Density, Demography, and Functional Response of a Harvested Wolf Population in West-Central Alberta, Canada

MANAGEMENT SUMMARY

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INTRODUCTION

The Clearwater Area in west-central Alberta is a unique ecosystem adjacent to Canada's two crown jewel national parks. It contains a nearly complete assemblage of large mammals, is used intensively for both recreational activity and resource extraction, and exists in close proximity to the province's major population centres. Wolves are an important component of this ecosystem, but public opinion regarding their management varies considerably among stakeholder groups. Wolves are valued by the general public for their aesthetic value, are a recreational resource for the hunting and trapping communities, are a flagship species for environmental organizations, compete with humans for ungulate prey, and can cause intense conflicts when depredating on livestock. Consequently, wildlife managers are faced with the difficult task of balancing a diversity of competing uses and opinions when attempting to manage wolves in the Clearwater.

Historically, wolves in the area have undergone major population fluctuations. They were reduced dramatically in the late 1800s and again in the 1950s during control efforts across both provincial lands and the National Parks (Alberta Forestry, Lands, and Wildlife 1991). Following the cessation of control efforts in the early 1960s, wolves increased rapidly despite liberal harvest regulations. However, wolf studies in the National Parks raised concern over the viability of recently recovered wolf populations (Callaghan 2002), resulting in demands for a buffer zone free of wolf harvest to protect wolves that used transboundary areas along Banff and Jasper National Park borders. In the early 2000s, an increase in wolf harvests in the Clearwater Area led to the question of whether harvest rates were sustainable. At the same time, perceived declines in elk populations resulted in renewed calls for wolf control (Eldon Bruns, personal communication). Provincial biologists had little information on the status of wolf populations or their impact on prey populations with which to address these management concerns.

Beginning in summer 2003, and in close collaboration with local area biologist Jim Allen of Alberta Sustainable Resource Development, Dr. Evelyn Merrill and Nathan Webb from the University of Alberta initiated an intensive telemetry-based investigation of wolf population dynamics and predation rates in the Clearwater Area. This research program was intended to address several questions important for the management and conservation of both wolves and their prey in the Clearwater Area, while also providing information capable of informing wolf management activities across Alberta. The intent of this report is to provide a brief and practical summary of the principle results of our study, and we discuss their application to wolf management. Additional details and analyses related to the results presented here are available in Webb (2009).

MANAGEMENT OBJECTIVES

Our specific management-related objectives were to:

1) Estimate current wolf densities
2) Explore new techniques to monitor wolf populations
3) Determine wolf predation rates and prey selection
4) Estimate wolf harvest rates
5) Determine the sustainability of current wolf management regimes

STUDY AREA

We studied wolves and their prey in the Clearwater Area in west-central Alberta (Fig. 1). Where wolf packs crossed jurisdictional boundaries, our study area expanded to include small portions of Banff and Jasper National Parks. This area is located approximately 100 km west of Red Deer, and consists of lower foothills in the east, transitioning to upper foothills and mountains in the west. Prey for wolves included moose, elk, white-tailed deer, mule deer, feral horses, and bighorn sheep. Including portions of the National Parks, the study area was 22,994 km^2 in size.

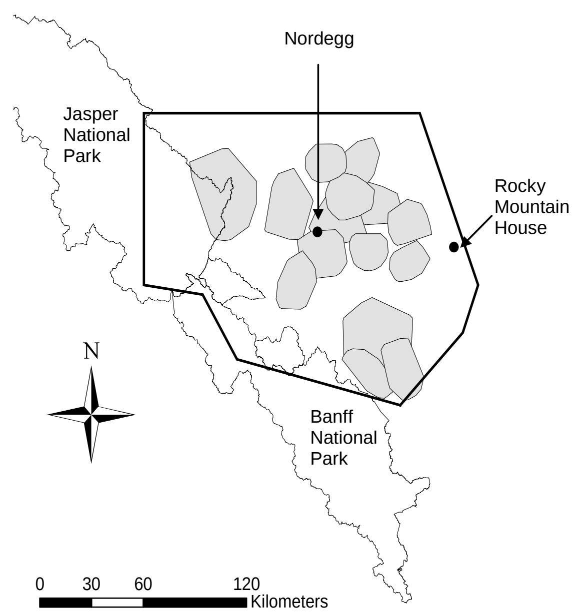

Fig. 1. Location of study area and research wolf packs in west-central Alberta.

RESULTS

Wolf Capture and Collaring: We radiocollared 84 adult wolves from 19 packs in 2003-2007 (pack sizes: 3-14 wolves). Wolves were captured with helicopter netgunning or padded foothold traps, and either physically restrained using a capture pole and hobbles, or chemically immobilized. All wolves were fitted with either traditional VHF radiocollars, or store-on-board or remote-downloadable GPS radiocollars. GPS collars were programmed to collect locations at 3-hour, 2-hour, or 15-minute intervals. We located wolves approximately bi-weekly during aerial telemetry flights, and occasionally from the ground. Collared wolves were monitored for an average of 363 ± 331 days ($\bar{x}$, s.d.).

Density and Population Estimates: We derived estimates of fall wolf density using the radiotelemetry-based approach advocated by Fuller and Snow (1988) and Burch et al. (2005). Because wolf home range sizes increased into the mountains along a northeast to southwest gradient, we calculated separate estimates of wolf densities for 3 census areas representing natural subregions: lower foothills, upper foothills, and mountains (Natural

Regions Committee 2006). Wolf densities across the 3 census areas were 22.3, 14.9, and 9.7 wolves/1000km^2, respectively, with variation in densities occurring due to both pack sizes and the size of wolf home ranges (see Webb 2009: Appendix VIII).

By combining radiomarked packs with uncollared packs identified during field observations, we confirmed a minimum of 32 packs within the study area. Assuming the average fall pack size of 7.8 ± 2.8 wolves that was recorded from research packs, and correcting for lone wolves, this resulted in a minimum population estimate of 286 wolves within the entire study area, for an average density of 12.42 wolves/1000km^2. Two alternative methods to determine wolf population size resulted in very similar estimates of 281 and 306 wolves (Webb 2009: Chapter 5).

Prey Composition and Selection: We used snowtracking, observations during aerial telemetry flights, and visits to location clusters of GPS-collared wolves (Webb 2009: Chapter 3) to locate a total of 192 wolf-killed ungulates from 11 different wolf packs in 2003-2006, with 17.5 ± 10.8 (range: 8-38) kills located per pack. Of these kills, 53% were deer, 17% elk, 24% moose, and 7% were feral horses. When converted to relative biomass, deer represented 22%, elk 23%, moose 43%, and feral horses 12% of the total prey biomass killed by wolves. Based on pellet group counts along transects across the study area (n = 372, Webb 2009: Chapter 4), individual packs differed substantially in the relative amounts of each prey species available within their home ranges; however, moose were the dominant prey species, in terms of biomass, available to most packs. Extensive variation existed among packs in terms of both prey composition and prey selection, with some packs exhibiting positive selection for deer, elk, and feral horses. In contrast, no packs selected positively for moose. Because of this high variation in prey composition across packs, wolf prey selection could not be generalized.

Wolf Kill Rates: We estimated kill rates for 6 packs during winter 2006 (December 2005-March 2006) by visiting a random selection of location clusters from GPS-collared wolves (Webb 2009: Chapter 3). Clusters were identified using 1-hour interval GPS location data, with 89 ± 38 (range 36-145) clusters visited/pack. These clusters corresponded to 58 ± 27 (range 22-82) sampling days/pack, with 74 ± 17% (range 54-100%) of the total identified clusters for each pack visited in the field to search for prey remains. Total kill rates averaged 0.34 ± 0.06 kills/pack/day (Webb 2009: Table AIV.1). On average, kill rates were 0.24 ± 0.09 deer/pack/day, 0.06 ± 0.10 elk/pack/day, 0.03 ± 0.04 moose/pack/day, and 0.01 ± 0.02 feral horses/pack/day. In total, this resulted in an estimated average of 7.95 ± 3.94 kg of prey killed/wolf/day (Webb 2009: Table AIV.1). Assuming 75% of prey carcasses were edible and no loss to scavengers (Peterson 1977, Hebblewhite et al. 2004), wolves consumed 5.96 ± 3.24 kg of prey/wolf/day.

Reproduction: We visited 17 occupied den sites from 13 packs in 2004-2006 (2004, n = 1; 2005, n = 7; 2006, n = 9) and documented 81 pups. We did not observe any evidence of multiple litters being produced by a single pack in one year, despite visiting all known den sites for each pack. Litter sizes averaged 5.6 ± 1.4 pups/pack (range = 4 - 7). Pups were produced in 24 (83%) of 29 pack-years that wolf reproductive success was monitored. Based on the estimated number of packs in the study area and these pup counts, we predicted that an average of 153 pups were produced in the study area each year in 2004-2006. No relationship was found between the production of litters and the number of wolves or proportion of wolves in a pack that were harvested ($P > 0.19$, n = 23). Similarly, for those packs that did produce pups, we found no relationship between the number of wolves or proportion of wolves in a pack that were harvested and litter size ($P > 0.12$, n = 11), indicating that harvest rates observed during this study did not negatively impact the production of pups.

Dispersal: A total of 21 radiocollared wolves left the pack within which they were first radiocollared, with 11 (6 males, 5 females) wolves remaining within the study area and 10 (7 males, 3 females) emigrating from the study area (Fig. 2). Five locally dispersing wolves joined existing packs upon dispersal, while 6 wolves were killed by humans prior to joining a pack. Fourteen dispersing wolves had the potential to breed and therefore may have contributed genetically to other wolf packs; 6 of these wolves were emigrants and 8 were wolves that dispersed within the study area. The total annual dispersal rate was 0.241 with an emigration rate of 0.108 (Webb 2009: Table 5.3). Using an estimate of 295 total wolves (Webb 2009: Table 5.4) with 15% of these as lone wolves, this resulted in 62 wolves dispersing per year, with 28 emigrating from the study area.

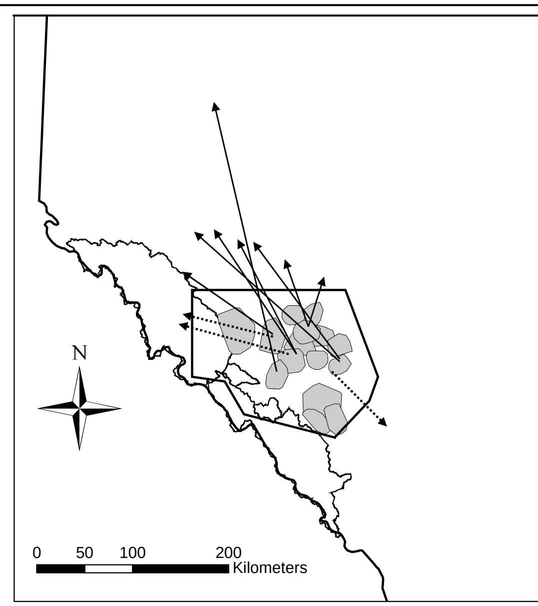

Fig. 2. Direction and distance of dispersal for wolves emigrating from the central east slopes of Alberta, 2003-2008.

Mortality and Harvest Rates: On average, 60% of radiomarked wolf packs had at least one wolf killed by trappers each year, and 29% ± 16% of the wolves in these trapped packs were killed. Including packs where no wolves were trapped, an average of 18% ± 19% of the wolves in each pack were trapped (range: 0 – 50%). Across all packs, an average of 1.44 ±1.73 wolves/pack were killed by trappers each year (range: 0 – 7) (Webb 2009: Appendix VI). Including losses due to hunting, an average of 2.0 wolves were killed by humans in each pack each year. Age composition of harvested wolves (n = 52) was 55% pups, and 71% were either pups or yearlings (Webb 2009: Figure 5.4).

Of the 42 radiomarked wolves that died, 26 (62%) died to trapping, 11 (26%) were shot by hunters, 4 (10%) died of natural or unknown causes, and 1 (2%) was hit by a car (Webb 2009: Figure 5.5). Annual survival of wolves within the study area was 0.615, for an annual mortality rate of 0.385. Because 90% of the mortalities of radiocollared wolves were human caused, the majority of wolf mortality occurred during the fall big-game hunting season and during the wolf trapping season from December-March.

Population Trajectory: We used a simple population model to estimate annual rates of increase based on observed rates of adult wolf mortality, dispersal, and reproduction (Webb 2009: Chapter 5). However, population growth of wolves is also dependent on immigration rates and over-summer pup survival, both of which were unknown. We found that moderate rates of pup survival ($\bar{x} \geq 0.65$) and immigration ($\bar{x} \geq 0.11$) would result in either a stable or slightly increasing wolf population ($\lambda = 1.0 – 1.1$), while the population was likely to decline at current harvest rates of 0.35 only if rates of pup survival were ≤ 0.65. These rates of pup mortality typically occur only in areas with a high prevalence of disease or low availability of prey, which we did not observe in this study (Fuller et al. 2003, Smith et al. 2006).

DISCUSSION AND MANAGEMENT IMPLICATIONS

We identified several aspects of wolf ecology and wolf-ungulate relationships that will help managers make more informed decisions on the future of wolves in the Clearwater Area. Wolf densities varied across the study area, decreasing from the eastern foothills (22.3 wolves/1000 km^2) to the western mountains (9.7 wolves/1000 km^2), and this likely reflects gradients in topography, vegetation, and winter severity, which influence prey abundance. Nonetheless, wolf densities in the mountainous portions of the Clearwater Area exceeded those (2.5 to 9.2 wolves/1000km^2) recorded in Jasper National Park (Cowan 1947, Carbyn 1974, Dekker 1986) and those (2.7 to 4.8 wolves/1000km^2) in Banff National Park (Huggard 1991, Hebblewhite 2000, Callaghan 2002, Hebblewhite 2006), likely corresponding to higher prey densities on provincial lands than in the national parks. Comparisons of current wolf density in the Nordegg area to estimates derived by Clarkson et al. (1984) and Schmidt and Gunson (1985) indicate that wolves have increased within the western portion of the Clearwater Area during the past 2 decades, which coincides with anecdotal reports from trappers and outfitters. While no previous estimates of wolf density exist for the lower foothills portion of the Clearwater Area, our estimates are similar to or higher than those recorded near the Simonette River (Bjorge and Gunson 1989: 10.8 to 23.8 wolves/1000 km^2), in the Swan Hills (Fuller and Keith 1980: 12.0 wolves/1000 km^2) and more recently, in caribou ranges in west-central Alberta (Kuzyk 2002: 11 wolves/1000 km^2).

Low rates of natural mortality, coupled with high pup production and low emigration rates, allowed wolves to sustain a liberal management regime and harvest rates of 35%. Harvest of wolves did not appear to negatively impact wolf reproductive success because mostly pups (55%) were harvested, and susceptibility of breeding-age wolves to hunting and trapping appeared to be low. While the current wolf harvest regime in the Clearwater Area does not appear to be causing population declines, wolf dispersal rates were lower than in most unharvested wolf populations (Fuller et al. 2003), and success of immigrants may be low due to high mortality rates in the transient segment of the population (Adams et al. 2008). However, wolf densities are high overall, and wolves do disperse from the study area and live long enough to breed in other areas. We confirmed that nearly 25% of wolves leave their pack each year, and Thiessen (2007) used genetic analyses to document dispersal from the Clearwater Area to all adjacent subpopulations, including those encompassing Banff and Jasper National Parks. Therefore, concerns that current wolf management may prevent dispersal from the Clearwater Area into the adjacent National Parks (Callaghan 2002) appear unfounded.

On a year-round basis, wolves are the primary predator of adult female elk in the Clearwater Area (Frair 2005, Hebblewhite 2006), and our study results can be used to help assess the effects of wolf predation on ungulate populations in harvest models. However, we provide only winter kill rates, and annual kill rates would be needed to fully understand the potential impacts of wolf predation. At present, there is some debate over whether wolf kill rates in summer are generally higher or lower than those in winter (Jedrzejewski et al. 2002, Sand et al. 2008). In either case, for most wolf packs, elk are clearly a secondary prey species, indicating that wolf predation on elk is decoupled from elk densities. In this case, the ecological relationship between elk and other prey species may be an example of “apparent competition” (Holt 1977), where the numerical responses of wolves to increases in alternate prey, such as white-tailed deer, may intensify the effects of wolf predation on secondary prey such as elk. However, whether elk currently are limited by wolf predation depends on many factors, including sources of calf mortality, predation by other predators, and trends in habitat condition, which we did not address in this study.

The Management Plan for Wolves in Alberta (Alberta Forestry, Lands, and Wildlife 1991) identifies public hunting and trapping as the primary tool to be used in the management of wolf populations. Our results suggest that current harvest levels, which result from liberal hunting and trapping seasons without bag limits, are not threatening wolf populations in this area nor are they sufficient to reduce wolf populations were this the management objective. Removal rates of ~ 60% or higher are generally needed to offset wolf reproduction and immigration (National Research Council 1997, Hayes and Harestad 2000). Therefore, if reductions of the wolf population in the Clearwater Area were a management objective to increase ungulate populations, intensive control programs may be the only viable approach. However, the Alberta Wolf Management Plan requires that before any efforts to control wolf populations can be implemented, wolves are identified as the primary limiting factor, a cost-benefit analysis is conducted to determine whether the program is economically feasible, and the program be subjected to a full public review (Alberta Forestry, Lands, and Wildlife 1991). In recent history, the necessity to maintain control efforts for many years (National Research Council 1997, Alberta Sustainable Resource Development, unpublished data) and the lack of public acceptance for wolf control has limited the application of intensive wolf reductions to the conservation of endangered species such as woodland caribou.

The high profile of wildlife management in the Clearwater Area, coupled with the diversity of opinions on the direction and approaches to wolf management, indicate that resolving the future of wolves and their prey will be challenging. Because the wolf population is currently abundant and stable, there are excellent opportunities for wolf viewing, trapping, and hunting. Implementing wolf control to increase ungulate populations would require careful evaluation because of the complexity inherent in multi-predator systems. For example, recent work in Alaska has demonstrated that a combination of bear and wolf control would be required to increase some low-density ungulate herds (National Research Council 1997). Control efforts would also need to be maintained for the long-term, which would be expensive unless more cost-efficient approaches to wolf control become publically acceptable. Further, uncertainty surrounding the effects of wolf control on populations in the adjacent National Parks remains a concern for some resource groups. Given these considerations, maintaining the present harvest strategies for wolves may be the most prudent approach at this time.

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