

Managing Predator-Prey Systems: Summary Discussion

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Introduction

Managing predator-prey systems involves complex challenges for resource managers. Inherently dynamic population fluctuations, multi-species interactions, and trophic cascades make it difficult to anticipate the outcome of wildlife management activities and decisions. When combined with the economic-socio-political dimensions of predator control, identifying optimal management policies can frustrate the most-seasoned wildlife biologist.

We have enlisted a diversity of case studies and perspectives for this workshop spanning a spectrum of issues concerning wildlife managers attempting to manage both predator and prey. Wildlife managers are increasingly being challenged to accommodate a broader perspective of ecosystem management (Boyce and Haney 1997). Many studies have demonstrated population consequences of predators on prey populations, but how managers should use this information is not easy to decide. Predator control can be effective at enhancing survival and recruitment in populations of prey, but certain methods for

controlling predators sometimes meet with fierce resistance from the public. Society demands that wildlife managers take a broader perspective on predator management than focusing solely on enhancing populations of those species preferred for hunting.

Accommodations can be made to allow predators to coexist with humans. In some instances this might entail reduced or altered hunting yields for prey species (Nilsen et al. 2005), and compensation for livestock raisers. Still, predators are appreciated in their own right (Weiss et al. 2007), and can offer opportunities for hunters and trappers to become part of the solution (Hammill 2007).

Ecosystem role of predators

Conservation focused at top predators can be justified ecologically because of the benefits to biodiversity (Sergio et al. 2005, 2006). The potential role of predators in structuring ecological communities has been recognized for some time (Errington 1967). For example, overexploitation of sea otter (*Enhydra lutris*) populations resulted in increases in sea urchins that subsequently destroyed kelp beds that provided habitats for fish and other marine organisms (Estes et al. 1998). Because of such complexity of food webs in ecological communities, it is difficult to anticipate the full ramifications of eliminating or restoring predators. For example, reducing predator numbers to increase abundance of prey can have counter-productive results such as increasing disease and parasite infections in prey (Packer et al. 2003).

Predators appear to have top-down influences in many ecological communities, resulting in trophic cascades, i.e., predators reduce herbivore abundance releasing vegetation (Terborgh et al. 2006). Several studies have documented trophic cascades associated with wolf

(Canis lupus) recovery in Yellowstone National Park, meaning that wolves have changed the distribution of habitats used by elk (Cervus elaphus), which has released aspen (Populus tremuloides; Ripple and Beschta 2004) and willow (Salix spp.; Beyer et al. 2007) from herbivory (Fortin et al. 2005). Subsequent increases in aspen and willow have provided habitats for a diversity of other species including songbirds and beavers (Castor canadensis), thus wolves influence many levels of the ecosystem (Hebblewhite 2007). Likewise, human activity associated with tourism has displaced cougars (Puma concolor) in portions of Zion National Park resulting in concentrations of mule deer (Odocoileus hemionus) that suppress vegetation, i.e., a trophic cascade (Ripple and Beschta 2006). Maintaining top-level predators is viewed to be an essential component of maintaining natural ecological processes in national parks (Boyce 1998).

Conflicts with predators

Although society recognizes values associated with maintaining predators (Weiss et al. 2007), there are many circumstances when predators can come in conflict with human interests. For as long as humans have maintained domestic animals we have had conflicts with large predators that kill livestock. Public reaction is often intense when predators kill pets, and cougar and wolf predation on dogs is relatively common and apparently increasing (Treves et al. 2002; Beck et al. 2005). Likewise, humans themselves are occasionally killed by large carnivores, triggering fear and resentment towards offending animals (Packer and Kissui 2007).

Mesocarnivores, including red fox (Vulpes vulpes), raccoon (Procyon lotor), striped skunks (Mephitis mephitis), and coyotes (Canis latrans), can have substantial consequences to waterfowl nesting

success (Rohwer and Fisher 2007), and likewise have been shown to suppress populations of bobwhite (Colinus virginianus; Carroll et al. 2007) and ring-necked pheasants (Phasianus colchicus; Hollevoet and Dixon 2007). Predator control has been practiced by game keepers in Europe for many decades (Redpath et al. 2004), and is increasingly used to support gamebird production in North America (Rohwer and Fischer 2007).

With expansion of cougar and wolf populations in North America during the past decade, wildlife managers are faced with a new dimension in trying to manage big game populations in the face of predation levels that did not exist in previous decades. In Alaska and Canada, managing ungulate populations in the face of wolf predation has been a continuing source of debate and controversy (National Research Council 1997). Wolf control is used to reduce predation on moose (Alces alces) in Alaska and the Yukon (Hayes et al. 2003; Titus 2007). Cougars and bears can be a substantial source of mortality on ungulate populations (Munro et al. 2006; Harris 2007; Knopff and Boyce 2007), but these species are less often targeted for predator control.

Lethal predator control often attempts to target offending individuals. This is particularly well justified in the case of cougars because of the high levels of prey specialization that have been documented among individuals of this species (Knopff and Boyce 2007).

Methods used for managing predators, and associated public perception, are a crucial consideration in developing effective systems of management for predators and prey. Wolf control by aerial gunning, poisoning, or killing pups at the den meets strong public opposition. Even though the great majority of wolves killed by humans in Alaska

are taken by hunting and trapping, it is the relatively few wolves killed by aerial gunning of wolves that evokes such bitter controversy over wolf control programs (National Research Council 1997).

Predators can sometimes be a serious threat to species at risk of extinction. For example, control of exotic red fox has been used to increase reproductive success and survival of greater sage-grouse (Centrocercus urophasianus) in Utah (Baxter et al. 2007), and California clapper rails (Rallus longirostris obsoletus) in California (Harding et al. 2004). Predator control can be a crucial element in protecting threatened or endangered species. Wolf control is being practiced in Alberta to protect dwindling populations of woodland caribou (Rangifer tarandus tarandus). And cougar culling is used to protect endangered populations of desert bighorns (Ovis canadensis) in New Mexico (Rominger 2007).

Coexisting with predators

Managing game populations for hunter harvest becomes more complex when predators are competing with humans for the same prey. Adjustments to harvest regimes may be necessary, but certainly we can have sustainable harvest of populations under predation (Nilsen et al. 2005). Elk on the northern range of Yellowstone National Park are harvested by hunters when they move into Montana during winter. The sustainability of this harvest is ensured because the Montana Department of Fish, Wildlife and Parks has density-dependent harvest guidelines so that the number of tags issued for the late-Gardiner elk hunt increases with the number of elk censused on the northern range (Varley and Boyce 2006). This helps to balance the hunter harvest with wolf predation ensuring that the elk population is not driven to low levels by excessive hunter harvest. Models have been developed that permit harvest guidelines while accommodating predators (Nilsen et al.

2005; Varley and Boyce 2006) and these can be used to achieve sustainable yields. Clearly, however, application of such models will require data on ungulate herds and predator populations.

We believe that predator management requires ecosystem management and this must include careful consideration of habitats as well as the particular predator and prey populations (Boyce and Haney 1997). Hollevoet and Dixon (2007) provided a conceptual framework whereby predators are managed in a manner similar to their prey. Management and population goals are determined and a potential suite of management activities are implemented based on desired outcomes. Management actions include adjusting season length and bag limits for hunters and trappers, but must also include other activities such as management of habitats that provide secure areas for prey. Ecosystem management acknowledges the value of predators in the environment and may reduce the need to engage more Draconian management activities.

Conclusions

Lethal control of predators is a highly controversial wildlife management practice (Niemeyer 2007). The practice appears to be more accepted when it is used to protect a threatened or endangered species (Dekker 2006), especially when control targets an exotic species of predator (Harding et al. 2001; Baxter and Bunnell 2007). Public resistance to lethal control of predators is most severe when predator populations are low, or when the sole justification is competition between predators and humans for the same prey.

Controlling predator populations to reduce predation on a threatened or endangered species may be difficult to achieve. Keeping wolf and cougar populations in check might require reducing alternate

prey (Gibson 2006; Wielgus 2007). Control of abundant mule deer populations in the Sierra Nevada mountains of California might be required in addition to reductions in cougar numbers to prevent extirpation of Sierra Nevada bighorn sheep populations (Gibson 2006). Industrial development in areas occupied by the Little Smoky caribou herd in western Alberta has increased the abundance of moose and deer. Consequently, the Alberta government has issued additional hunting permits for moose and deer in an attempt to reduce alternate prey for wolves, hoping to reduce wolf numbers and thereby predation pressure on caribou. Yet, the ultimate cause for the decline in caribou is habitat alteration due to industrial development (McLoughlin et al. 2003; James et al. 2004). The only long-term solution must involve habitat management (see Hollevoet and Dixon 2007).

Human harvest of prey can be in competition with predators. This has resulted in political pressure on state and provincial governments to reduce predator numbers. One approach is to do this with recreational hunting and trapping of predators. Predator hunting is increasingly popular in many areas, and fur trapping also can be used to help control predator populations. In Alaska, for example, the majority of wolf removals are by recreational hunting and trapping with aerial wolf control contributing a relatively small proportion of total wolf removals (see Figure 1 in Titus 2007). In other areas, however, harvest of predators is low because there are few hunters or trappers skilled in removing predators (Zager et al. 2007). Also, in recent years low fur prices have reduced the incentive to trap predators.

We believe that wildlife managers have not fully taken advantage of the opportunity to involve hunters and trappers in harvesting predators, and we need to understand how to use these people more effectively in predator management (Hammill 2007).

Even though large numbers of predators are taken by hunters and trappers, they often are not very effective at achieving predator control (Zager et al. 2007) because predators are not removed from populations where predator control is most needed. However, bounties are viewed negatively by the public, and bounty systems are easily abused, e.g., claiming bounties for animals taken from non-target areas. Other incentives should be considered for focusing the efforts of hunters and trappers.

Non-lethal methods for deterring predators sometimes can be effective at reducing wildlife and livestock depredation on a local scale (Musiani et al. 2003; Shivak 2006). These include fladry, electronic guards, and radio-activated guards. Although expensive, invasive, and labor intensive, contraceptives can be effective at limiting wolf numbers, at least temporarily (Hayes et al. 2003). Finding effective ways to manage predator-prey systems in ways that are effective while remaining sensitive to public opinion will continue to be a challenge for wildlife managers. Several speakers in this workshop have indicated the importance of engaging human dimensions research to understand public responses to predator management (Mansfield 2007). We need to know which forms of predator management are most acceptable to the public and when predator control is justified.

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