

LARGE CARNIVORES, MOOSE, AND HUMANS: A CHANGING PARADIGM OF PREDATOR MANAGEMENT IN THE 21st CENTURY

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ABSTRACT: We compare and contrast the evolution of human attitudes toward large carnivores between Europe and North America. In general, persecution of large carnivores began much earlier in Europe than North America. Likewise, conservation programs directed at restoration and recovery appeared in European history well before they did in North America. Together, the pattern suggests there has been an evolution in how humans perceive large predators. Our early ancestors were physically vulnerable to large carnivores and developed corresponding attitudes of respect, avoidance, and acceptance. As civilization evolved and man developed weapons, the balance shifted. Early civilizations, in particular those with pastoral ways, attempted to eliminate large carnivores as threats to life and property. Brown bears (*Ursus arctos*) and wolves (*Canis lupus*) were consequently extirpated from much of their range in Europe and in North America south of Canada. Efforts to protect brown bears began in the late 1880s in some European countries and population reintroductions and augmentations are ongoing. They are less controversial than in North America. On the other hand, there are no wolf introductions, as has occurred in North America, and Europeans have a more negative attitude towards wolves. Control of predators to enhance ungulate harvest varies. In Western Europe, landowners own the hunting rights to ungulates. In the formerly communistic Eastern European countries and North America, hunting rights are held in common, although this is changing in some Eastern European countries. Wolf control to increase harvests of moose (*Alces alces*) occurs in parts of North America and Russia; bear control for similar reasons only occurs in parts of North America. Surprisingly, bears and wolves are not controlled to increase ungulates where private landowners have the hunting rights in Europe, although wolves were originally exterminated from these areas. Both the inability of scientific research to adequately predict the effect of predator control on ungulate populations and a shift in public attitudes toward large carnivores have resulted in an accelerating number of challenges to predator management in places where it is still espoused. Utilitarian attitudes towards wildlife are declining in Western cultures and people now increasingly recognize the intrinsic value of wildlife, including large predators. In the future, agencies responsible for managing resident wildlife will face increased pressure to balance the needs of the hunting public with the desires of non-hunting publics. We suggest that in the next century we will witness a continued shift in how wildlife agencies manage both moose and large carnivores. More attention will be paid to maintaining and restoring intact ecosystems and less toward sustainable yield of meat.

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There is ample evidence that both wolves (*Canis* spp.) and bears (*Ursus* spp.) kill and eat moose. There is also empirical data suggesting that this predation can limit moose numbers under certain conditions (Ballard and Van Ballenberghe 1998). Wolf reduction can result in increased numbers of moose under some circumstances (Gasaway et al. 1983). However, there are only a few empirical studies supporting the principle that bear reduction programs result in enhancement of moose numbers (Stewart et al. 1985, Ballard 1992). To our knowledge, no study has addressed the long-term effects of bear control on moose numbers.

In only a few places in North America does control or reduction in wolf and bear numbers continue to be strongly advocated by some citizens groups and agencies responsible for wildlife management. A similar attitude regarding wolf control for livestock safety also exists in Europe. However, in the past 2 decades, agencies have witnessed increasing levels of concern toward and criticism of predator control programs by a more vocal public, particularly the environmental community. These groups question both the scientific validity and the philosophical basis for carnivore control. Concurrently, there is an apparent shift in how society in general values large predators, particularly bears and wolves (Duda et al. 1998). In recent times, a larger contingent of the public and scientific community finds inherent intrinsic value in carnivores and perceives their role as necessary in ecosystem function (Miller et al. 2001); they oppose predator control that favors the more utilitarian attitude of "game production" as the objective of wildlife management. These attitudinal shifts are prevalent in both North America and Europe despite dissimilar legal systems of game management.

Here, we review the evolution of predator control in North America and Europe, agency culture and big game management,

the scientific basis of predator management, and an apparent shift in social values in the past decades away from predator control and toward large carnivore conservation and management.

EARLY HUMAN-PREDATOR RELATIONSHIPS

Three stages between humans and their environment have been described: hunting, shepherding, and agricultural (Boitani 1995). Human attitudes toward large carnivores have been shaped by these relationships. Hunting economies were centered on herbivores as an important source of food. Large predators were perceived as competition, but not as a threat. Hunters had respect for and kinship with predators. This was reflected in attitudes of aboriginal peoples. Nomadic shepherds disdained wolves as threats to their livestock and basis for livelihood. In contrast, sedentary herders had more tolerant attitudes toward wolves because they had housing to protect their livestock. Farmers, producing crops and limited livestock, had leeway to be more tolerant. However, agricultural people living in Latin cultures, characterized by closed villages, were more tolerant than those living in Germanic societies, characterized by more open settlements and solitary farms (Breitenmoser 1998).

Bears and wolves played important roles in the legends, beliefs, and lives of prehistoric peoples. Bears were potentially dangerous and fearsome creatures to hunt and kill and had physical similarities to man (Rockwell 1991). Like man, bears were omnivorous, generalists, intelligent animals with binocular vision. They lived sympatrically with humans and ate many of the same foods; when they stood erect or were skinned out, they shared physical similarities to humans (Shepard 1996). These characteristics may have contributed to many similar myths and legends involving

creatures that were half human and half bear as a consequence of mating between humans and bears (Rockwell 1991, Shepard and Sanders 1992). Bears disappeared in the fall and reappeared in the spring giving rise to beliefs that they had a special 2-way route to the afterlife and could commute readily between worlds; an ability worthy of great respect. All these characteristics gave bears a special importance in early cultures closely bound to wild animals. Throughout the shared ranges of bears and humans, people developed elaborate and detailed rituals to appease the spirits of bears they killed (Rockwell 1991, Shepard and Sanders 1992, Edsman 1994) and many of these rituals continue today in some Native American and Eurasian cultures (Black 1998). Wolves played a great mythic-religious role because they possessed many similar characteristics with humans; they were great hunters, members of a pack (tribe or clan), defended territories, and hunted cooperatively (Lopez 1978).

Large carnivores were eliminated from much of their former range both in Europe and North America. The extermination of wolves in Europe started in the Middle Ages and continued well into the early part of the 20th century (Mallinson 1978, Boitani 1995). In Great Britain, wolves were considered a threat to livestock and exterminated by the 17th century. They were exterminated from Northern Europe by the beginning of the 20th century, but survived in lower numbers in Southern and Eastern Europe (Boitani 1995). The extermination of brown bears followed a similar pattern; bears were extirpated from Denmark before the Middle Ages (Jessen 1929) and from Britain during the 10th century (Corbet and Harris 1991). Bears survived in relict populations in Northern and Southern Europe, and in greater populations in Eastern Europe (Swenson et al. 2000).

The eradication of wolves and bears,

and the Eurasian lynx (*Lynx lynx*), a predator on small ungulates, was directly caused by persecution, including bounties, and indirectly through habitat destruction and elimination of prey. Bounties on wolves were initiated in England in the 1500s, on wolves and bears in Sweden in 1647, and Norway in 1733 (Myrberget 1990, Swenson et al. 1995, Elgmork 1996). The destruction of the forests, due to the expansion of cultivation and overgrazing by domestic livestock, was an important factor, as was the extermination of native herbivores (Breitenmoser 1998). For example, by the year 1200, 40% of Switzerland's forests had been cleared (Breitenmoser 1998). The Hungarian landscape was converted from 87% forest and wetland around 900 to less than 11% forest by 1920 (Csányi 1997). Also, the Napoleonic wars in the 1800s resulted in the spread of modern firearms. The result was the virtual elimination of the remaining big game species in much of Europe (Breitenmoser 1998), even though over-hunting had contributed to the extinction of the wild boar (*Sus scrofa*) in England in the 1500s, the capercaillie (*Tetrao urogallus*) in Britain around 1790, and the complete extinction of the auroch (*Bos primigenius*) by 1627 (Myrberget 1990). The famous Swedish taxonomist, Carl von Linné (Linnaeus) probably never saw a wild moose, and his description of the species in 1746 was based on a captive individual. In 1789, a Swedish law allowed landowners unrestricted hunting on their land, with the result that moose were almost totally exterminated in Sweden by 1825, when the law was repealed (Bergström et al. 1993). With little wild ungulate prey, the large carnivores attacked the abundant domestic animals, increasing conflicts and persecution by people.

When Europeans colonized the North American continent, they brought their old world culture and traditions with them, including a view of wilderness as "something

alien to man—an insecure and uncomfortable environment against which civilization had waged an unceasing struggle” (Nash 1982:8). To early settlers, wilderness was villainous as were the wild animals and Indians living in it. Taming wilderness meant the extermination of large carnivores, particularly wolves and bears. The prevailing attitude of colonial America was summarized in a quote from John Adams in 1756: “The whole continent was one continuing dismal wilderness, the haunt of wolves and bears and more savage men. Now the forests are removed, the land covered with fields of corn, orchards bending with fruit and the magnificent habitations of rational and civilized people” (Kellert 1996:104). The difference between European colonizers and the American Indians in attitude to wild lands and wild places was eloquently phrased by Sioux Chief Luther Standing Bear (1932, from Deloria 2001): “We did not think of the great open plains, the beautiful rolling hills, and winding streams with tangled growth as ‘wild.’ Only to the white man was nature a ‘wilderness’ and only to him was the land ‘infested’ with ‘wild’ animals and ‘savage’ people. To us it was tame. Earth was bountiful and we were surrounded with the blessings of the Great Mystery.”

As civilization moved westward, the pioneers viewed predators much like the nomadic shepherds described by Boitani (1995). Since the prevailing form of livestock husbandry was to allow large herds of cattle and sheep to graze freely over vast areas, carnivores, particularly wolves and grizzly bears, were considered an economic threat. The pervasive attitudes of the time were captured in 2 salient quotes (from NRC 1997:135). Historian and trapper Stanley Young wrote: “There was sort of an unwritten law of the range that no cow man would knowingly pass by a carcass of any kind without inserting in it a goodly dose of strychnine sulfate, in the hope of killing one

more wolf” (Young 1946:27). An early director of the U.S. Biological Society, E. A. Goldman, wrote, “Large predatory animals destructive of livestock and game, no longer have a place in our advancing civilization” (Dunlap 1988:51). An early American stockman had similar views: “The destruction of these grizzlies is absolutely necessary before the stock business... could be maintained on a profitable basis.” (Bailey 1931 cited in USFWS 1993).

With the exception of extreme northern Minnesota, wolves were eliminated from the conterminous 48 states by the 1900s (Boitani 1995). Between 1800 and 1975, grizzly bears were eliminated from nearly 98% of their historic range (USFWS 1993, Mattson et al. 1995). At the time of the Lewis and Clark expedition, grizzly bears inhabited most of the western United States and extended out into the Great Plains (Servheen 1999). They flourished where Pacific salmon (*Oncorhynchus* spp.) were abundant far inland into eastern Idaho. Today, they exist as only 5 remnant populations south of Canada. Three of these populations contain <50 individuals and only 2 contain >350 individuals (Servheen 1999). One population, in the north Cascades along the Pacific coast, is highly endangered in both the United States and Canada. No bears have been verified on the United States side of the border in recent decades.

Bears and wolves fared better north of the 49th parallel. The chronology of wolf extirpation in southern Canada followed the pattern of agricultural and industrial settlement (Hayes and Gunson 1995). Wolves were extirpated from many areas in the eastern provinces by the early 1900s, and significantly reduced in the western provinces by the 1930s (Carbyn 1987, Hayes and Gunson 1995). Grizzly bears followed a similar pattern. They were extirpated from part of their historic range in Mani-

toba, Saskatchewan, and Alberta, primarily in the prairies and boreal plains and are scarce in southern Alberta and British Columbia, where human populations are concentrated (Macey 1979, Banci 1991, Banci et al. 1994, McLellan and Banci 1999).

Even in Alaska, where wolves and brown and black bears are still abundant, there were several attempts to eliminate them. According to Sherwood (1981:24) "Periodically Alaskan civic leaders advocated the extermination of the animals [brown bears] and make *Ursus* the symbol of an alleged colonialism that they claimed was inspired by conservationist sentiment and directed by bureaucrats in Washington D.C., working in concert with vested absentee interests. This colonialism, they believed, prevented resident Alaskan entrepreneurs from exploiting the Territory's natural resources and prevented resident politicians from setting the terms of that exploitation."

Brown bears were perceived as a direct threat to the fledgling cattle industry on Kodiak Island (Van Daele 2003). Political pressure from the industry resulted in regulations in 1929 allowing Kodiak cattlemen to kill bears at any time they were considered a menace to livestock or property. According to Sherwood (1981:59) one rancher's advice to anyone encountering a brown bear was, "shoot them in the guts, in the foot, any place, but get a bullet into them."

Prior to statehood in 1959, wolves in Alaska were targeted in a major predator control program led by the United States Government. Wolf control was pervasive with the intent to increase moose and caribou populations. Strychnine and cyanide were commonly used and later aerial gunning was employed as a very effective technique. Following statehood, state management eventually evolved to where the wolf was listed as a game animal in 1963 (NRC 1997).

As civilization expanded and human densities increased, predators were either significantly reduced or eliminated from much of their range in both North America and Europe (Woodroffe 2000). As we shall see, these early attitudes toward large carnivores have persisted, to varying degrees, around the world.

EARLY DEVELOPMENT OF WILDLIFE MANAGEMENT SYSTEMS

Throughout most of the historical record, wildlife managers have targeted predators and have had a significant impact on their numbers, distribution, and more recently, conservation. Because wildlife has value for recreation and food, there are significant economic incentives for individuals, such as landowners, to acquire property rights to wildlife. Thus, the system of wildlife management in a country can contribute to the attitudes towards predation by large carnivores on big game (Lueck 1995).

Europe

In most of Europe, the Kings and their chieftains controlled most of the lands and hunting rights during this feudal period, which was at its peak around 1000. The oldest general game law, introduced by King Knut of Denmark in 1016, established that no one owned wild animals, but that the king had some hunting privileges. This system declined as a result of corruption and the Black Death, and around 1348-49, hunting privileges, especially for big game, were transferred to the large landowners. This was completed in Europe by the 17th and 18th centuries. In some countries, such as Finland, Norway, and Switzerland, small farmers and others held many hunting rights (Myrberget 1990). The Norwegian Parliament transferred all hunting rights, except for killing large carnivores, to landowners in 1899 (Søilen 1995).

Landowners often lost exclusive hunting rights following changes in political systems, such as the revolutions in France and Russia and the introduction of communism in Eastern Europe. Interestingly, the decision that hunting rights in the United States would not be held by the landowner, as is the case in Britain, was made following the American Revolution. After World War II, Europe had essentially 2 systems, with landowners having the hunting rights in Western Europe and governments managing hunting in the communistic Eastern Europe. Hunting remained open to all citizens of Portugal, Italy, Greece, and Turkey (Myrberget 1990). Since the fall of communism, countries of Eastern Europe have been in flux about whether to revert to the former system of landowners owning hunting rights, as Hungary has, or to retain state control over wildlife management, independent of land ownership, as has Poland, Slovakia, Ukraine, and Romania (Csányi 1997, Salvatori et al. 2002).

North America

In North America, prior to European colonization, the American Indian tribes claimed rights to wildlife by protecting hunting and fishing territories (Carlos and Lewis 1995). "The ownership of game among Native Americans had an uncanny resemblance to current United States institutions. Indian tribal societies, like state agencies, controlled wildlife stocks by enforcing the rights to hunting and fishing territories and restricting the time and method of harvest by tribal members." (Lueck 1995:3).

American game laws are rooted in the past history of English common law. However, today's American and English wildlife laws are markedly different. In the United States, ownership of wildlife resides with the people and is administered on their behalf by government, primarily the state governments. In Great Britain, the law

places nearly all control in the hands of private landowners. In Canada, wildlife is managed by the Provincial Governments on behalf of the people similar to the United States, but ownership is vested in the Crown until the wildlife is legally killed. At this point property rights transfer to the hunter. The states and provinces have retained control over most wildlife management, but they have lost some authority to the federal governments with international treaties (e.g., the Migratory Bird Treaty Act and Marine Mammal Protection Act) and, in the United States, with the Lacey Act (controls interstate transportation of game) and the Endangered Species Act. But the states and provinces have vigorously fought to retain the authority to manage wildlife (Peek 1986).

CONFLICTS SURROUNDING PREDATOR CONTROL TO IMPROVE HARVEST OF WILD UNGULATES

In his classic book "Game Management," Leopold (1933:3) defined game management as "the art of making land produce sustained annual crops of wildlife for recreational use." This definition espoused a utilitarian philosophy of game management that established the direction of wildlife management for the next half century. Wildlife agencies "managed" game populations for a "sustained yield." Their primary clients were the hunting public, and up until the 1970s virtually all state and provincial wildlife agencies operated primarily under the principle of sustained use. Most universities that trained students in the field of wildlife management were Land Grant or Agricultural colleges with a focus on production and emphasized sustainable yield concepts.

Peek (1986:25), discussed 2 groups of conservationists as defined by Harry et al. (1969): those with a conservation-utilization emphasis, and those with a conservation-

preservation emphasis. Both groups were concerned with the perpetuation of natural resources and therefore could be classed as conservationists. However, people with a utilization emphasis were oriented toward the goal of resource exploitation, such as hunting, with aims of producing sustained yields by cropping surpluses. "Wise use" was the doctrine of those with conservation-utilization emphasis and their philosophy was adopted by most wildlife and natural resource management agencies. This was encouraged by the importance of fees paid by hunters that were vital to management activities including the salaries of the managers. Conservationist-preservationists, by contrast, were not oriented towards "wise use" but rather espoused an appreciative interest in the resource, preferably in its "natural state" (Harry et al. 1969). State wildlife agencies were slow to acknowledge this doctrine in part, perhaps, because there was no mechanism for conservation-preservationists to regularly support wildlife management efforts with their fees.

The conservationist-preservationist movement in North America greatly increased in influence in the early 1970s and became a major part of the biopolitical scene during the 1980s. It was largely responsible for broadening activities of wildlife and land management agencies in nongame management and has evolved into what is termed environmentalism (Peek 1986). Conservation-preservationists were and still are largely responsible for challenging predator control programs.

Alaska has carried out a program of wolf control with the specific goal of increasing ungulate populations for hunters during the same period that conservation and enhancement programs were underway elsewhere in the United States. The history of predator control in Alaska provides a good example of the conflicts between the

wise use and the conservation-preservation groups. During the decade of the 1980s, controversy grew around the state's wolf control programs (Stephenson et al. 1995), and environmental groups filed several court cases against the states in an attempt to stop wolf control. These conflicts reached a peak in the early 1990s. By 1994, the governor of Alaska suspended the state's wolf control program because it was judged to be an unacceptable treatment of wolves (NRC 1997). The governor called for a scientific review and indicated that he would not reinstate predator control unless it met 3 criteria: (1) it was based on solid science; (2) a full cost-benefit analysis showed it made economic sense for Alaskans; and (3) it had broad public support. Similar confrontations over wolf control programs have also occurred in Canada (Hayes and Gunson 1995).

Alaska began efforts to reduce grizzly bears in some areas in 1980 in response to indications that moose numbers in certain areas were being maintained at chronically low levels by bear predation on neonates. Moose numbers declined in the 1970s as a consequence of a series of severe winters and overharvest by hunters, in addition to significant predation on moose calves by bears (Ballard et al. 1981). Unlike efforts to control wolves, grizzly bear control efforts in selected areas were done by liberalization of hunting regulations instead of by trapping and shooting by state employees. Bear reductions started in 1980 and ultimately included elimination of requirements that residents buy a special tag to hunt bears and generous bag limits that allowed hunters to take bears more frequently in targeted areas than elsewhere in Alaska. Moose numbers increased during the 1980s and 1990s but calf survival remained low. Available evidence indicated that increases in moose numbers were unrelated to the increased bear harvests (Miller and Ballard

1992).

Efforts are ongoing in targeted areas of Alaska to reduce bear numbers in order to provide more moose for hunters. Unlike efforts to reduce wolf abundance to accomplish the same objective, bear reduction efforts have generated less controversy, perhaps because control efforts are done gradually by legal sport hunters instead of by government agents using trapping and aerial gunning techniques. Also, unlike the government sponsored control efforts in the United States south of Canada in the early 20th century, bear reduction by hunters has not yet resulted in measurable declines in bear density in the portions of Alaska where it is ongoing, although it has caused changes in population composition (Miller 1997).

Control of wolves to enhance hunting opportunity is supported by 48% of Alaskan voters and by 65% of Alaskan hunters (Miller et al. 1998). The most vehement opposition to wolf control efforts comes from conservation groups outside of Alaska, but these groups have been effective at stopping or curtailing active wolf reduction programs. It is possible that the general public may be more amenable to reductions in bear abundance than to reductions in wolf abundance because, unlike wolves, bears occasionally attack humans, resulting in a fear of bears in a significant proportion of the population. A survey of Alaska voters indicated that 34% had concerns about bears that sometimes kept them from going into the countryside (Miller et al. 1998).

Similar to the grizzly bear case in Alaska, black bears (*Ursus americanus*) and mountain lions (*Puma concolor*) were thought to be reducing recruitment of elk (*Cervus elaphus*) in the Clearwater area of central Idaho. In 2000, a research program was proposed to evaluate the biology of this relationship through predator reduction efforts accomplished by liberalized hunting regulations as well as control by govern-

ment officials. Predator advocacy groups organized a national campaign against the proposed research similar to that conducted against the wolf reduction effort in Alaska. Idaho officials modified their research proposal to accomplish targeted reductions using only liberalized regulations for hunting of predators. Subsequently, objections to the research have largely dissipated even though the liberalized hunting regulations have been expanded beyond the boundaries of the originally proposed research area. Difficulties in convincingly documenting trends in black bear and mountain lion abundance are likely to confound interpretation of any changes in elk recruitment or abundance found in the Idaho study.

We know of no case of planned reduction in bear densities in Europe to increase ungulate numbers. The European brown bear is much less aggressive towards humans than the North American brown/grizzly bear (Swenson et al. 1996), which may also influence people's attitudes. The persecution of wolves in recent times has been justified partially by the reduction of predation on ungulates in some areas. Nevertheless, we are unaware of any case where this was the primary justification, as reductions of livestock losses seem to be the primary objective (Promberger and Schröder 1993). We expected that planned reductions of these predators would have occurred in the countries where landowners own the economic rights to hunting. However, in such countries, bears seem to be popular enough for hunting in their own right that owners of the hunting rights accept this tradeoff. No country with this system has a huntable population of wolves, which might not be a coincidence. However, wolves recently have been established in Norway and Sweden, where this system exists. In Norway, the state pays compensation for the loss of hunting income due to wolf predation, but it is a country where conflicts surrounding

depredation on free-grazing sheep are very intense. In Sweden, where there are almost no free-grazing sheep, large forest companies are contributing to the funding of wolf research because they want to know if wolves can help reduce forest damage caused by high moose densities.

STUDIES OF PREDATOR-PREY RELATIONSHIPS

Ballard and Larsen (1987), Van Ballenberghe (1987), Boutin (1992), NRC (1997), and Ballard and Van Ballenberghe (1998) all provide thorough reviews of the recent studies of predator-prey dynamics of moose in North America; only 1 intensive study has been conducted in Europe (Swenson et al. 2001). Wolves, brown bears, and American black bears are the principal predators of moose. There is general agreement that predation is a limiting factor for moose populations, but there is controversy regarding the magnitude of this limitation and if the evidence supports the hypothesis that predation regulates moose numbers (Boutin 1992). Many of the predator-prey studies dealing with carnivore- (wolves and bears) moose relationships were not designed to answer specific questions about the impacts of predator control on moose demographics. Additionally, the full impact of wolf predation and wolf control on moose demographics has received considerably more attention than similar impacts from bears. Few studies detail the influences of both bear and wolf predation on moose in the same system at the same time (Table 1). Even fewer studies have been conducted long enough to determine the long-term impacts of predator control on moose population dynamics. In a review of predator control in Alaska, the NRC (1997) came to 3 conclusions: (1) predator control experiments provide only negative evidence for the existence of an alternative stable state with relatively high

numbers of both predators and prey. Only 2 studies were monitored long enough to reveal the existence of such a state, and the evidence from those studies was negative or equivocal. Existing evidence suggests that if predator control is to be used as a tool to increase ungulate populations, control must be both intensive and relatively frequent. There is no factual basis for the assumption that a period of intensive control for a few years can result in long-term changes in ungulate population densities; (2) experiments that resulted in increases in moose populations were conducted where wolves were relatively numerous, where bears were relatively uncommon and were not preying heavily on ungulate calves, where habitat quality was high, and weather was relatively benign. The evidence is inconclusive, but there is reason to believe that an intensive control effort, during which wolf populations are greatly reduced for several years and other factors are favorable, can result in short-term increases in moose populations; and (3) control experiments that appeared to have had some success used methods, such as aerial shooting, that are not currently politically acceptable.

During the 1970s and early 1980s, wolf removal had strong support among management agencies in Alaska and the Yukon as a means of increasing moose densities (Gasaway et al. 1983, Ballard and Larsen 1987). However, some wolf control experiments met with limited success, and telemetry studies during the same period (Franzmann et al. 1980, Ballard et al. 1981, Franzmann and Schwartz 1986, Boertje et al. 1988, Ballard and Miller 1990) implicated bears as a limiting factor in calf survival. Consequently, emphasis shifted toward both wolf and bear control programs, yet there was little empirical data to support bear control as a long-term management tool to increase moose numbers (Table 1). Current science allows manag-

Table 1. Predator reduction experiments (from NRC 1997).

Method and location	Predator reduction		Results
	Wolves	Bears	
Air-assisted East-central AK (GMU20A)	Wolf population reduced to 55-80% below pre-control numbers for 7 yrs (1976-82).	Not done	Average annual rate of increase of moose populations was 15% during wolf control, and 5% for 12 yrs after the end of wolf control. Average annual rate of increase of caribou populations was 16% during, and 6% for 7 yrs after the end of wolf control.
Finlayson, Yukon	49-85% of wolf population removed for 6 yrs (1983-89); human harvest rate of moose and caribou reduced by 90%.	Not done	Increased survival of adult caribou; increased numbers of calves/100 cows for both moose and caribou. Average annual rate of increase for moose and caribou about 16-18%. Hunting success increased. Seven years after wolf control ended, moose and caribou numbers began to decline. No substantial increase in moose populations or cow:calf ratios during predator removal.
Southwest Yukon	Wolf numbers reduced by 40-80% for 5 years (Rose Lake; 1982-87).	Bear population reduction estimated at 7-9% (1982-87).	No substantial increase in moose populations or cow:calf ratios during predator removal.
Aishihik, Yukon	Approximately 76% of wolf populations removed over 4 yrs (1993-96). Moose and caribou hunting curtailed.	Not done	Increased numbers of caribou calves/100 cows. Response of moose highly variable and not clearly related to wolf reduction. Control ended in 1996, too recently to assess long-term trends.
Northern BC	1,000 wolves removed in 10 years (1978-87); almost 800 of which were removed in the last 4 yrs of removal.	Not done	Calf survival rates and population sizes apparently increased for all ungulates in the area. When wolf control ended, wolf numbers increased rapidly and calf survival decreased to pre-control levels.
Québec	Wolf population reduced to 48-62% over 4 years (1982-85).	A total of 81 bears removed over a 3 yr period in a different area (1983-1985).	No apparent change in moose calf survival rate in either wolf or bear removal area.

Table 1. continued.

Method and location	Predator reduction		Results
	Wolves	Bears	
East-central AK (GMU20E)	Wolf population was reduced by 28-58% for 3 yrs (1981-84).	Not done	Wolf control had no measurable effect on calf survival.
South-central AK (GMU13)	Extensive aerial shooting and poisoning reduced wolf numbers dramatically (1948-1954).	Poisoning probably also reduced bear numbers.	During and after this predator reduction period, caribou numbers increased and had more than doubled by the early 1960s. This coincided with favorable weather and range conditions and low harvest by humans.
	Wolves were reduced by 42-58% for 3 yrs (1976-78).	After wolf control ended, 60% of the bear population was trans-located or reduced by liberalized hunting regulations.	Wolf control did not result in high annual increases in the moose population. Calf survival increased after bear removal, but bears returned to the area after summer and moose calf survival returned to levels before bear removal. No change in calf numbers could be attributed to increased bear harvests.
Ground-based Kenai Peninsula, AK	Recreational harvests increased for 4 yrs (1976-79).		Wolf reductions were associated with increased moose populations, but the highest number of moose occurred in areas that had burned 10-25 years earlier regardless of the extent of wolf reductions.
Vancouver Island, BC	Wolf density was reduced over a 4-yr period (1983-86) to about 10% of pre-control levels.	Not done	Deer populations increased following wolf control. Hunter effort appeared to be enhanced by wolf control.
Saskatchewan	Not done	Unknown proportion of black bear population was removed in spring of 1983, and from another area in spring of 1984.	Increased calf:cow ratios after bear removal. The following year, proportion of yearlings in the moose population was higher than before predator control.

ers to predict with reasonable confidence that predator removal at low moose densities can improve calf survival, but increased recruitment and subsequent growth of the moose population may or may not occur. Data are generally unavailable on long-term effects of predator reduction.

**TIMES CHANGE: FROM
PREDATOR EXTERMINATION TO
PREDATOR CONSERVATION**

Europe

Because of the degradation of forests and loss of indigenous large herbivores, the attitudes of Europeans towards the environment were changing by the end of the 1800s. In Switzerland, laws requiring reforestation, banning livestock from forests, restricting hunting, and establishing game sanctuaries were passed in 1876 (Breitenmoser 1998). Similar laws, and an increase in effort to reintroduce ungulates into former habitats, occurred throughout Europe. The first modern law regulating hunting and protection of game in Norway was passed in 1845 (Søilen 1995). The Swedish Hunter's Association, the Norwegian Association of Hunters and Anglers, and the Swiss League for the Protection of Nature were founded in 1830, 1877, and 1909, respectively. During this same time period when forests and ungulate populations were increasing, human numbers were declining in rural areas as people migrated to industrial cities or emigrated to North America. As a consequence, numbers of livestock also declined (Breitenmoser 1998). Efforts to increase ungulate populations have been spectacular, and at present, many European countries have high densities. For example, in the mid-1980s, nearly 250,000 moose were harvested annually in the Nordic countries, compared with about 72,000 in all of North America (Haagenrud et al. 1987, Kelsall 1987). Most of these great increases occurred in the absence of large

carnivores. Today, forest damage caused by abundant ungulates is a widespread problem in Europe (Bergström et al. 1993, Breitenmoser 1998) and this over-browsing has reduced the biodiversity of plants and invertebrates (Suominen et al. 1999).

During this period, steps were taken in several countries to save the remaining brown bears. In Sweden, for example, official requests to remove the bounty on bears were made in 1889 and 1891, the second by a chapter of the Swedish Hunter's Association. Parliament approved these requests in 1893 (Lönnberg 1929). In 1905 the Royal Swedish Academy of Sciences issued a statement saying, "it is a matter of honor for our country that this interesting animal be protected from complete extermination." Several measures were taken to protect bears, including complete protection in national parks, which were first established in 1910. This effort was successful, and hunting was reintroduced in 1943 (Swenson et al. 1995). Brown bears received protection in Poland in 1932 and in Italy in 1939 (1992 in the Abruzzo area). But, the bear received protection much later in other countries: 1955 in France, 1967 in Spain, and 1972 in Norway (Servheen et al. 1999). Efforts to save and increase bear populations in Europe have been successful in many areas, and there are now about 50,000 brown bears in Europe (ca. 14,000 outside of Russia) with increasing and expanding, or at least stable, populations found in Northeastern Europe, the Carpathian Region, the Dinaric Mountain Range in former Yugoslavia, and Scandinavia (Zedrosser et al. 2001). In many instances, bears are returning to countries that exterminated them because of successful conservation efforts in neighboring countries. In addition, the population has been increasing in most of Russia, with the greatest increase in the European part (Chestin et al. 1992). However, 8 of the 12

European populations are less than 500 bears and are decreasing. Efforts to save the brown bear have concentrated on protection, and the species is protected or is a game animal in all of Europe (Zedrosser et al. 2001). Additionally, 2 reintroductions have been attempted, and 2 populations have been augmented. The first reintroduction attempt in the world was in Poland in 1938-44 and was unsuccessful. A second occurred in the central Pyrenees of France in 1996-97. Augmentations have occurred in Austria in 1989-93 and an ongoing project in Italy that started in 1999.

Brown bears are an important and prized big game animal in many countries. This is probably why Swedish hunters worked actively for the species' protection in the 1800s. It is also an important game species in many Eastern European countries (Salvatori et al. 2002). Zedrosser et al. (2001) concluded that communism in Eastern Europe was not nearly as destructive to bear populations as the political systems in Western Europe, possibly because bears were managed for hunting by a few hunters, including foreign hunters with convertible currency, and because gun ownership was strictly limited. The extreme consequence of this was the situation in Romania, where the dictator Nicolae Ceausescu allowed the bear population to increase to the highest densities in Europe to provide hunting opportunities, such as shooting 24 bears in one hunt, and trophies for himself only (Crisan 1994). Romania is the only European country that has decided to reduce its brown bear population, from 8,000 to 6,000 by hunting, in order to reduce loss of human life and livestock losses (Servheen et al. 1999, Swenson et al. 2000).

The situation for the wolf is quite different, even though some Russian scientists began writing about the importance of the wolf's place in nature at the end of the 19th and beginning of the 20th centuries (Bibikow

1990). Protection came much later: 1966 in Sweden, 1973 in Norway, 1976 in Italy, 1993 in France, and 1995 in Croatia and Greece (Promberger and Schröder 1993, Boitani 2000). It is fully protected in 11 of 27 European countries and has no protection at all in 9 countries. The total European population outside of Russia is estimated to be over 18,000, but only 6 countries have more than 1,000 wolves, 11 have more than 500, and 8 have less than 50 (Boitani 2000). Wolves are increasing in many European countries and, like bears, are expanding into countries where they were formerly extirpated. In the Soviet Union, wolves were managed by zones, with extermination in intensive agricultural and reindeer (*Rangifer tarandus*) husbandry areas, controlled at low density in areas with fewer people and agriculture, management as a hunted species in the largest zone, and complete protection in reserves (Bibikow 1990).

We know of no efforts to reestablish wolves in Europe by reintroductions. However, in addition to the reintroductions and augmentations of bear populations, lynx have been reintroduced into many parts of Europe, and more are planned (Breitenmoser et al. 2000).

Both the brown bear and the wolf are protected and managed according to national legislation. In addition, most European countries are signatories of the Bern Convention, undoubtedly the most important agreement protecting large carnivores in Europe. The Bern Convention was ratified on 19 September 1979 in Bern, Switzerland. Its goal is to preserve wild animal species and their natural habitats. Member countries must pay special attention to endangered, and potentially endangered, species listed in different appendices, each representing a different stage of endangerment. The brown bear and wolf are listed in Appendix II (strictly protected fauna species) requiring that actions must be taken

to protect them; forbidden are the capture or killing; wilful disturbance, and possession and trade. In addition, the recolonization of indigenous species must be promoted if doing so will enhance the likelihood of preservation. Member countries can make reservations to the Bern Convention regarding means or methods of killing, capture, or other exploitation of listed species. Seven countries have made reservations regarding protection of the brown bear (Bulgaria, Czech Republic, Finland, Slovenia, Slovakia, Ukraine, and Turkey) and 10 regarding the wolf (Bulgaria, Czech Republic, Finland, Latvia, Lithuania, Poland, Slovenia, Slovakia, Spain, and Turkey) (Boitani 2000, Swenson et al. 2000).

In addition, Council Directive 92/43/EEC, Conservation of Natural and Wild Fauna and Flora (ABL L 206, 22.07.1992), binds member states of the European Union (EU). The main goal of the so-called Flora-Fauna-Habitat Directive is to secure species diversity by protection of habitats and protection of wild flora and fauna. Actions must be taken by member countries to preserve all species and their habitats. The brown bear is a priority species of the EU. It is listed in Appendix II (species needing specially protected areas, except the populations in Finland and Sweden) and Appendix IV (strictly protected species; capture, killing, and wilful disturbance not permitted). Possession, transport, and trade of Appendix IV species are strictly prohibited. The wolf is listed in Appendix II and IV (in both cases except for some populations in Spain, Greece, and Finland). Exemptions are given when it can be established that there is no negative impact to species preservation, to prevent serious damage to culture and livestock, for public health, sanitary, and safety reasons, and for scientific, restocking, and re-colonization purposes.

The European Parliament requests that

members of the EU consider their resolutions, although they are not legally binding. Those relevant to large carnivores are: (1) European Parliament Resolution, 24 January 1989 (A2-0377/88, Ser. A), which calls for immediate steps to favor wolf conservation in all European countries, adopts the International Union for Conservation of Nature Wolf Manifesto, and invites the European Commission to expand and provide financial means to support wolf conservation; (2) European Parliament Resolution, 17 February 1989 (A2-339/88, ABL C 69/201, 20.3.1989), which states that the European Commission should promote or continue programs to protect the brown bear in the EU. Actions for socio-economic development should be promoted in return for communities with protective measures for the brown bear. Systems for bear damage prevention and damage compensation should be developed. A network of connected reserves and specially protected areas should be established (called the "NATURA 2000 Network"); and (3) European Parliament Resolution, 22 April 1994 (A2-0154/94, ABL C 128/427, 09.05.1994), which states that the European Commission should not support and finance development that would have a negative effect on bear populations. Protected areas and corridors for genetic exchange should be established to correct actions that have had negative impact on bear populations. Measures to prevent the killing and capture of bears and protect bear habitat should be undertaken. Financial support for damage compensation, and compensation for economic restrictions due to bear conservation, should be provided.

North America

Wolves and grizzly bears were among the first species to be protected under the Endangered Species Act (ESA) in the United States, signed in 1973. Wolves were listed

as endangered in 1974 and grizzly bears as threatened in 1975. The ESA is probably the most significant law in any nation designed to preserve and maintain biodiversity. The ESA establishes that preservation of animal and plant species is a national priority that takes precedence over local interests in wildlife management, over economic interests, and even over certain rights of owners of private property (Czech and Krausman 2001). Although the intent of the ESA to apply to private lands is clear, the legal basis for this remains controversial and unresolved to some degree (Sax 2001). Distinct population segments can be listed under the ESA for species like wolves and bears that are reduced in significant proportions of their former range but remain abundant elsewhere (e.g., wolves and grizzly bears are not listed in Alaska, only south of Canada). This national priority for species recovery mandated by the ESA has worked well in the United States to recover large predators, like wolves and grizzly bears, which sometimes conflict, or are thought to conflict, with local economic or hunter interests. The ESA was amended in 1982, to include Section 10(j) designed to reduce landowner opposition to restoration of controversial species, like wolves and bears, to portions of their former range from which they were extirpated. This is accomplished by designating such reintroduced populations as “experimental”. Populations restored as “experimental” are permitted more management flexibility on issues such as taking of nuisance individuals, permitting multiple uses of habitat, and reducing the requirement for federal review of land management and use activities (such as logging) that could adversely affect the species in experimental populations. This “experimental” provision was successfully used to restore wolves in Yellowstone National Park and central Idaho. It was also the key to the reintroduction of red wolves (*Canis rufus*)

to the southeast and of Mexican wolves (*C. l. baileyi*) to the southwest of the United States. So far, however, Section 10(j) provisions have been inadequate to accomplish grizzly bear restoration in the wilderness areas of central Idaho, which, even with this management flexibility, was opposed by key politicians in Idaho. This opposition was based largely on misguided concerns over the level of physical danger grizzly bears posed to humans; a reprise of misconceptions that existed a century ago.

A number of programs began in the 1990s, directed at long-term conservation and enhancement of large carnivores. Much of this activity in North America was directed at areas where both wolves and bears had either been extirpated by early colonization or significantly reduced and declared threatened or endangered under the ESA. Wolves were reintroduced into the Yellowstone Ecosystem and to central Idaho in 1995 and have recovered through improved management and natural dispersal in the Midwest (Minnesota, Wisconsin, Michigan). In both places, recovery goals in terms of population number have been achieved and proposals are pending to downlist and, ultimately, delist the species. Thanks to the emphasis placed on the species under the ESA, grizzly bear populations have also increased in the Yellowstone and Northern Continental Divide Ecosystems and proposals to delist the species in and around Yellowstone National Park are expected as numerical population objectives have been achieved.

In much of North America, there appears to be widespread recognition of the value of restoring healthy populations of predators like wolves and grizzly bears (Duda et al. 1998, 2001). However, these attitudes are not universal and some states, notably Idaho and Alaska, retain strong sentiments against predators in favor of aggressive predator management designed to reduce

or eliminate depredations on livestock and the wild ungulates favored by hunting interests. These attitudes mirror the anti-predator attitudes that resulted in the near extirpation of predators in the previous century. Such local opposition from political leaders has, temporarily, blocked efforts to restore grizzly bears to the Bitterroot Ecosystem in central Idaho. The 14,800-km² reintroduction area is designated wilderness and represents the best and largest place to restore a significant new population of grizzly bears in North America. The reintroduction proposal provided an unprecedented level of local participation and experimental designation of the restored grizzly population (Fischer and Roy 1998, USFWS 2000, Schoen and Miller 2002). It received widespread national and local support from the public (Duda et al. 1998, Roy 2001) and from all professional wildlife management groups who commented. We believe it is likely that public support will ultimately result in grizzly bears being restored to this habitat. Restoration and recovery for controversial and environmentally sensitive species like grizzly bears requires a collaborative approach to build popular support (Servheen 1998). However, as the Idaho Bitterroot example demonstrates, even such approaches are sometimes insufficient to achieve success because of local negative attitudes about bears.

CHANGING SOCIAL VALUES

Wildlife management evolved originally as a means to assure continuation of hunting opportunities. Frequently, attitudes of wildlife managers as well as of hunters reflect these origins and result in policies, such as predator control, that conflict with the concerns and preferences of the general public over the conservation of predators. The changes in official attitudes towards large carnivores, from policies of extermination, to those of conservation and enhancement,

reflect changes in the attitudes of the general populace (Duda et al. 1998, 2001). Obviously, conflict will arise if the managing authorities are seen to be out-of-step with the prevailing public attitudes. One example of this was the liberalization of black bear hunting regulations, including spring hunting, hunting with hounds, and baiting, in Colorado. Citizens objected to these regulations based on concerns they were inhumane, but an intransigent bureaucracy failed to respond. The result was an overwhelmingly approved citizens' initiative that set aside these regulations (Beck and Gill 1995, Beck et al. 1995). Similar initiatives passed in Oregon (Boulay et al. 1999) and, for mountain lions, in California. In Alaska, voters approved a citizens' initiative that overturned a regulation that allowed persons to take wolves by landing aircraft and shooting them. In British Columbia, opponents of hunting grizzly bears succeeded in getting a moratorium on grizzly bear hunting implemented in 2001. The moratorium on hunting has since been lifted but it is clear that citizens threaten the continuation of grizzly bear hunting with conservation-preservationist attitudes toward bears.

Citizens' initiatives are not practiced in European countries, but there is an obvious trend towards more protection of large carnivores. Also, the killing of a few wolves by State employees shooting them from a helicopter in Norway in winter 2000-2001 resulted in enormous European media coverage and negative public reactions from other parts of Europe. Some in Europe are questioning the wisdom of the high densities of ungulates, which cause traffic accidents, forest damage, and reductions in forest biodiversity.

These examples, and those provided earlier about opposition to predator control programs in Alaska, illustrate aspects of a trend that sociologists have been observing;

that utilitarian attitudes towards wildlife are declining in Western cultures (Decker et al. 1992, 2001). A recent metaanalysis (Williams et al. 2002) of 38 studies about people's attitudes towards wolves showed that people were generally positive to wolves (61%), that age, residence, occupation, education, and income influenced one's attitude, and that about one-fourth of the people are neutral. The analysis also found that wolves are less popular in Europe than in North America, as is also suggested by our review, based on levels and dates of protection. In Europe, this may be influenced by a historical fear of wolves as a carrier of rabies that dates back to the Middle Ages (Bibikow 1990), or a fear of the wolf as a potential killer of humans, which has more historical support from Europe than North America (Linnell et al. 2002). Also, attitudes towards wolves vary within Europe (Boitani 1995), even in adjacent areas, as Norwegians have more negative attitudes towards wolves than Swedes (Bjerke et al. 2001).

Wolf biologists working in Scandinavia have reported the impression of an increased support for wolves, although they could not substantiate it (Wabakken et al. 2001). However, the metaanalysis, which covered studies from the period 1972–2000, did not find any trend in support for wolves. Williams et al. (2002) predicted increasing support for wolves over time due to increasing education and urbanization, but stressed that positive attitudes towards wolves in the general public are often weak and have the potential to shift rapidly if linked to other stronger attitudes.

SUMMARY

Human attitudes toward large carnivores have been shaped by centuries of coexistence. These attitudes have changed markedly as human civilizations matured and industrialized. Early peoples lacked the

appropriate weapons to effectively control large predators. These cultures adapted ways to live with carnivores. As man acquired modern weapons, large predators and native ungulates were exterminated. We witnessed this first in Europe where modern civilization first developed. However a second wave of extermination followed with the European colonization of North America. Old World values were transported to the New World. In North America, attitudes of predator control were also adopted as part of the evolving profession of wildlife management, where large carnivores were still abundant in northern environments. Carnivores were perceived as competitive and a threat to ungulates harvested by hunters.

Through history, human values toward large carnivores seem to be inversely proportional to carnivore abundance. Society tends to value them more when they become rare or endangered. Because predators were largely eliminated or reduced to remnant population in Europe, social attitudes away from extermination and towards protection evolved more quickly. These attitudinal shifts are reflected in the recolonization of carnivores back into historic habitats. Many citizens and scientists view this reoccupation as a valuable contribution to society and ecological processes. A similar transition has come more slowly to North America and even today there is an apparent inability by some members of the public and some wildlife managers to engender the changing social dimension that values predators in a broader context of ecosystem function, rather than an impediment to ungulate management for the hunting public.

Agencies in North America responsible for the management of ungulates and carnivores are currently faced with conflicting values and differing demands. If we can use information about the wolf as a guide, it

is possible to make some general conclusions. On the one hand, old values prevail with a continued emphasis on predator control. However, there appears to be a gradual shift toward carnivore conservation, especially among the more highly educated, urban, youth (Williams et al. 2002). Extrapolation of these results into the future suggest that there will likely be a gradual shift away from negative attitudes toward more positive attitudes as the older population is replaced (Williams et al. 2002). Game management agencies will need to shift toward a more modern construct that recognizes the intrinsic value of wild ecosystems and the wildlife they contain, including large predators. Today's biologists and moose managers face a difficult challenge of balancing biological principles with a diverse array of social and economic values often in conflict with principles of optimum or maximum sustained yield harvest.

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