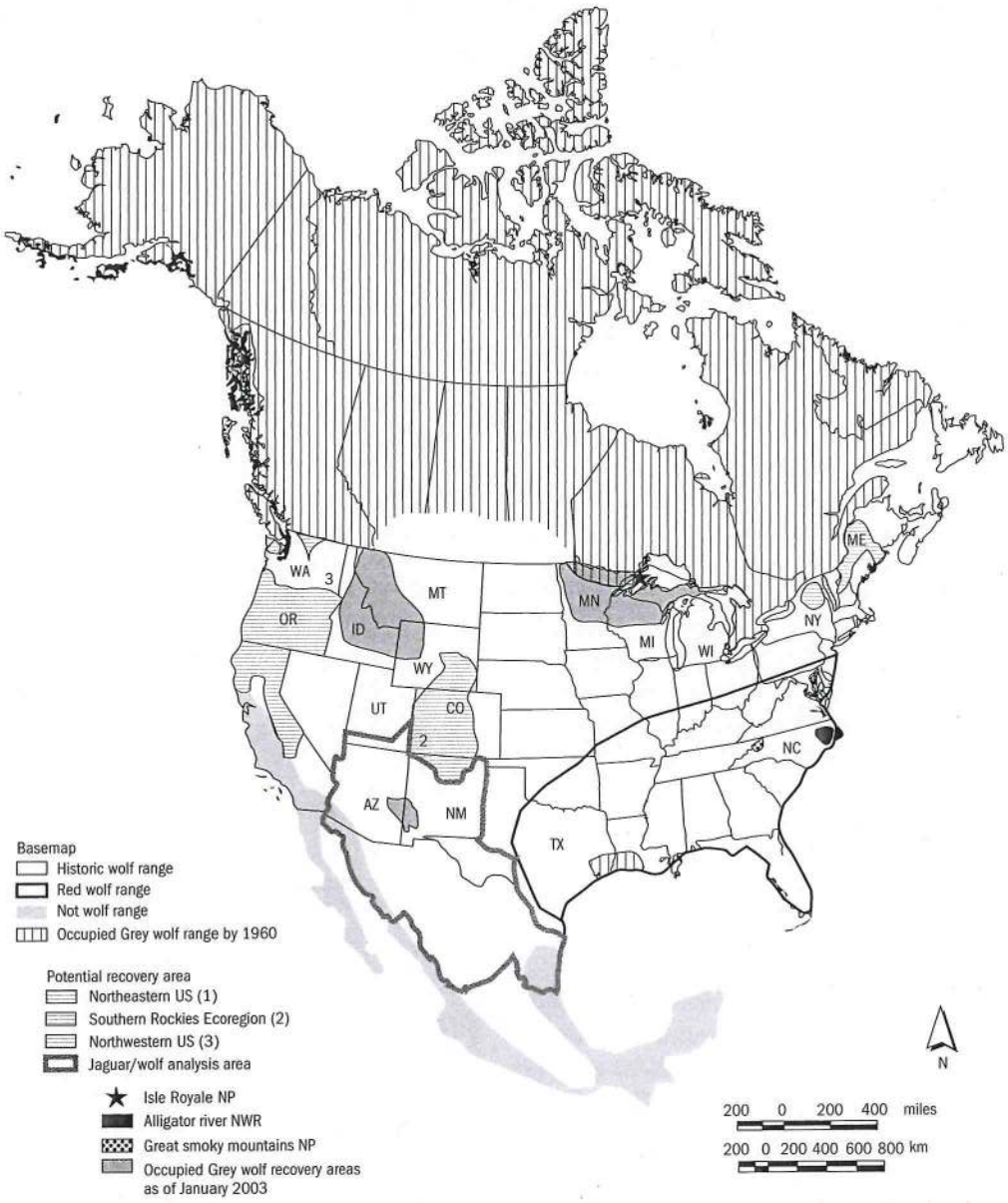

Figure 19.1 Areas that are relevant to the extermination and recovery of the red wolf and grey wolf in North America. The historic range that is portrayed for both species is from Nowak (1995). These recovery programmes were based on recognized wolf subspecies before Nowak's (1995) changes.

Red wolf

The decline of the red wolf was recognized in the 1960s (McCarley 1962). In addition to persecution by humans, the species was threatened by hybridization with coyotes (*Canis latrans*) (McCarley 1962; Nowak 1972, 1979). In 1973, a captive breeding programme was established at the Point Defiance Zoological Gardens, Tacoma, Washington. From a founding stock of 14 wolves, by December 2002, the captive population included 160 animals maintained at 32 facilities. By 1980, the red wolf was considered extinct in the wild (McCarley and Carley 1979; US Fish and Wildlife Service 1984).

The origins of the red wolf have been debated since the 1960s. Some authorities have considered the red wolf to be a full species (Nowak 1992, 2002), while others have considered that it might be a subspecies of the grey wolf (Lawrence and Bossert 1967; Phillips and Henry 1992) or a hybrid resulting from interbreedings of grey wolves and coyotes (Mech 1970; Wayne and Jenks 1991; Roy *et al.* 1996). The debate led to challenges to the integrity of the red wolf recovery programme (Gittleman and Pimm 1991) and was used by the American Sheep Industry as a rationale on which to petition the Secretary of Interior to remove the species from the list of endangered and threatened wildlife. The Service determined that the petition did not present substantial information to warrant delisting (Henry 1997). Recent genetics work suggests that the red wolf and eastern timber wolf share a close taxonomic relationship that justifies classification as a separate species, *Canis lycaon* (Wilson *et al.* 2000). However, Nowak (2002) presents morphological and distribution data that counter this claim and support the current taxonomic separation between the red wolf and the eastern timber wolf. The Service currently recognizes the red wolf as a valid species distinct from the grey wolf and coyote.

Recovery efforts

A recovery plan was finalized in 1984 that established the foundation for reintroducing up to 15 wolves for five consecutive years to the Alligator River National Wildlife Refuge (ARNWR) in northeastern North Carolina (Fig. 19.1) (US Fish and Wildlife Service 1984). The final plan called for the released wolves and their offspring to be designated as members of experimental-nonessential populations per section 10(j) of the ESA (Parker *et al.* 1986). Such a designation allows the Service to relax the restrictions of the ESA to facilitate wolf management (Parker and Phillips 1991). The ARNWR reintroduction is notable for several reasons, including its position as the first attempt ever to restore a carnivore species that was extinct in the wild. Wolves selected for release were taken from the Service's certified captive-breeding stock. Age, health, genetics, reproductive history, behaviour, and physical traits representative of the species were considered in the selection process. From 1987 through 2002, 85 red wolves were released on 38 occasions. During the fall of 2001, the last free-ranging red wolf that had been born in captivity died at the age of 13. After that the wild population consisted entirely of wild-born animals. By June 2003, free-ranging red wolves had given birth to >300 pups over four generations, and the population included approximately 100 red wolves in 20 packs across 6912 km^2 (2700 $miles^2$) of the restoration area. This area is composed of 60% private land and 40% public land that include three national wildlife refuges.

A revised red wolf recovery plan (US Fish and Wildlife Service 1989) called for additional reintroduction projects and indicated that for the foreseeable future it would not be feasible to downlist (change species' classification from endangered to threatened) or delist (remove species from list of threatened and endangered species) the red wolf (Table 19.1). In 1991, a second reintroduction project

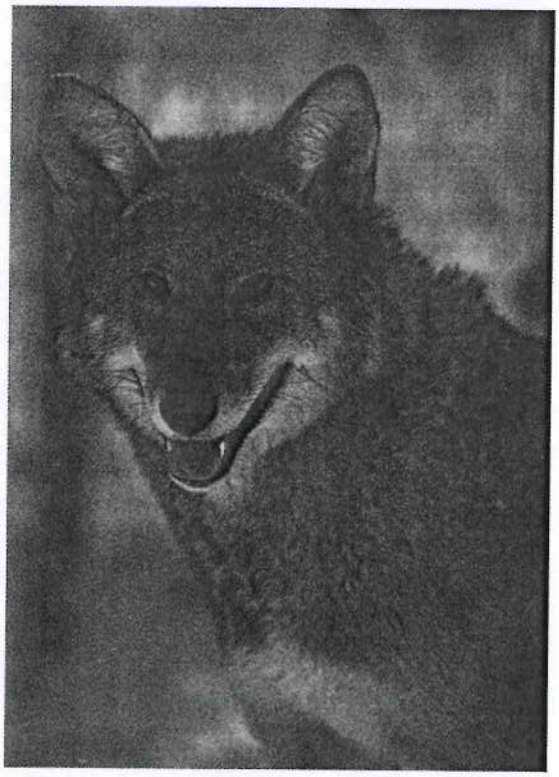

Figure 19.2 Red wolf *Canis rufus* © M. S. Murri.

Table 19.1 Federal recovery criteria for the red wolf and the grey wolf

Recovery programme	Recovery area	Criteria for downlisting[a]	Criteria for delisting[b]
Red wolf	Southeastern United States	None[c]	None[c]
Eastern timber wolf	Minnesota, Michigan, Wisconsin	≥ 100 wolves inhabiting Michigan or Wisconsin for three consecutive years[d]	Assurance that the Minnesota population includes ≥1251 wolves Establishment of a second population outside of Minnesota and Isle Royale National Park If the second population is 160 km (100 miles) from the Minnesota population, it must consist of ≥200 wolves for at least 5 years (based on late winter counts) If the second population is within 160 km of the Minnesota population, then it must consist of ≥100 wolves for at least 5 consecutive years
Northern Rocky Mountain wolf	Montana, Wyoming, Idaho	10 breeding pairs[e] for 3 successive years in 2 of the recovery areas	≥30 breeding pairs comprising ≥300 wolves in a metapopulation with genetic exchange between subpopulations for 3 successive years
Mexican wolf	Southwestern United States	None[f]	None[f]

Notes:

[a] Downlisting refers to a classification change from endangered to threatened as per the federal ESA.

[b] Delisting refers to a classification change from threatened to removed from the list of endangered and threatened wildlife as per the federal ESA.

[c] The US Fish and Wildlife Service believes that establishment of 225 red wolves in the wild and maintenance of 325 animals in captivity would provide for preservation of the species. The Red Wolf Recovery Plan states that for the foreseeable future it is not feasible to either downlist or delist the species.

[d] Downlisting to threatened does not apply to the grey wolf in Minnesota, which was previously reclassified from endangered to threatened in 1978.

[e] A breeding pair is considered an adult male and an adult female wolf that have produced at least two pups that survived until December 31 of the year of their birth, during the previous breeding season.

[f] The Mexican Wolf Recovery Plan states that maintenance of a captive breeding programme and establishment of a population of >100 wolves would provide for maintenance of the subspecies. The plan further expresses no possibility for delisting the Mexican wolf.

was initiated in the Great Smoky Mountains National Park with the experimental release of one family (Fig. 19.1) (US Fish and Wildlife Service 1992a). Results suggested that restoration was feasible. The Service subsequently released 37 wolves from 1992 through 1996. Of these, 26 died or were recaptured after travelling outside the Park. Of 28 pups born in the wild and not removed, none survived the first year. Disease (canine parvo virus) was implicated in the death of many of the pups. Because of the inability of wolves to establish home ranges in the Park, low pup survival, and low winter prey availability, the Service terminated the project in 1998 (Henry 1998).

From 1987 through 1994 it seemed that the red wolf reintroduction project at ARNWR was succeeding (Phillips *et al.* 1996, 2003). During the mid-1990s, the prognosis changed as it became apparent that hybridization between red wolves and recently established coyotes was becoming increasingly common (Kelly and Phillips 2000). A comprehensive assessment (Kelly *et al.* 1999) facilitated development of an adaptive management plan to address the hybridization problem (Kelly 2000). The plan was implemented in April 1999 and called for hybridization to be eliminated or reduced through intensive fieldwork to euthanize or sterilize coyote and hybrids and promote the formation and maintenance of red wolf pairs. By 2002, the plan was beginning to show significant progress and the Service intends to continue its implementation. However, even if the effort at ARNWR ultimately proves successful, the ubiquitous distribution of coyotes indicates that hybridization with that species will remain the central challenge to red wolf recovery.

Problems of red wolf recovery

Red wolves and wild ungulates

Few conflicts with humans have arisen since the red wolves were released. White-tailed deer (*Odocoileus virginianus*) are abundant in northeastern North Carolina and hunter harvest has remained heavy since red wolves were reintroduced.

Red wolves and livestock

Very few depredations have been reported or documented for red wolves. For example, by June 2002, only three cases of minor depredations involving a pet or farm animals have been documented despite exhaustive efforts to investigate every complaint. No cases of wolf-induced loss of livestock have been reported for the recovery area.

The future of red wolf recovery

Despite the challenges arising from hybridization, the ARNWR restoration project is showing success in the presence of intensive management of wolves and coyotes. 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 as well (Phillips 1990). A study done by Cornell University concluded that on average the ARNWR red wolf project generated an annual regional economic benefit of about $37.5 million due to increased tourism (Rosen 1997). Public opinion polls conducted as part of the Cornell study and by North Carolina State University (Quintal 1995) revealed that the majority of local residents strongly favoured red wolf recovery in northeastern North Carolina. 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*) by reducing nest predation by raccoons. Food habits data and observations by local landowners reveal that red wolf predation on coypu (*Myocaster coypu*) has the potential to reduce nutria damage to water control levees. For these reasons and others, Rosen (1997) predicted that the public would strongly support and benefit from efforts to reestablish red wolves elsewhere. It seems likely that the red wolf could be recovered through the reestablishment of additional populations via reintroduction of captive-born animals if not for the species' predilection to hybridize with coyotes.

The intensive management required to restore red wolves by minimizing hybridization with coyotes poses an important ethical question: Is it legitimate to disadvantage one species (the coyote) for the sake of another species (the red wolf)? This question was, of course, carefully considered when the adaptive

management plan was developed. It was noted then that the coyote was non-native to the southeastern US and the coyote that was invading northeastern North Carolina represented a mix of genes from domestic dogs, western coyotes, and wolves (US Fish and Wildlife Service unpublished data). Consequently the Service determined that actively selecting against coyotes and hybrids, by capturing and sterilizing or euthanizing them, was a legitimate measure for restoring the red wolf.

Such management actions are not unique to red wolf recovery. Coyote control programmes have been included in efforts to conserve the imperiled San Joaquin kit fox (*Vulpes macrotis mutica*) (Cypher and Scrivner 1992) and restore the imperiled swift fox (*Vulpes velox*) (Kunkel *et al.* 2003). Eradication efforts directed at non-native trout (i.e. rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*)) are important components of efforts to restore populations of imperiled native trout such as Gila trout (*Oncorhynchus gilae*) (Propst *et al.* 1992) or several subspecies of cutthroat trout (*Oncorhynchus clarki*) (Gresswell 1991; Young and Harig 2001; New Mexico Department of Game and Fish 2002).

Grey wolf

Recovery of the grey wolf in the Western Great Lakes States (Minnesota, Wisconsin, Michigan)

The first recovery plan was written for the eastern timber wolf in May 1978 (US Fish and Wildlife Service 1978). A revised plan was finalized in 1992 and included two delisting criteria (Table 19.1) (US Fish and Wildlife Service 1992b). The recovery plan for the eastern timber wolf includes no goals or criteria for the wolf population on Isle Royale, because it is not considered important in the long-term survival of the species. The population on the island is small (i.e. it usually includes 12–25 animals and has never included more than 50 wolves) and is almost completely isolated from other wolf populations (Peterson *et al.* 1998).

Various surveys conducted from the late 1950s to 1973 indicate that the Minnesota population did not exceed 1000 animals during that time (Fuller *et al.* 1992). After federal protection in 1974, its increase began accelerating and, by January 2003, the Minnesota population included over 2500 animals (Minnesota Department of Natural Resources 2001; Refsnider 2003).

Wolves were considered extirpated from Wisconsin by 1960 (Thiel 1993). Until the mid-1970s occasional sightings were reported but there was no evidence of reproduction (Wisconsin Department of Natural Resources 1999). In response to persistent reports of wolves, population monitoring was initiated in 1979. By 1997, the Wisconsin wolf population had exceeded the criterion for downlisting to threatened (i.e. 80 or more wolves present for three successive years). By January 2003, the population included over 300 animals.

The last known breeding population of wolves in Michigan (outside of Isle Royale) occurred there in the mid-1950s. While numbers continued to decline through the 1970s, it is likely that wolves were never completely extirpated from the State (Michigan Department of Natural Resources 1997). During the late 1980s, reports of wolves in Michigan's Upper Peninsula (UP) began to increase. A pair produced pups there in 1991. Since then, the Michigan population has increased and spread throughout the UP with immigration occurring from Wisconsin, Minnesota, and Ontario. By 1997, the Michigan population had exceeded the threshold for downlisting to threatened. By January 2003, the population included over 300 animals.

Growth of wolf populations in the Great Lakes region prompted the recovery team to modify delisting criteria to consider wolves in Wisconsin and Michigan as a single population. The 1993–94 late winter count of the Wisconsin–Michigan population was the first to exceed 100 wolves. Subsequent late winter counts have all exceeded 100. Moreover, the Minnesota population has included $\geq$1251 wolves since at least the late 1980s. Consequently, by 1999, delisting criteria for the eastern timber wolf had been met.

Recovery of the grey wolf in the Northern Rocky Mountains

In 1974, an interagency team was formed and completed the Northern Rocky Mountain Wolf Recovery

Plan (US Fish and Wildlife Service 1980). Revisions to the plan (US Fish and Wildlife Service 1987b, 2002) focused recovery on northwestern Wyoming, western Montana, and central Idaho. These areas are characterized by large tracts of public land, healthy populations of native ungulates, and relatively few livestock. The plan indicated that about 300 wolves would inhabit the region at the time of recovery (Table 19.1). The Plan promoted natural recovery for Montana and Idaho, unless two packs had not become established in Idaho by 1992, at which time reintroduction would be considered. The Plan recognized that the most certain way to restore wolves to the Greater Yellowstone Ecosystem was by reintroducing animals to Yellowstone National Park (YNP).

By the 1970s, dispersing wolves from Canada were travelling through northwestern Montana, and by 1982 a pack used Glacier National Park (Ream and Mattson 1982). In 1986, the first litter of pups in over 50 years was born there (Ream *et al.* 1985, 1989). By January 2003, about 108 wolves inhabit northwestern Montana (US Fish and Wildlife Service *et al.* 2003).

In November 1991, the Service was directed by Congress to prepare an Environmental Impact Statement (EIS) on wolf reintroduction to YNP and central Idaho. The final EIS was published in April 1994 and recommended reintroducing about 15 wolves from Canada to each area every year for 3–5 years (US Fish and Wildlife Service 1994). The final EIS also recommended that released wolves and their offspring be designated as members of experimental-nonessential populations (Bangs 1994). By July 1994, the Secretary's of Interior and Agriculture had signed a 'Record of Decision' effecting the final EIS as the federal government's official policy.

By the end of 1994, several lawsuits had been filed by wolf proponents and opponents that questioned the application of the experimental-nonessential designation. In December 1997, a Wyoming federal judge determined that the designation had been illegally applied and ordered the Service to remove the reintroduced wolves and their offspring (US District Court, Court of Wyoming, Civil No. 94-CV-286-D (lead case), Civil No. 95-CV-027-D, Civil No. 95-CV-1015-D (consolidated)). Given the ramifications of his determination, the order was stayed on its execution pending appeal. The appeal was settled in January 2000 as the 10th Circuit Court of Appeals (Denver, Colorado) reversed the Wyoming court order (US Court of Appeals, Tenth Circuit, Nos. 97-8127, 98-8000, 98-8007, 98-8008, 98-8009, 98-8011).

In January 1995, 15 wolves from Alberta, Canada were released in Idaho. In January 1996, 20 wolves from British Columbia, Canada were released in Idaho (Bangs and Fritts 1996; Fritts *et al.* 1997). These animals spawned a population that by January 2003 included about 284 wolves (US Fish and Wildlife Service *et al.* 2003). During March 1995, 14 wolves from Alberta were released in YNP. In January 1996, 17 wolves from British Columbia were released in YNP (Phillips and Smith 1996). Furthermore, due to a wolf control action in northwestern Montana, 10 pups were placed in an acclimation pen in the Park in late 1996. These pups and three adults from an earlier reintroduction were released in the spring of 1997. By January 2003, this population included about 271 wolves (US Fish and Wildlife Service *et al.* 2003).

The reintroduced wolves adapted better than predicted. Only 2 years of reintroductions were required to ensure population establishment rather than 3–5 years of reintroductions as predicted (Fritts *et al.* 1997). Compared to predictions in the EIS, the wolves have produced more pups, survived at a higher rate, and caused fewer conflicts with humans (Phillips and Smith 1996; Bangs *et al.* 1998; Smith *et al.* 1999; Fritts *et al.* 2001). Additionally, over 100,000 visitors to YNP have observed wolves (YNP unpublished data) and public interest in recovery remains high.

Recovery of the Mexican grey wolf in the southwestern United States

Between 1977 and 1980, five 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 to establish a captive breeding programme. Shortly thereafter it was widely accepted that the Mexican wolf was extinct in the wild. In 1979, the Service formed a Mexican Wolf Recovery Team that finalized a binational recovery plan with Mexico by 1982 (US Fish and Wildlife Service 1982). While the plan contains no downlisting or delisting criteria (Table 19.1), a new plan will.

Given the absence of wild Mexican wolves, captive breeding is of central importance to recovery. By December 2002, the captive breeding programme included 230 animals maintained at 43 facilities in the US (30) and Mexico (13).

By 1997, the Service had completed a plan for reintroducing about 15 wolves every year for up to five consecutive years in the Blue Range Wolf Recovery Area (BRWRA) (US Fish and Wildlife Service 1996a). The plan called for designating reintroduced wolves and their offspring as members of an experimental-nonessential population (Parsons 1998). The BRWRA encompasses 17,752 km^2 (6854 miles^2) of the Gila National Forest in New Mexico and the Apache National Forest in New Mexico and Arizona. The reintroduction aims to restore about 100 wolves.

The Service began reintroductions by releasing 11 wolves in March 1998. From then until July 2002, the Service released another 63 wolves on 83 occasions. A comprehensive review of the reintroduction project was completed in June 2001 and recommended continuation of the project with modification (Paquet *et al.* 2001a). Reintroductions and management actions though April 2003 have resulted in the establishment of a population of Mexican wolves comprised of eight known packs, including two that formed naturally, of 22–37 individuals. Many of these packs are now producing pups every spring, and the Service has documented the production of one litter of second generation wild-born Mexican wolves.

Recovery of the grey wolf elsewhere

Other regions in the US possess suitable habitat for grey wolves. Recovery planning, however, has not been developed for these areas.

Northeastern United States

Recent studies show that suitable habitat and sufficient prey exist for wolves in the northeastern US from New York to Maine (Fig. 19.1) (Harrison and Chapin 1998; Mladenoff and Sickley 1998). These studies indicate that 1000 or more wolves could inhabit the region. However, Paquet *et al.* (2001b) conclude that while Adirondack State Park in New York contains sufficient habitat to support a small population of wolves, regional landscape conditions and development trends are not ideal for sustaining wolves over a long period. Mech (2001a) countered this conclusion by arguing that active management could resolve the shortcomings cited by Paquet *et al.* (2001b). While there is a remote possibility that wolves from Canada might recolonize the northeastern US, recovery will probably require reintroductions (Wydeven *et al.* 1998).

Recent genetic work suggests that the eastern timber wolf may be a separate species from the grey wolf and more closely related to the red wolf (Wilson *et al.* 2000). Interestingly, Nowak's (2002) reported that the red wolf's historic range extended into Maine. Verification of this will create new legal, policy, and management questions regarding recovery (Fascione *et al.* 2001). Moreover, there is concern that the eastern timber wolf, like the red wolf, readily hybridizes with coyotes thus complicating recovery efforts (Theberge and Theberge 1998, pp. 233–234, 250–262). Nonetheless, several non-governmental conservation organizations are advocating the wolf's return to the northeast. Public opinion surveys indicate strong support for the idea (Responsive Management 1996; Downs and Smith 1998).

Southern Rockies ecoregion

This ecoregion extends from southcentral Wyoming through western Colorado into north central New Mexico and contains 100,000 km^2 (39,000 miles^2) of public land that supports healthy populations of native ungulates (Fig. 19.1) (Shinneman *et al.* 2000). The ecoregion contains almost 1.5–1.8 times more public land than is available to wolves in the Yellowstone area (64,000 km^2 or 25,000 miles^2) and central Idaho (53,200 km^2 or 20,781 miles^2), and 6 times the amount of public land available to Mexican wolves in the BRWRA (i.e. 17,752 km^2 or 6854 miles^2). Moreover, the Southern Rockies contain 1.7–25 times more habitat than do other sites that have been considered for wolf recovery (Ferris *et al.* 1999). Extensive tracts of public land in the ecoregion are managed in a fashion that could facilitate wolf recovery (Shinneman *et al.* 2000; Carroll *et al.* 2003). For example, the ecoregion contains about 36,000 km^2 (14,000 miles^2) that are roadless

and about 18,000 km^2 (7031 miles^2) that are legally designated or de facto wilderness.

A 1994 Congressionally mandated study concluded that the Colorado could support over 1000 wolves (Bennett 1994). Three additional studies also conclude that the Southern Rockies could support a self-sustaining population of wolves (Phillips *et al.* 2000; Southern Rockies Ecosystem Project 2000; Carroll *et al.* 2003). Recovery will require reintroductions as there is little chance for wolves to do so through natural recolonization (Carroll *et al.* 2003).

Some believe that wolf recovery in the Southern Rockies could be especially significant when considered against a continental perspective. Because the ecoregion is nearly equidistant from the Northern Rockies and the BRWRA, it is possible that a Southern Rockies population, through the production and movement of dispersers, would contribute to the establishment and maintenance of a wolf population that extended from Canada to Mexico. On the significance of restoring the wolf to the Southern Rockies, Mech (1999a) wrote: 'Ultimately, then, this restoration could connect the entire North American wolf population from Minnesota, Wisconsin, and Michigan through Canada and Alaska, down the Rocky Mountains into Mexico. It would be difficult to overestimate the biological and conservation value of this achievement'.

Several non-governmental conservation organizations are advocating the wolf's return to the Southern Rockies. Regional public opinion surveys indicate that there is strong support for the idea (Manfredo *et al.* 1994; Pate *et al.* 1996; Meadows 2001).

Northwestern US

A Congressionally mandated study of the feasibility of restoring wolves to Olympic National Park, Washington concluded that an estimated 56 wolves could survive within the Park boundaries (Fig. 19.1) (Ratti *et al.* 1999). The authors, however, observed a number of potential problems with restoration and urged that further consideration proceed cautiously. Carroll *et al.* (2001a) determined that there was good potential for restoring wolves to the Pacific Northwest (Fig. 19.1). They caution that current development trends may quickly obviate the accuracy of their results. Because of their proximity to wolf populations in British Columbia and Alberta, Washington state's North Cascades and Selkirk Mountains offer some but limited potential for natural wolf recolonization. Moreover, wolves from Montana and Idaho will likely recolonize eastern Oregon and Washington. One radio-collared wolf from Montana was found dead from unknown causes in eastern Washington (Fig. 19.3). In early 1999, a radio-collared female dispersed from Idaho

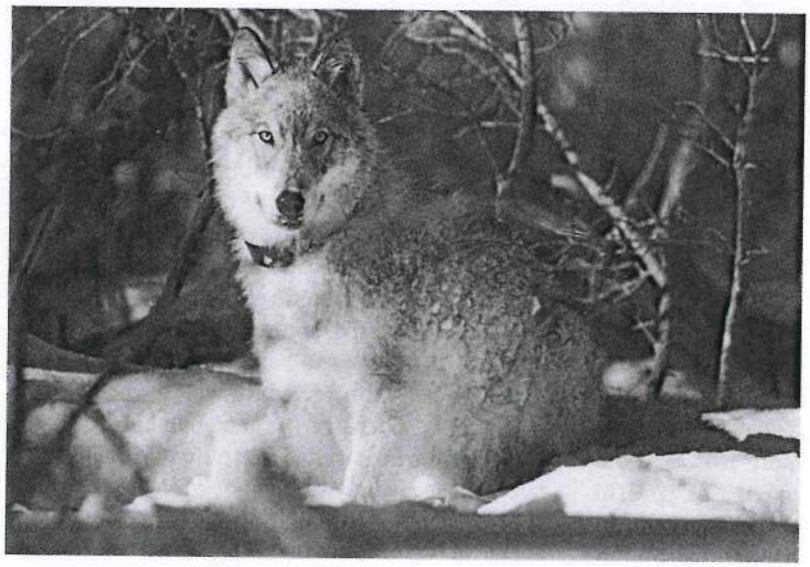

Figure 19.3 Radio-collared grey wolf *Canis lupus* © W. Campell.

to Oregon. She localized movements before being recaptured and returned to Idaho. Two other wolves from Idaho have been found dead in eastern Oregon. It is likely that additional wolves will similarly disperse there since they are capable of travelling great distances (up to 886 km (532 miles) straight line) (Fritts 1983).

Southwestern US and northern Mexico

In May 2002, Carroll *et al.* (2002) began a comprehensive assessment of potential habitat, landscape-level threats, and population viability for Mexican wolves (and jaguars (*Panthera onca*)) across the southwestern US and northern Mexico (Fig. 19.1). This area encompasses the majority of the estimated historic distribution of the Mexican wolf. Such a comprehensive conservation assessment has not been attempted previously due to challenges associated with gathering consistent habitat data over such a large region spanning two nations, and lack of tools to link population dynamics to mapped habitat data at this scale. To resolve the latter problem, the study will use the programme PATCH (Schumaker 1998), which provides a means of building biologically realistic regional-scale population models. Study results combined with previous work for the Southern Rockies ecoregion (Carroll *et al.* 2003) will be useful for developing a regional-scale strategy for recovering the wolf in the southwestern US and Mexico.

Proposed recovery future for the grey wolf

By the end of 2002, wolf numbers and distribution in the contiguous US were greater than during the previous several decades. At this time, >3700 wolves occupied about 4% of the species' historic range in the 48 contiguous states (Fig. 19.1). The wolf populations in the Great Lakes States and the Northern Rocky Mountains had exceeded delisting criteria since 1999 and 2002, respectively. The Mexican wolf reintroduction project in the BRWRA was showing signs of becoming firmly established.

In response to the species' improved conservation status and continued public interest in wolf restoration, the Service finalized a reclassification rule or national recovery strategy (Refsnider 2003) that established three distinct population segments (DPSs) for the grey wolf (i.e. areas supporting wolf populations that are somewhat separated from one another, are significant to the overall conservation of the species, and are considered separately under the ESA). The highlight of the strategy was the determination that the grey wolf would be delisted in the US, except for the southwestern portion of the country (Arizona, New Mexico, southern half of Utah and Colorado, and the western half of Oklahoma and Texas), based on the recovered populations in the Great Lakes States and the Northern Rocky Mountains. In the southwest, the wolf remains endangered, and the Service is required to develop recovery efforts that result in establishment of populations adequate for delisting.

The Service's strategy was comprehensive, complex, and controversial. It did not satisfy everyone, and litigation has resulted. Since about 95% of the species' historic range in the 48 states is unoccupied, wolf advocates argue that it is inappropriate for the strategy to not require the Service to restore more wolves to more places. Since wolf populations have significantly increased throughout select regions of the contiguous US, wolf opponents argue that it is appropriate for the strategy to not require the Service to restore more wolves to more places.

Disagreements over the specifics of the Service's strategy are to be expected and pivot on the federal government's responsibilities under the ESA. Unfortunately, the Act does not define the term recovery. On this matter the 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, p. 2). Some believe that recovery should be the establishment of functional densities of the species over a significant portion of suitable habitat within the species' historic range (Rohlf 1991; Tear *et al.* 1993; Shaffer and Stein 2000; Ninth Circuit Court of Appeal 2001). The ESA also includes the phrase 'significant portion of range' in the definitions for both an endangered species (any species which is in danger of extinction throughout all of 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). Currently there is no accepted biological or legal standard for defining a 'significant portion of range'.

Problems of grey wolf recovery

As wolves become more common, conflicts with humans can increase in frequency, complexity, and seriousness. This is so because wolves prey on wild ungulates and sometimes on livestock, all of which are important resources for state wildlife managers, special interest groups, landowners, and private citizens.

Grey wolves and wild ungulates

To date, few conflicts have arisen over interactions between wolves and native, wild ungulates (cervids). In the western Great Lake states, where white-tailed deer are the primary prey, wolf predation will not usually negatively affect hunter harvest (Michigan Department of Natural Resources 1997; Wisconsin Department of Natural Resources 1999; Mech and Nelson 2000; Minnesota Department of Natural Resources 2001).

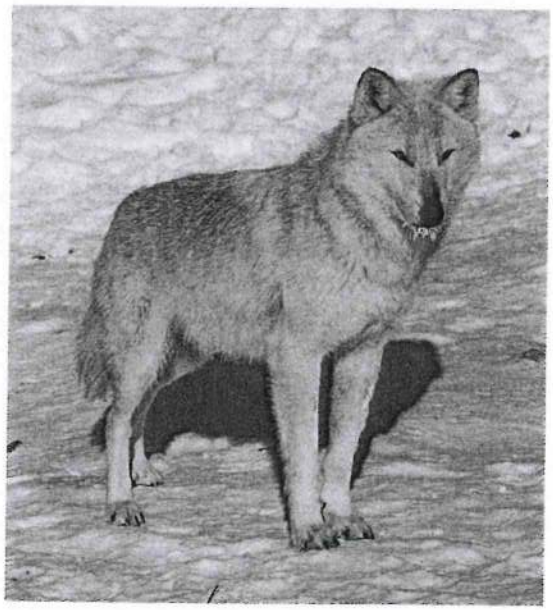

Figure 19.4 Grey wolf *Canis lupus* in Minnesota © D. W. Macdonald.

In the Northern Rockies, where elk and mule deer are also important prey and recovery has occurred in areas that support cougars (*Puma concolor*), bears (*Ursus* spp.), and coyotes, wolf predation, as one of many mortality factors affecting cervid survival, may negatively affect hunter harvests (Kunkel and Pletscher 1999). This issue was a central concern to the public regarding wolf recovery in the region. The EIS predicted that in the GYA (Greater Yellowstone Area) wolf predation may reduce elk and deer populations in some herds by 5–30% and 3–19%, respectively (US Fish and Wildlife Service 1994). Such reductions might prompt a reduction in the number of permits issued to hunters. To date, however, wolves in the GYA have apparently not effected a reduction in elk numbers (Smith *et al.* 2003a). However, wolves have most extensively preyed upon elk that inhabit YNK northern range. By winter 2002–03 this herd was estimated to include 12,000 animals which is 13% less than the 25-year average (1976–2001) of 13,890 (Smith *et al.* 2003a). We caution that the effects of wolf predation on elk cannot be fully understood after only a few years of study. Nonetheless, we believe that it is reasonable to expect lower cervid populations that remain low for extended periods where wolves, bears, cougars, coyotes, and humans vie for the same prey (Kunkel and Pletscher 1999) and where winter weather can greatly affect ungulate population dynamics (Mech *et al.* 2001).

The relationship between Mexican wolves and wild ungulates in the arid southwest is unclear. Clarity would require intensive monitoring of ungulates and reintroduced wolves and their wild-born offspring over an extended period.

Grey wolves and livestock

Conflicts between wolves and livestock or pets have occurred and they have been controversial and complex (Mech 1995, 1996, 1999a, 2001b; Clark *et al.* 1996; Mech *et al.* 1996, 2000; Phillips and Smith 1998). Even though wolf depredations are relatively uncommon, the public demands immediate and certain action when problems arise. For example, as the Minnesota wolf population increased during the last three decades, the number of wolves killed to resolve conflicts with livestock increased from 21 animals in 1980 to 216 in 2000 (Paul 2001). During those 21 years, 1875 wolves were killed. From 1987 through

July 2002, almost 125 wolves have been killed in control actions in the Northern Rockies. Interactions between wolves and livestock or pets have been a problem for the nascent population of Mexican wolves in the BRWRA. At a minimum, over half of the free-ranging Mexican wolves have been involved in such interactions (Paquet *et al.* 2001). Resolution of these conflicts is a common reason for Mexican wolves to be recaptured for re-release or permanent placement in captivity.

The frequency of wolf control belies the actual magnitude of the wolf–livestock problem. For example, only about 1% 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, in the Northern Rockies, average annual confirmed losses have been slight: 4 cattle and 28 sheep (and 4 dogs) in the GYA and 9 cattle and 29 sheep (and 2 dogs) in Idaho. These rates are one-third to one-half of the rates predicted in the EIS (US Fish and Wildlife Service 1994). Since 1987, in northwestern Montana, wolf depredations averaged six cattle and five sheep (and less than one dog) annually. In contrast, livestock producers in Montana annually reported losing annually an average of 142,000 sheep and 86,000 cattle to all causes between 1986 and 1991 (Bangs *et al.* 1995). While it is certain that far more livestock are lost to wolves than are verified (Roy and Dorrance 1976; Fritts 1982; Bangs *et al.* 2001), it is equally certain that wolf depredations have little effect on the economics of the livestock industry. Nonetheless, if not addressed quickly, wolf depredations can cause significant losses for individual producers and create great animosity towards wolf recovery. Many livestock producers have cooperated with recovery because they believe that wolf-induced problems will be resolved equitably. Monetary compensation for livestock losses has proven useful in this regard and for minimizing animosity towards wolves (Fischer 1989; Fischer *et al.* 1994).

The tension between promoting wolf survival and population expansion and killing wolves to resolve conflicts with humans has complicated wolf recovery. With the exception of lethal control, most approaches for resolving conflicts seem to be ineffective, cost-prohibitive, and/or logistically unwieldy when applied over a large scale (Cluff and Murray 1995; Mech *et al.* 1996). This reality prompted Mech (1995, p. 276) to observe that: 'Because wolf-taking by landowners or the public is the least expensive and most acceptable to people who do not regard the wolf as special, there will be greater local acceptance for wolf recovery in areas where such control is allowed. Thus, if wolf advocates could accept effective control, wolves could live in far more places'.

Conclusions

The conservation statuses of the red wolf and grey wolf have greatly improved since the 1950s when three centuries of intense persecution began to end as both species approached extinction in the contiguous US. This improvement is a direct result of science-based planning and implementation of recovery activities under the authority of and impetus provided by the ESA.

Progress notwithstanding, habitat loss continues to accelerate, further reducing the suitability of most areas to support wolves (Carroll *et al.* 2001, 2003; Paquet *et al.* 2001b). Moreover, coyotes are now firmly established throughout the US causing additional challenges to red wolf recovery and probably grey wolf recovery in the northeastern US. Nonetheless, significant credit is due to citizens, non-governmental conservation organizations, elected and appointed officials, state and tribal governments, livestock producers, and the federal government for recognizing the importance of recovering the red wolf and grey wolf, controversial but vitally important components of North America's natural heritage.