25 Plains bison restoration in the Canadian Rocky Mountains? Ecological and management considerations

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Introduction

Evaluations of long-term ecosystem states and processes for the Canadian Rockies (Kay and White 1995; Kay et al. 1999; Kay and White, these proceedings) have demonstrated that plains bison *(Bison bison)* were a significant prehistoric and historic component of Banff National Park's faunal assemblage. Bison were eliminated from most their historic range by human overhunting (Roe 1970). The park management plan (Parks Canada 1997) requires an evaluation of bison restoration (Shury 2000). In this paper we summarize some perspectives on the ecological significance of bison, potential habitat use and movement patterns, and implications for management. We conclude by describing the ongoing restoration feasibility study process.

Bison ecological interactions

Bison are the largest North American land mammal and may have had significant ecological effects on ecosystem states and processes where the species occurred. Understanding potential ecological interactions in the Canadian Rockies (Figure 25.1) has provided a focus for interdisciplinary research of archaeologists, anthropologists, and ecologists (Magne et al. 1996; Magne 1999; Kay et al. 1999). Current ecological research is of obvious importance, but it is of necessity carried out on existing circumstances that may not accurately reflect the variety of past ecological conditions. Archaeologically derived data about bison population structure, distribution, diet, and human use can provide important baseline information about bison ecology in the long time period before European intervention (Cannon 2000). Modern bison management should integrate ecological data from both contemporary and long-term approaches.

Humans. In Banff, bison bones have been identified at archaeological sites widely spread apart in time and space throughout the park, although bison are not always the dominant fauna in an assemblage, and bones of any kind are seldom found in abundance (Langemann 2000a-b). Poor bone preservation often impedes identification to a particular ungulate species; mtDNA (mitochondrial DNA) amplification may be able to distinguish ungulate bone fragments (Monsalve 2000), and has the potential to address more detailed questions about bison populations. The earliest known bison occur at the deeply stratified Lake Minnewanka site in Banff (EhPu-1);

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radiocarbon dates of 9990 ±50 BP (year before present; Beta 122723) and 10370 ±60 BP (CAMS 60442) have been obtained on the collagen from bison bone in clearly cultural contexts (Landals 2000). At the Vermilion Lakes site near Banff townsite (EhPv-8), a single bison bone occurred in a component dated to 9930 ±50 BP; however, the dominant fauna in this and the earlier components was mountain bighorn sheep *(Ovis canadensis)*. In the archaeological sites from Waterton Lakes National Park and the Crowsnest Pass, however, bison were consistently the dominant fauna, and bison bones were often found in abundance.

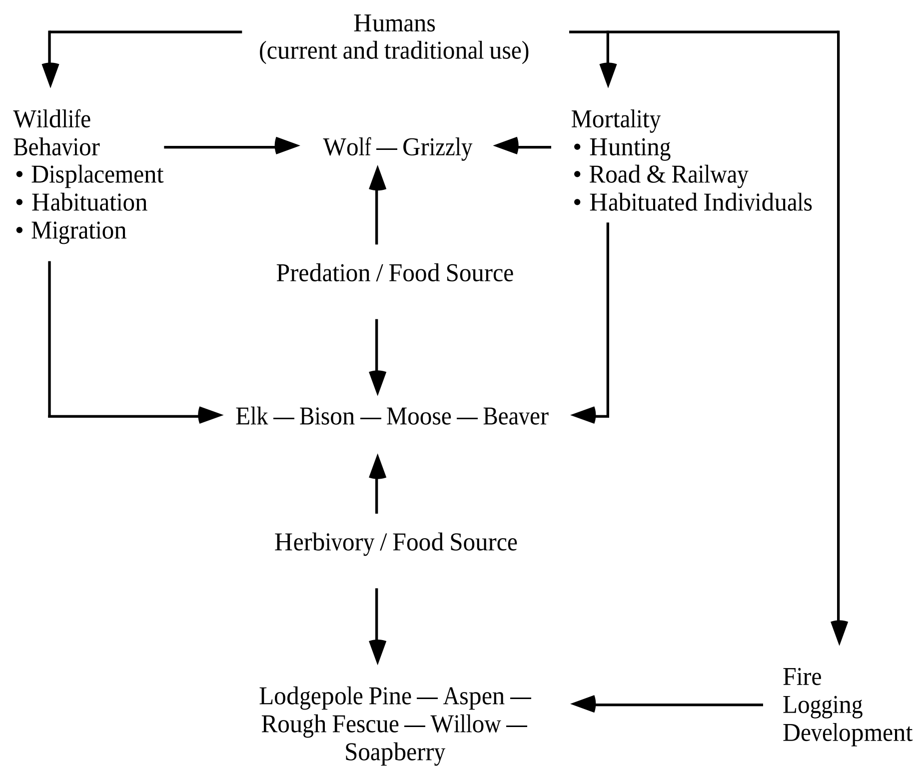

Figure 25.1. Simple trophic model for long-term Rocky Mountain ecosystem states and processes.

Archaeological research demonstrates that the Canadian Rockies were a cultural ecotone that was used as part of the regular seasonal round by a number of different peoples. Throughout the nearly 11,000-year-long record, sites in Banff show alternating influences from both the plateau and plains, in terms of projectile point styles and the source of lithic materials. The number and density of sites also shows that the mountains were intensively used, and were not a marginal no-man's land. The K'tunaxa (Kootenay) and Secwepemc (Salish) peoples have for millennia lived in the mountains, with a seasonal round that included moving across the continental divide between the eastern and western valleys of the mountains (Reeves 2000). Peoples from the plains including the Siksika (Blackfoot), Piikani (Peigan), and, most recently, the Stoney (Nakoda) peoples wintered in the sheltered valleys of the front ranges. In Banff, a series of repeatedly occupied house pit sites in the Red Deer and Bow River valleys suggests the regular use of these valleys over the last 3,000 years by people with cultural ties to the interior plateau of British Columbia. Bison bones have been found in these house pit and earth oven features (Langemann 2000a).

Bison were preferred prey for many First Nations, providing food, clothing, shelter, and tools (Roe 1970; Geist 1996). Human hunting may have been highly effective in virtually eliminating any bison that entered the steep-walled valleys of the Canadian Rockies (Haines 1967; Kay et al. 1999). Although grassland habitat is abundant in intermountain areas to the west, and could have supported abundant numbers of bison, zooarchaeological evidence of bison is scarce (Kay 1994). Kay et al. (1999) proposed that bison persisted in east-slope valleys despite heavy human harvesting because they were sustained by large, migrating herds from the Great Plains. White et al. (2001) suggested that Kootenay and Salish peoples may have even purposely driven bison from the foothills into mountain valleys—in effect using the valleys as giant pounds. Here, bison could be easily found and killed, particularly when snowpacks were deep. In times of conflict, they could have been processed at campsites more secure from Siksika enemies to the east. Further, in the period before horses, hunting bison deep in these mountain valleys would have meant a much shorter distance to pack the dried meat back to the winter camps in the western valleys. Evidence from dendrochronology (White et al. 2001) and ignition studies (Heathcott 1999) indicated that historic east-slope fires were predominantly human-ignited. Burning may have been used by people to maintain grassland areas and movement corridors favorable for bison herds to move into the mountain valleys from the nearby prairies (Kay et al. 1999; White et al. 2001).

Humans, sustained by bison and plant resources, likely affected densities of other large herbivore species (Martin and Shutzer 1999; Kay 2000). The general order of preference by human hunters for ungulates in the mountain areas was probably bison > elk > moose *(Alces alces)* > mule deer *(Odocoileus hemionus)* > bighorn sheep = white-tailed deer *(O. virginianus)*. Historically, elk and moose populations may have been driven to very low densities by human hunting combined with other predation (Kay et al. 1999). Singer and Mack (1999) made similar predictions for elk densities when recreational hunting was combined with wolf *(Canis lupus)* predation in the Yellowstone ecosystem.

Other predators. Wolves, grizzly bear *(Ursus arctos)*, black bear *(U. americanus)*, and cougar *(Felis concolor)* competed with humans for bison and other prey. Joly and Messier (2000) showed that wolf population size was correlated with bison numbers, similar to the numerical response seen in other wolf–prey systems (Packard and Mech 1980; Fuller 1989; Messier 1994). Selectivity by wolves for extant large mammal prey species in the Canadian Rockies is elk >= deer > moose > bighorn sheep (Huggard 1993; Hebblewhite 2000). Bison are less vulnerable to wolf predation than moose (Larter et al. 1994) or elk (Smith et al. 2000). Hebblewhite (2000) observed a steep Type 2 functional response for wolf–elk predation. Bison restoration could thus result in lower densities of more vulnerable prey such as elk or moose, where wolf numbers are sustained by bison, but where wolves prefer to kill more vulnerable prey (Gates and Larter 1990).

Herbivores. Competition between bison and other herbivores has not been studied in ecosystems that include both elk and keystone predators such as wolves and humans. Bison are predominantly grazers (Hudson and Frank 1987), in contrast to browsers such as moose or deer, or the generalist elk (Telfer and Cairns 1979). In a boreal mixedwood system with few predators, sympatric elk and bison both selected upland grassland vegetation types in all seasons (Cairns and Telfer 1980), while moose and deer selected aspen and shrubland types. However, food competition between elk and bison may be minimized because, although these species use the same habitats, the use occurs in different areas at different times (Telfer and Cairns 1979; Wydeven and Dahlgren 1985). Similarly, Singer and Norland (1994) observed only moderate habitat overlap between elk and bison even with high ungulate densities.

The release of herbivores from the long-term effects of human and carnivore predation has restructured Rocky Mountain national park montane ecosystems (Kay 1994; Kay et al. 1999; White et al. 1998; Berger 1999). Elk, normally vulnerable to predation in these systems, have become extremely abundant (Banff–Bow Valley Task Force 1996), and through competition for browse and other interactions may have sharply reduced the abundance of moose (Hurd 1998) and beaver *(Castor canadensis)* (Hess 1993; Nietvelt 2001). Birds may also be affected where release from predation has resulted in high browsing impacts on riparian willows by elk (Nietvelt 2001) or moose (Berger 1999).

Important diseases such as anthrax, tuberculosis, and brucellosis are endemic to certain bison populations in North America. Anthrax, caused by the bacterium *Bacillus anthracis,* is indigenous to North America (Gates et al. 2001). *B. anthracis* persists in neutral-to-alkaline soils in the form of highly resistant endospores (Dragon and Rennie 1995). Outbreaks typically last for six to eight weeks, then may not occur again in the same area for many years (Gates et al. 1995). Bovine tuberculosis exists only in bison populations in and near Wood Buffalo National Park (Tessaro et al. 1990). Bovine brucellosis is present in bison in the Wood Buffalo National Park area (Tessaro et al 1993) and in bison and elk populations in and around Yellowstone National Park (Roffe et al. 1999). Control measures in the Northwest Territories and unrestricted hunting near Wood Buffalo National Park in Alberta reduce the risk of infection of other northern Canadian bison populations (Gates et al. 1992). Bison at Elk Island National Park, location of the Canadian national breeding herds, are tested annually and are negative for both brucellosis and tuberculosis.

Vegetation. Bison effects on vegetation depend on population density (Larson 1940), and foraging and movement patterns driven by predation risk and habitat conditions (Bamforth 1987; Epp 1988; Carbyn et al. 1993). Historic bison densities were likely low in the parklands and Rocky Mountains compared with the nearby prairies (Malainey and Sherriff 1996; Kay et al. 1999). Stable carbon isotopic analysis of bison bone from archaeological sites dating from the last 3,000 years in Waterton Lakes National Park and Banff National Park has shown that all but one of 28 individuals tested obtained at least 10% to 23% of their diet from C4 vegetation. The implication is that even bison found in high-elevation areas and mountain valleys spent some portion of their life in the more xeric prairie, where C4 grasses are present (Langemann 2000b). However, grasslands in which C4 species occur are much closer to the mountains in the Waterton Lakes area than in areas to the north. Bison may have used mountain valley bottoms most often during the fall and winter if they migrated off the prairies into surrounding foothills and aspen parklands (Moodie and Ray 1976), or moved downwards from upper elevations (Meagher 1973; Van Vuren and Bray 1986). This would have favored selection of forage species adapted to relatively low-intensity, dormant-season grazing such as rough fescue *(Festuca saximontana;* Dormaar and Willms 1998). As noted above, the decline of bison and its main predators, and the resulting increase in elk herbivory has resulted in the decline of numerous Rocky Mountain plant species (White et al. 1998) including aspen *(Populus tremuloides;* Kay 1997; White et al. 1998), willow *(Salix* spp.; Nietvelt 2001), and possibly rough fescue (C. White, personal observation).

Fire effects on vegetation communities used by elk and bison were evaluated by Boyce and Merrill (1996), and Singer and Mack (1999) for Yellowstone National Park. Fire-removal of lodgepole pine *(Pinus contorta)* cover was thought to decrease forage availability immediately after burning, but was followed by a period of increase in both graminoid and forb diversity and production. In the absence of limitation by predators, an increase in forage production following burning could support growth in bison and elk populations.

Restoration implications: source or sink population management?

Our review suggests that bison could have been a significant species in the montane ecosystem, interacting with humans, predators, other herbivores, and vegetation. Hence, reintroduction of bison would contribute to restoring the ecological integrity of mountain park ecosystems. Furthermore, historic evidence clearly shows that bison in the Rocky Mountains were at the edge of their western range, and that this range limit was likely human-caused (Haines 1967). Thus, we make the interesting proposition that if bison are restored to this ecosystem, they should be managed as a sink, not a source population.

Sink-population management would require novel techniques for national parks that traditionally have source-population management policies, such as low human predation and encouragement of out-of-park movement of potential dispersers (Caughley and Sinclair 1994; Wagner et al. 1995). Sink-population management techniques might include periodic reduction of bison to very low densities (by traditional human techniques or other predators), routine importing of animals from other populations, and minimal out-of-park dispersal (Soulé et al. 1979; Berger and Cunningham 1994). Research would be required to test the strength of potential regulating factors (Sinclair 1991), and manage for those that likely had greatest long-term effects on bison ecology in mountain environments. For example, Geist (1996) suggested that aboriginal hunters played an important role in developing bison morphology and behavior. Further, bison restoration at its western range limit could provide interesting research opportunities to understand what factors are important at range edges following the methods suggested by Caughley et al. (1988).

Restoration feasibility study process

Parks Canada hosted a Rocky Mountain bison restoration research forum in October 1999 (Shury 2000). Attendees included ecologists, archaeologists, and land managers. Main issues discussed included containment of bison, range carrying capacity, adaptive management approaches, involvement of First Nations, and monitoring and research requirements. A consistent message from provincial land managers was that movements of reintroduced bison on to Alberta lands could cause serious problems related to recreation and agriculture. It was recommended that any trial restorations be restricted to national parks until critical knowledge gaps are addressed.

The group reviewed a proposed future direction and proposed actions. Research is ongoing to provide additional ecological and spatial habitat information that would be used in the next bison restoration feasibility workshop scheduled for January 2002. If stakeholder concerns can be addressed, a trial restoration experiment, with appropriate research design and management controls, would then be developed for further review.

In April 2000, the University of Calgary Faculty of Environmental Design (EVDS) developed a strategic plan for reintroduction of plains bison to Banff National Park (Fleener et al. 2000). The EVDS plan recommended that Parks Canada follow the IUCN guidelines for species reintroductions, including maintenance of genetic integrity, habitat and historic range assessments, and elimination of previous causes of decline.

Both the research forum and EVDS groups recognized that First Nations are critical stakeholders to the bison restoration process. In fact, both groups recognized that the long-term ecological relationships of bison could only be understood in the context of First Nation traditional use and values. The approach of integrating long-term cultural processes into ecological management was also recently recommended by the minister's independent panel on ecological integrity (Parks Canada 2000).

Conclusion

Bison restoration to Canadian Rockies national parks provides an interesting set of challenges that, if surmounted, could help achieve Parks Canada's ecological integrity objectives. First, by restoring a complex set of predator–prey and herbivore interactions, bison reintroduction could help solve a persistent set of problems tied to elk overabundance and intense herbivory. Second, bison restoration as a sink population would encourage managers to develop alternative paradigms than the source population model for wildlife management currently used for Rocky Mountain national parks. Third, the full participation of First Nations in the planning and restoration effort would not only recognize the great historical and spiritual value of bison to their cultures, but also provide a focus on factors such as traditional hunting and burning, likely prevalent in long-term ecosystem states and processes, but largely missing in current management regimes.

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