# Developing Policy Alternatives for the Management of Wood Bison (*Bison bison athabascae*) in Kluane National Park and Reserve of Canada

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**Abstract:** A reintroduced population of wood bison (*Bison bison athabascae*) in the southwest Yukon has been growing and expanding its range; without intervention these bison are expected to soon migrate into Kluane National Park and Reserve of Canada. In order to enable a proactive response, we identify the key historical, social, ecological, and legal issues faced in the development of a wood bison management strategy for the park, including the critical question of whether they should be considered a native or an exotic species in the park. We believe wood bison should be considered native there. It is unclear what impact—positive or negative—bison will have on the ecological integrity of the park, since ecological integrity is a sufficiently plastic concept that it can be interpreted as including or excluding bison. We identify a range of alternative management strategies and the largely normative trade-offs associated with each, plus a set of actions that would be useful regardless of the alternative ultimately selected. A rational, feasible, and justifiable decision about the future of bison in the park will require a high-functioning and open co-management process so that participants with different values, knowledge, strategies, and interests can articulate and achieve their common interests.

## Introduction

> Goals concerning the management of land, water, and living resources, including bison restoration, are a matter of societal choice. (Gates et al. 2010, p. 105)

Since the reintroduction of wood bison (*Bison bison athabascae*) into the Yukon's Nisling River watershed in the early 1980s the Aishihik bison herd has been growing at a rate of 10%–20% per year and currently exceeds

1,000 animals (Yukon Environment 2010). The herd is expanding its range southwest towards Kluane National Park and Reserve of Canada (KNPR), located in the southwest corner of the Yukon. At the time of writing (2010-2011), park staff[1] were well aware that the growing bison herd may range into the park in the near future, and had concerns regarding the unknown potential environmental and cultural impacts of wood bison within the park. Their fear was that wood bison impacts could compromise the ecological integrity of the park (D. Clark, unpubl. data). In the 2004 Park Management Plan there is no mention of wood bison (Parks Canada 2004), but the 2010 Park Management Plan (Parks Canada 2010a) acknowledges the potential migration of the species into the park and the need for a wood bison management strategy. The policy problem at hand, then, is that the park currently lacks a management strategy for the species, yet could be faced with a natural immigration at any time. Responding to such a situation without a rational, feasible, and justifiable strategy in place could cause a range of problems, and delay would likely lead to the bison themselves determining outcomes. Such outcomes may indeed be the ones the park managers ultimately decide they want, but the intervening period of indeterminacy could damage relationships with First Nations and regional stakeholders, possibly foreclosing future management options both in and out of the park. The development of a wood bison management strategy for KNPR will require a careful examination of the historical, social, ecological, and legal issues involved. Any decision about whether or not the wood bison should be allowed to expand their range into KNPR will result in social and ecological consequences that affect many participants.

Difficulties in the reintroduction of large mammals, and bison in particular, are not uncommon in natural resources management as multiple practical and ethical challenges often arise (Noss 2001). People who stand to be impacted may oppose the reintroduction of large mammals, often for understandable reasons (ibid.). Wood Buffalo, Prince Albert, Elk Island, and Yellowstone National Parks have long grappled with a host of bison management issues: disease transmission (Cromley 2002); migration patterns (Frandsen 2004); public conflict (Cromley 2002, D. Clark 2010); nuisance bison (Larter and Allaire 2007); and highway accidents (Wildlife Collision Program 2010). With the significant exception of disease, KNPR faces all these issues as well as others specific to the region. Not only have socio-economic concerns about bison been expressed by local communities (D. Clark 2010), but the park also must contend with the history of relations with local First Nations, the evolution of co-management regimes with First Nations following the 1993 *Umbrella Final Agreement* between the federal,

territorial, and First Nation governments, and the park's commitment to maintain ecological integrity (Parks Canada 2010a). While enshrined in the *Canada National Parks Act* ("the Act"), the principle of ecological integrity can be interpreted in multiple ways that could support profoundly different decisions (D. Clark et al. 2008), and the Act provides little guidance on how to actually apply the principle in practice. Given the large geographic area under consideration, the social and political complexity of park and wildlife co-management, and the dynamic nature of the regional ecosystem (Slocombe 2001), what the park should do about bison is not a question with a straightforward, obvious answer.

The park currently lacks explicit policy or procedural guidance for how to respond to this foreseeable immigration by wood bison, and park managers are keenly aware that they will need to clarify the park's goals and act to achieve them; preferably sooner rather than later since the bison are now close enough that they could enter the park at any time they choose. The purpose of this paper is threefold: (1) to describe the social and ecological context within which this problem is embedded; (2) to identify the issues and obstacles facing KNPR in the decision making process; and (3) to integrate the foregoing into a set of policy alternatives that KNPR can select among to assist them in determining the future of wood bison in the park. We do not recommend a specific course of action here, since that determination should rightly be made by the responsible governments and the established co-management institutions they participate in. Instead, our intent is simply to clarify the main issues and options available to participants in this situation, and the trade-offs associated with each alternative course of action. Similarly, we do not undertake a detailed analysis of the potential ecological impacts of bison becoming established within the park, because we believe that there are substantive questions of values and policy that must be answered *before* such an undertaking if it is to be of sufficient value to guide park management.

**Methods**

We apply an analytic framework based on the policy sciences to describe and analyze this situation, and develop policy alternatives for wood bison management in KNPR (e.g., T.W. Clark et al. 2000, D. Clark et al. 2008, S. G. Clark 2011, Rutherford et al. 2009). Our analysis is primarily based on a systematic review of territorial and federal government documents—especially species and park management plans and planning process reports, as well as peer-reviewed literature on the historical, social, ecological, and legal aspects of this issue. This undertaking was also informed by

correspondence with bison managers and scientists from the Yukon and elsewhere in North America during 2010-2011.

## Context

*Wood Bison in the Yukon*

Available evidence from archaeological, paleontological, and historical sources suggests that wood bison occurred throughout the Yukon from 2,000–3,000 years ago, to within the last 500 years (Stephenson et al. 2001). They were present in southwest Yukon (Farnell et al. 2004, Heffner 2008). By the late 1800s the decline in bison populations was evident, and by the early 1900s bison had completely disappeared from the territory. It is unclear exactly why they disappeared, though it is commonly accepted that they existed only at low densities and the combination of habitat deterioration through the succession of grassland to forests, followed by the arrival of the fur trade and the availability of firearms contributed to their extinction in the territory (ibid.). Before their disappearance they appear to have been an important subsistence species for First Nations people (Lotenberg 1996).

Since the early 1980s, the Yukon government has participated in the national wood bison recovery effort with the goal of establishing one free-roaming herd of viable size in the territory (Yukon Wood Bison Technical Team 2009). The Canadian Wildlife Service conducted a range inspection in 1982 and recommended the Nisling River watershed as the most promising release site for a reintroduction, with a carrying capacity of approximately 400–500 bison (Yukon Fish and Environment 2010). Wood bison were reintroduced into the Nisling River watershed between 1988 and 1992 (Yukon Environment 2010) and, since then, the population has migrated southwest into the Aishihik region and continues to grow, surpassing 500—the predetermined goal of maintaining a sustainable herd (Yukon Wood Bison Technical Team 2009). The Aishihik bison herd's range has been expanding towards KNPR since the reintroduction (Figure 1), and park managers have predicted that it could migrate into the park within the next few years. Indeed, on January 22, 2010, park staff photographed an adult male bison along the Alaska Highway within easy reach of the park boundary (Figure 2). Bison are known to exhibit pulsed dispersal and their population density fluctuates as they disperse, in response to both density-dependent and density-independent factors (Larter et al. 2000, Plumb et al. 2009). While the mechanism(s) driving apparent dispersal of bison towards the park is not known, local inhabitants' observations of abrupt shifts in bison distribution and density documented by Clark (2010) are consistent with that pattern.

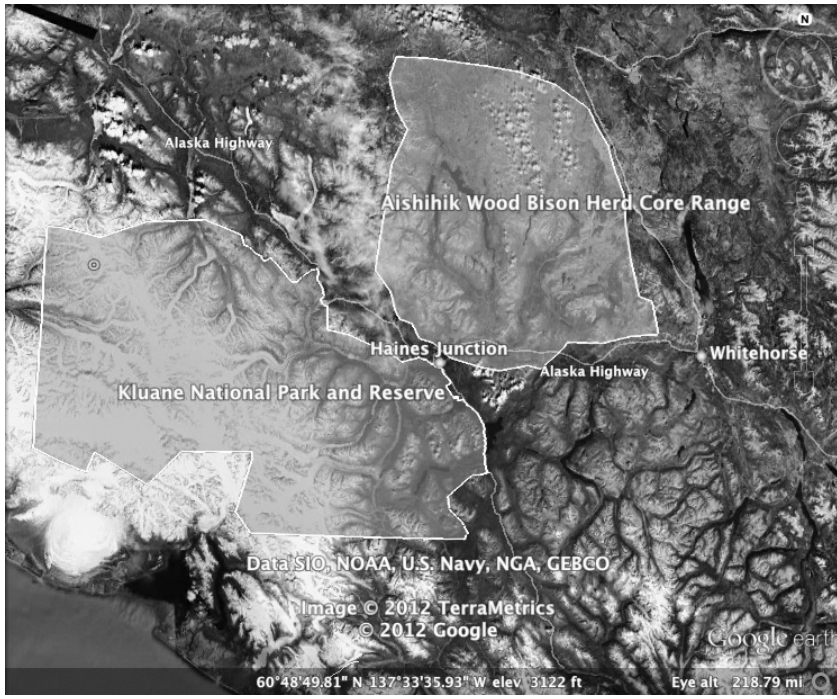


Figure 1. Aishihik wood bison herd range in relation to Kluane National Park and Reserve boundaries.

Documented impacts of reintroduced wood bison on ecosystems elsewhere include overgrazing the landscape, competing with other species, acting as a disease reservoir, increasing predation rates in the region, and degrading meadows or wetland habitat (Gardner and DeGange 2003, Harper et al. 2000). Champagne & Aishihik First Nation (CAFN) members expressed broadly similar concerns for the southwest Yukon, though impacts on culture, bison-human conflicts, and damage to heritage sites were also significant (D. Clark 2010). Conversely, bison are also known to provide a wide range of benefits to ecosystems across North America including the creation of landscape heterogeneity through wallowing and grazing; nutrient redistribution; prey for wolves, bears, and humans; habitat creation for birds and herbivores; modification of fire regimes; disturbance of woody vegetation by rubbing; and the provision of bison wool for small mammals and nesting birds (Sanderson et al. 2008, Gates et al. 2010). As far as some community members are concerned, the reintroduction of wood bison has at times appeared to be yet another incidence of First Nation's exclusion and disempowerment; though more recently the benefits of being able to hunt bison are becoming widely appreciated by First Nations citizens

and Yukoners as a whole (Clark 2010). Wood bison have been described as a keystone species within the boreal forest and are important to the connectivity and complexity of the ecosystem, influencing processes such as nutrient cycling and population dynamics between carnivores and other herbivores (Gates et al. 2001). The immigration of bison into KNPR would have effects that may be positive or negative depending on one's perspective and values; which effects will outweigh the others remains unknown and difficult to predict due the large knowledge gaps and changing landscape of the region.

Figure 2. Wood bison bull on the east side of the Alaska Highway near Sulphur Lake, northwest of Haines Junction, January 22, 2010. Kluane National Park would normally be visible in the background of this image, but for the weather (Photo: Richard Cherepak).

Wood bison are listed as a threatened species within Canada by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the federal *Species at Risk Act* (SARA) and are considered both a native species and a species-at-risk in the Yukon according to COSEWIC, the National Wood Bison Recovery Team, and the World Conservation Union/IUCN Bison Species Specialist Committee. Wood bison were previously listed as a Specially Protected Species under the *Yukon Wildlife Act*, though since the Aishihik herd has surpassed the population goal of 500 they are now listed as a Big Game Species in the territory (Yukon Wood Bison Technical Team 2009). Bison hunting is permitted throughout much of the Yukon and

is the primary means of controlling the bison population (Environment Yukon 2010). Since their reintroduction, wood bison have apparently adapted to hunting pressure, learning strategies to avoid hunters such as moving to higher altitudes and thicker cover (Clark 2010) and making the hunt an increasingly ineffective means for maintaining the population near the original goal of 500. The COSEWIC designation of wood bison was downlisted from endangered to threatened in 1988, and this assessment was re-evaluated and affirmed in 2000. Globally, wood bison are also considered a species-at-risk. Under the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) wood bison were downlisted from CITES Appendix I to Appendix II in 1997 based on Canada's ability to satisfy the "precautionary measures" of Resolution 9.24 (Gates et al. 2010). American bison were also recently listed as "Near Threatened" in the IUCN Red List of Threatened Species (Gates et al. 2010).

*Co-Management of Wood Bison and Kluane National Park*

Aboriginal–State relations in the Yukon have evolved from state control, displacement, and exclusion of Aboriginal people towards co-management and co-operation, largely due to the settlement of comprehensive land claims (Penikett 2007). That process confirmed First Nations' shared responsibility with the Yukon and federal governments for resource management and land use planning (Natcher and Davis 2007). Coordinating the co-management of bison in the Yukon is the responsibility of two bodies: (1) the Wood Bison Technical Team, made up of territorial, First Nations, and federal wildlife managers and biologists plus representatives of the local Renewable Resource Councils (see Natcher et al. 2005 for a detailed description of these councils); and (2) the Wood Bison Management Team, comprised of territorial and First Nations wildlife directors. The technical team makes recommendations to the management team, whose decisions are then implemented as legislation, regulations, and policy by their respective governments. Although Kluane National Park was established in 1973, its co-management regime came almost two decades later—a challenging transition (Lotenberg 1998, Nadasdy 2003, Parks Canada 2010a). Since the beginning of the park's co-management regime in 1995, the KNPR Management Board, Kluane First Nation (KFN), Champagne Aishihik First Nation (CAFN), and Parks Canada have experienced both success and disappointment (Clark 2009). Governments and First Nations are still learning how to "do" co-management in national parks (Hayes and Allen 2007). For KNPR and its co-managers, it has been unclear what co-operative management should look like in application (Parks Canada 2010a), potentially leading to confusion and frustration about

the roles and responsibilities of park staff, KFN, CAFN, and community members (Henry et al. 2008). According to the 2010 Management Plan (Parks Canada 2010a), such a lack of common understanding about co-management means there is a continued need for relationship building. There are differing opinions regarding the park management board's credibility with various groups in the community; most noteworthy is the fact that "60% of the board perceived the board's credibility with CAFN as poor" (Henry et al. 2008, p. *ix*).

Building cross-cultural understanding is crucial because Aboriginal and Euro-Canadian epistemologies differ in their perception of the landscape and the consequent ways in which each group believes natural resources should be "managed" (Castro and Nielson 2001, Stevenson 2004, Natcher and Davis 2007). Differences in world views and the frustrations that occur because of them are not uncommon during fish and wildlife management planning in the Yukon. There are many examples besides wood bison where such controversies have emerged in the Yukon, such as commercial game-ranching, wildlife introduction programs, and the implementation of catch-and-release fishing policies (Natcher et al. 2005). Clark and Slocombe (2005) also found that in grizzly bear conservation in the southwest Yukon there were significant disagreements between what the public and the park believed to be acceptable research methods for wildlife management. Although KNPR has been striving to improve co-management processes, with some success (Clark 2009), factors affecting participants' ability to achieve successful co-management include: (1) overcoming the legacy of First Nations peoples' exclusion from the park; (2) Aboriginal history, entrenched positions, and resource limitations (Lotenberg 1998, Clark and Slocombe 2005); and (3) the ongoing multi-faceted negotiations amongst state management agencies and First Nations over the allocation of legitimacy, authority, and control.

**Wood Bison Management Issues**

*1. Unclear Status of Bison Within the Park*

Parks Canada's position on whether bison are considered native to KNPR remains unclear. In the KNPR Five-Year Management Plan Review and Update, Newsletter 2 (Parks Canada 2010c), "Objective 2" (p. 16) addresses the need for reducing threats from non-native species and discusses the need for active management of species-at-risk. Under "Activities" for species-at-risk, the Plan Review states the need to "Resolve KNPR's and Parks Canada's position on the status of wood bison, should they enter the park, in the context of their being the subject of a national recovery strategy" (p. 17). However, although wood bison are mentioned in the park's 2010 Management Plan (Parks Canada 2010a), the plan does not make an explicit determination about

the species' status in the park, stating only that research on bison impacts is underway that will inform future decisions about bison management in the park (p. 10) and that a bison management strategy will be developed (p. 33, 71). The plan does not reiterate the need to make such a determination, so one could interpret the discussion of bison within the plan as tacit acceptance of them as a native species. Regardless of the intent of the plan's authors, which we do not claim to know, the document effectively leaves the question of the species' status unanswered. An important consideration for the park is that if wood bison are indeed deemed native within KNPR, then CAFN feels their citizens have subsistence rights to them (L. Workman and L. Joe, pers. comm.), the implications of which are discussed below.

This is not a novel situation. Peek et al. (1987) considered the question of whether introduced plains bison (*B. bison bison*) are exotic in Wrangell-St. Elias National Park and Preserve in Alaska, which borders KNPR. Although they didn't provide a conclusive answer, they promoted a management approach that considered those bison as native. They justified their prescription on the basis of the species' history in the region (acknowledging the difference in subspecies), the persistence of the herds two decades after introduction, and the apparent lack of negative effects from bison on habitat and other wildlife.

Considerable research and historical accounts indicate that wood bison historically occurred in the Kluane region, including a specimen dated at 2180 +/- 30 years BP from Kluane Lake at Congdon Creek, which is within a few kilometres of the park boundary (Stephenson et al. 2001). The question of whether or not wood bison are native to the park area itself—as distinct from the regional ecosystem—is ecologically moot. There are no reasonable grounds for arguing that wood bison are not native to Kluane National Park, and they should be managed as though they are.

*2. Imprecise Park Policy Direction*

National parks are governed by the *Canada National Parks Act* (Parks Canada 2000), which states that "the maintenance or restoration of ecological integrity, through the protection of natural resources and natural processes, shall be the first priority of the Minister when considering all aspects of the management of parks" (Parks Canada 2000, p. 5). According to the Act, ecological integrity means, with respect to a park,"a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes" (Parks Canada 2000, p. 1).

Under this definition, if bison were considered a native species then a priori their presence would enhance the ecological integrity of the park. However, it isn't clear precisely whether KNPR's operative definition of ecological integrity means keeping the park's ecosystems "as-is" and bison-free, restoring an unknown past ecosystem state that included bison, or allowing the park landscape to evolve in concert with the larger regional ecosystem—in which bison are playing increasingly significant ecological and social roles. Sorting out that operative definition of ecological integrity will be critical. Without a clearer definition, the legal commitment to maintain ecological integrity within KNPR confounds the park's decision making processes since the concept could, at present, be legitimately invoked both in support of wood bison in the park and against it.

Multiple definitions of ecological integrity have been identified in the literature and strong critiques have been levelled at its definition in the *Canada National Parks Act* (Fluker 2003, Clark et al. 2008). The Act's definition of ecological integrity fails to take into account that ecosystems can—and often do—exhibit multiple stable states over time, and the judgment of whether one state has more or less integrity than any other is fundamentally a social decision based on values associated with particular system states (Clark et al. 2008). Any particular landscape can potentially exist in alternative ecosystem states, each of which may be ecologically stable. The implication for good governance of national parks is that such choices about who desires which particular ecosystem state—and why—must be made explicit. In order to provide guidance and direction for the management of parks, Parks Canada is responsible for determining which alternative ecosystem states satisfy the requirements of their definition of ecological integrity (Hobbs et al. 2009).

Process as well as content is also an issue in implementing decisions based on ecological integrity. Parks Canada's objective for the maintenance of ecological integrity in KNPR specifically involves having a strong First Nations presence in the park, where First Nations are interacting with the ecosystem and contributing to park management through the incorporation of their cultural traditions and knowledge (Parks Canada 2004). However, Parks Canada also states that ecosystem management shall be the process used to achieve the goal of maintaining ecological integrity, and should be both credible and solidly based in science (Parks Canada 2010b), suggesting that science takes precedence over traditional ecological knowledge (TEK) when it comes to ecosystem management of national parks. Parks Canada remains entrenched in a western scientific paradigm, which according to White (2005) restrains such an organization from successfully integrating inherently complex TEK into their management regime. Consequently, Parks

Canada's current policy framework actually reinforces the longstanding privileging of science over other knowledge sources, and also those who control or promote it (Clark et al. 2008, Sandilands 2010). Given these constraints on operationalizing ecological integrity in KNPR, the park and its co-management partners would probably arrive at better decisions if they set their goals for wood bison management in the park clearly within the region's specific social and ecological context, rather than unreflectively seeking definitive answers from higher-level policy formulations that prescribe ecological integrity in a simplistic, acontextual manner based on western science.

As well, the precautionary principle has nominally been adopted by Parks Canada as a guiding rule for determining whether a particular type or level of activity is appropriate in a national park, and "principles of precaution and adaptive management are exercised when there is a potential for significant adverse effects on the ecosystem" (Henry et al. 2008, p. 9). The current management plan for KNPR indicates that where there is insufficient empirical data or a lack of scientific certainty, decision makers should adhere to a precautionary approach (Parks Canada 2010a). However, arguments for a precautionary approach can also be given as a rationale for either the exclusion or the inclusion of bison into KNPR. On one hand, wood bison may have damaging impacts on the landscape, while on the other hand they may be seen as providing potential ecological benefits that have been absent since their extirpation. Whether precaution is used to argue for or against bison in the park depends entirely on the specific ecosystem state desired and the reference point from which judgment is made. Without clarifying such ecological goals, the lack of knowledge regarding wood bison in the park and arguments for a precautionary approach could easily lead to disagreements and impede actually reaching a decision.

*3. Resolving Subsistence Hunting of Wood Bison in KNPR*

For most species listed as extirpated, endangered, or threatened, the protections of SARA apply automatically on all federal lands, which include national parks. Under SARA, Parks Canada is responsible for the protection and recovery of listed species in national parks, national marine conservation areas, national historic sites, and other protected heritage areas administered by Parks Canada. Parks Canada assists in the protection and recovery of listed species by leading and participating in recovery teams; developing and supporting recovery strategies and priority actions; educating Canadians on species-at-risk; collecting detailed information on species' distribution and population status; and assessing how activities might affect species-at-

risk within Parks Canada's protected heritage areas and monitoring these activities for their effects (Parks Canada 2010d).

The concern for KNPR is how they would manage wood bison should the Aishihik herd expand its range into the park. Section 32(1) of SARA contains automatic prohibitions against killing or harming threatened species on federal lands. Section 35(1) states that "section 32 applies in each of the territories in respect of a listed wildlife species only to the extent that the Governor in Council, on the recommendation of the Minister, makes an order providing that they, or any of them, apply" (Government of Canada 2002). Section 35(2) states that section 35(1) does not apply on land under the authority of the Minister or the Parks Canada Agency, which means that section 32(1) applies within KNPR, prohibiting bison hunting in the park. Further, the *Canada National Parks Act* indicates that except as permitted by the regulations, no person shall hunt, in a park, any wild animal of a species named in Part 2 of Schedule 3, in which the wood bison is listed. Although there are exceptions made for traditional harvesting rights where the settlement of land claims have been finalized, it has not been resolved whether these would apply for CAFN and KFN due to the fact that wood bison in the Yukon are regarded as a "transplanted population" and not considered wildlife under the Umbrella Final Agreement (Yukon Environment 2010). Outside the park, First Nations people do not have subsistence rights for the harvesting of bison and therefore, like non-Aboriginal bison hunters, must currently obtain licences and seals from the Yukon Government. Under the *Yukon Wildlife Act's* Regulations and the *Canada National Parks Act* it is unlawful for licensed hunters to hunt wildlife of any kind within the boundaries of KNPR. Although CAFN and KFN have the right to practice traditional harvesting activities in the park, those rights are exercised within negotiated parameters and do not presently include harvesting wood bison. This situation is, however, contested by CAFN, who assert that if bison are native to the park then their citizens would have subsistence rights to bison in the park. The question of whether wood bison are native to KNPR thus assumes considerable political importance.

## Alternative Strategies for Managing Wood Bison in Kluane National Park

Based on this analysis, there are three main alternative courses of action that the park could choose: allow bison to immigrate into the park without restriction (Alternative 1); allow some bison to inhabit the park but control the number (Alternative 2); or prevent bison from entering and re-establishing in the park (Alternative 3). These alternatives are summarized in Table 1 and described further below.

Table 1. Policy alternatives for wood bison management in Kluane National Park and Reserve

| Alternative | Pros | Cons | Considerations for Implementation |
|---|---|---|---|
| **1. Allow Bison to migrate into KNPR** | • Enhances ecological integrity (depending on how defined)<br>• Enhances visitor experience<br>• Relieves pressure outside park<br>• Lowest cost<br>• Consistent with legislation and conservation initiatives | • Risk to ecological integrity (depending on how defined)<br>• Public safety concerns<br>• Increase park costs and resources<br>• Lack of knowledge<br>• Risk of property and cultural site damage<br>• Risk of conflict with Yukon government, First Nations for failing to respect the existing bison-free zone<br>• Hunting prohibited in park, difficult to control population | • First Nations subsistence harvest for bison within KNPR an unresolved issue<br>• Ensure the wood bison remain disease free, genetically diverse, and wild within park boundaries<br>• Need to determine carrying capacity of park<br>• Consistent with idea that KNPR is a wilderness park<br>• Contributes to uncertainty of changing conditions of park<br>• May need to implement mitigative measures to reduce bison impacts on ecosystem components |
| **2. Allow pre-determined number of bison into KNPR** | • Enhances ecological integrity (depending on how defined)<br>• Enhances visitor experience<br>• Less cost<br>• Knowledge acquisition<br>• Consistent with legislation and conservation initiatives | • Risk to ecological integrity (depending on how defined)<br>• Public safety concerns<br>• Risk of property and cultural site damage<br>• Higher cost–may be more costly to keep any number of bison out<br>• High risk of public criticism depending on methods<br>• Take time and resources to monitor and determine impacts<br>• Hunting prohibited in park, difficult to control population | • First Nations subsistence harvest for bison within KNPR an unresolved issue<br>• Ensure the wood bison remain disease free, genetically diverse, and wild within park boundaries<br>• Incorporates principle of precaution and adaptive management<br>• Need to determine carrying capacity of park<br>• Removal of some bison will be necessary, preventing others may be difficult<br>• Consistent with idea that KNPR is a wilderness<br>• Contributes to uncertainty of changing conditions of park<br>• May need to implement mitigative measures to reduce bison impacts on ecosystem components |
| **3. Restrict bison from entering KNPR** | • Maintains ecological integrity “as-is”<br>• Alleviates concerns of disease transmission, species competition, and impacts on cultural sites | • Loss of natural processes operative elsewhere in regional ecosystem<br>• High risk to park reputation as a wilderness park<br>• High risk of public criticism depending on methods<br>• May be very costly to keep bison out–monitoring and hands-on management will be required over the long-term<br>• Inconsistent with federal legislation and national park policy on species-at-risk | • First Nations subsistence harvest for bison within KNPR an unresolved issue<br>• Hazing, removal could be costly & difficult<br>• Would require increased hunting in area<br>• Might require increased number of tags for bison in the Yukon |

*Alternative 1*

The first alternative identified is to allow the wood bison range to expand into KNPR at the pace and extent determined by the herd itself, with no attempt to control bison numbers. Alternative 1 would be most consistent with Parks Canada's overall institutional role in conserving species-at-risk, though if this alternative was opposed by co-management partners, that symbolic gain would come at real cost in day-to-day management of the park. A deliberate decision to allow uncontrolled immigration of bison into KNPR should be preceded by resolution of the question of First Nation subsistence harvest rights for bison within the park, in order to prevent confrontations or legal challenges. KNPR would need to continue its evolution from sole management authority towards increased co-operation with other participants, largely because this would be the alternative most at odds with the policies of the greatest number of those other institutions. Community well-being could be affected positively or negatively depending on the spatial and temporal distribution of bison in the park, especially their proximity to the Village of Haines Junction (e.g., if they settled into the Dezadeash River wetlands), and whether that proximity increases bison-human conflict. Direct operational costs to KNPR may or may not be increased by this alternative as the resources required to cope with some of these contingencies could be substantial.

*Alternative 2*

The second alternative would involve KNPR predetermining an acceptable herd size to let become established within the park. As with Alternative 1, the park would need to relinquish some degree of authority and co-operate closely with stakeholders to bring this about, for much the same reasons. This alternative would require close and ongoing co-operation with the Yukon government, the Wood Bison Technical Team, First Nations, and the local pubic. Operational costs would likely increase for the park as more resources may be required to maintain a herd within the park while also investing resources into methods to restrict additional bison from immigrating. Restricting wood bison from KNPR might be accomplished through hazing, harvesting, fences, salt blocks, and the removal of bison (Gates et al. 2010), though non-lethal aversive conditioning has generally proven ineffective with Aishihik wood bison (D. Clark 2010). Of necessity, park staff would gain knowledge and skill as they learned how to actively manage wood bison. However, once the bison begin to expand their range into the park techniques to limit herd size would likely prove to be difficult, costly, time consuming, and ultimately ineffective (Meagher 1989, Plumb et

al. 2009). First Nation subsistence hunting could potentially become a means to control bison numbers and distribution within KNPR. Such an approach would reduce the costs to the park of bison control, and would allow First Nations people to reap some of the benefits of having bison on the land, as they currently do outside the park (Clark 2010). Although from CAFN's perspective having bison in the park (or elsewhere in the bison exclusion zone) is undesirable because of their potential impacts on other wildlife (Yukon Wood Bison Technical Team 2009), being able to hunt those bison might ameliorate some of those concerns. Consequently, this alternative may be the one that satisfies the broadest range of participants' distinct and shared objectives.

*Alternative 3*

The last alternative identified is to completely prevent the Aishihik wood bison herd from expanding its range into KNPR, which is the only option that CAFN currently supports. The park's primary goal to protect and maintain ecological integrity through a precautionary approach may be best achieved through this alternative. The values promoted by this alternative are in accordance with a risk-averse approach that implicitly assumes a steady-state ecosystem within the park that must be preserved in its present bison-free state. The resources required to exclude bison from the park would likely be substantial, and the park may have to pay that cost itself. The desire by First Nations to maintain the status quo of no bison in the bison exclusion zones (south of the Alaska Highway and west of the White River, including KNPR) would be indulged and would remain consistent with the intent of the draft bison management plan. As with Alternative 2 above, it is easy to conceive a potential solution that involves First Nation subsistence hunting in and adjacent to the park to effect the exclusion of bison.

## Implementing a Wood Bison Management Strategy for Kluane National Park

The decision to allow or prohibit bison from KNPR involves a complex set of issues and many legitimate participants interacting in a rapidly-changing ecosystem. Developing a bison management strategy for the park will require the active engagement of stakeholders and their interests, mandates, and aspirations, and further enhancing local community and agency capacity to engage in the co-operative management of bison throughout the Yukon landscape (Gates et al. 2010). The proximate policy problem described is that KNPR currently lacks such a strategy for wood bison, but there are a multitude of underlying unresolved issues identified, which such a document

would have to address. Such issues include historic relations with First Nations, challenges of maintaining co-management regime functionality, the integration of science with local and traditional knowledge, knowledge gaps, scientific uncertainty, the debated status of wood bison within KNPR, park policy regarding the operational definition of ecological integrity, and First Nations subsistence rights for wood bison within the park.

Specifying the goal for the park's bison management strategy will require difficult normative choices to be made. Essentially, these choices are about who receives what benefits (or bears what costs) from the presence or absence of bison within Kluane National Park, and under what circumstances. These choices will necessarily be more about values than science, and while science can inform such choices it alone cannot provide the answers. The long-running conflict over mountain goat management in Olympic National Park, Washington is a cautionary tale for KNPR that underscores the importance of acknowledging and dealing explicitly with values in controversial situations (Wright 1992, Wagner et al. 1995). Resolving the question of First Nations subsistence rights to bison within the park is an urgent priority, and should not become a reason to avoid making a determination on the species' native or non-native status there. Failure to come to agreement on such rights in a timely manner—especially if bison entered the park on their own, forcing some kind of response—would risk acrimony and tensions that would hinder further decision making in the co-management arena.

Nonetheless, there are specific actions that would be beneficial no matter what course of action is desired and pursuing one or more of these might help co-managers build consensus about bison management goals. If an alternative involving bison immigration is selected, the next step should be determining desired population and range condition thresholds for the regions of the park that the bison are expected to make use of. This would ensure clarification of what ecological integrity means for KNPR in this situation: a critical task. Second, undertaking a regional-scale Population and Habitat Viability Analysis (Westley et al. 2003) would involve the park, co-management partners, and other stakeholders in a collaborative exercise intended to provide a comprehensive set of projections and identified uncertainties about the effects of bison immigrating into the park. As a means for enhancing co-operation and clarifying standpoints, such an exercise could be beneficial for the Yukon's bison policy process as a whole. Neither of these techniques, however, would reduce the likelihood of ecological surprises, which participants also need to be aware of. Given the history of the Aishihik herd's range expansion, it may eventually come to occupy a larger area of the park—or even unexpected regions of it—than currently anticipated.

Finally, any bison management strategy for the park should not be a stand-alone document, but must be developed and implemented in concert with the existing territorial bison management plan (Yukon Environment 2010). This isn't to say that the management objectives should be the same inside and outside the park; just that the planning processes should be coordinated through authoritative decision making arenas. Those arenas already exist: the Yukon Wood Bison Technical Team and Management Team, the Alsek Renewable Resource Council, and the Kluane National Park Management Board. Active, consistent, and ongoing participation by KNPR personnel in the Technical Team (an engagement that has now begun) would be the logical approach to such coordination, and is endorsed in the most recent park management plan (Parks Canada 2010a, pp. 33, 71). Eventually, formal participation by Parks Canada and/or the Kluane management board on the Yukon Wood Bison Technical and Management Teams would become warranted if wood bison re-inhabited the park.

Contributing to the difficulty of filling the knowledge gaps regarding wood bison in the park is the constantly changing landscape of the region (Slocombe 2001). Current concerns for the park involve impacts of climate change, absence of natural fire regimes, and spruce beetle outbreaks (Henry et al 2008, Parks Canada 2010a). Adaptive management is an approach for managing ecosystems under uncertainty (Prato 2006) and may be a useful strategy for making decisions here, where there is a great deal of uncertainty regarding how wood bison will influence ecosystem states and responses within the park. In a view shared by many other authors (e.g., Holling 1978, Walters 1986, Lee 1993, Ludwig et al. 1993), Prato (2006) indicates that the dynamic nature of the environment results in a certain degree of ecological uncertainty when it comes to the management of ecosystems: managers ought to prepare themselves for occasional unexpected outcomes, and perceive such outcomes as learning opportunities rather than as a failure to predict ecological responses. An adaptive management approach could help park personnel to learn cumulatively from wood bison dynamics in the park, improving the chances of developing a long-term management strategy that could help address the difficult question of whether the benefits of bison integration into the park outweigh the costs. Deterrents to an adaptive management approach involving wood bison range expansion into the park likely exist though, including financial and human resource constraints and even rigid interpretations of what are at least nominally the core park management principles: ecological integrity and the precautionary approach. While adaptive management could generate new knowledge and a greater understanding of both wood bison and KNPR ecology, doctrinaire

interpretation of national policy may also inhibit park managers from adopting such a strategy for fear of compromising ecological integrity.

Conversations about the management of free-ranging herd animals such as bison often result in debates over values and epistemologies (Cromley 2000). Therefore, the best way for KNPR to begin is "first, with a partnership that can effectively understand and address all the problems at hand, and second, with an integrated, adaptive, problem solving approach" (Clark and Brewer 2000, p. 14). The development of a successful wood bison management strategy for Kluane National Park is contingent upon KNPR, the park's co-management partners—especially First Nations—and all other participants continuing to build mutual respect and collaboration as they face this challenging, dynamic, and complex situation. The common interest in wood bison management in southwest Yukon seems to be for a healthy, viable herd that benefits all Yukoners in diverse but legitimate ways, while minimizing negative socio-economic impacts from the species and associated human activities. A rational, feasible, and justifiable decision about the future of bison in the park will require a high-functioning and open co-management process so that participants with different values, knowledge, strategies, and interests can articulate and achieve that common interest.

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## Notes

1. Federal budget cuts in spring 2012 have resulted in the loss of some park staff. Consequently, we do not claim that this observation is necessarily representative of current knowledge and positions of the remaining staff, nor should it be interpreted as the position of KNPR, Parks Canada, or any other organization we have listed.

## Literature Cited


Castro, A.P., and E. Nielson. 2001. "Indigenous Peoples and Co-management: Implications for Conflict Management." *Environmental Science and Policy* 4: 229–239.

Clark, D. 2009. "Societal Dynamics in Grizzly Bear Conservation: Vulnerabilities of the Ecosystem-Based Management Approach." *Park Science* 26(1): 50–53.

Clark, D. 2010. Assessment of the Socio-Economic Impacts on First Nations from the Wood Bison Transplantation in the Southwest Yukon, Draft.

Clark, D., S. Fluker, and L. Risby. 2008. "Deconstructing Ecological Integrity Policy in Canadian National Parks." In *Transforming Parks and Protected Areas: Policy and Governance in a Changing World*, edited by K.S. Hanna, D. Clark, and D.S. Slocombe, 154–168. New York: Routledge.

Clark, D., and D.S. Slocombe. 2005. "Re-Negotiating Science in Protected Areas: Grizzly Bear Conservation in the Southwest Yukon." In *Presenting and Representing Environments*, edited by G. Humphreys and M. Williams. GeoJournal Library, Volume 81, 33–53.

Clark, D., D. Lee, M.M.T. Freeman, and S.G. Clark. 2008. "Polar Bear Conservation in Canada: Defining the Policy Problems." *Arctic* 61(4): 347–360.

Clark, S.G. 2011. *The Policy Process: A Practical Guide for Natural Resource Professionals*. New Haven CT: Yale University Press.

Clark, T.W. and G.D. Brewer. 2000. "Introduction." In *Developing Sustainable Management Policy for the National Elk Refuge, Wyoming*, edited by T.W. Clark, D. Casey, and A. Halverson, 9–22. Bulletin No. 104. New Haven: Yale School of Forestry and Environmental Studies Bulletin Series.

Clark, T.W., N. Mazur, S. Begg, and S. Cork. 2000. "Interdisciplinary Guidelines for Developing Effective Koala Conservation Policy." *Conservation Biology* 14(3): 691–701.

Cromley, C.M. 2000. "Developing Sustainable Management Practices: Lessons from the Jackson Hole Bison Management Planning Process." In *Developing Sustainable Management Policy for the National Elk Refuge, Wyoming*, edited by T.W. Clark, D. Casey, and A. Halverson, 66–100. Bulletin No. 104. New Haven: Yale School of Forestry and Environmental Studies Bulletin Series.

Cromley, C.M. 2002. "Bison Management in the Greater Yellowstone." In *Finding Common Ground, Governance and Natural Resources in the American West*, edited by R.D. Brunner. New Haven: Yale University Press.

Environment Yukon. 2010. *Yukon Hunting Regulations Summary 2010-2011*. http://environmentyukon.gov.yk.ca/huntingtrapping/documents/huntingregs2010_11.pdf.

Farnell, R., P.G. Hare, E. Blake, V. Bowyer, C. Schweger, S. Greer, R. Gotthardt. 2004. "Multidisciplinary Investigations of Alpine Ice Patches in Southwest Yukon, Canada: Paleoenvironmental and Paleobiological Investigations." *Arctic* 57: 247–59.

Fluker, S. 2003. "'Maintaining Ecological Integrity is Our First Priority'"—Policy Rhetoric or Practical Reality in Canada's National Parks? A case comment on *Canadian Parks and Wilderness Society v. Canada (Minister of Canadian Heritage)*." *Journal of Environmental Law and Practice* 13: 131–146.

Frandsen, D. 2004. Developing a Transboundary Management Strategy for a Free-ranging Plains Bison Population, Species at Risk 2004, *Pathways to Recovery Conference, March 2–6, Victoria, BC.* http://www.llbc.leg.bc.ca/public/pubdocs/bcdocs/400484/toc.htm.

Gardner, C.L., and A.R. DeGange. 2003. *A Review of Information on Wood Bison in Alaska and Adjacent Canada, With Particular Reference to the Yukon Flats*. Alaska Department of Fish and Game, Appendix A – Joint ADF&G and FWS review of wood bison restoration on Yukon Flats.

Gates, C.C., C.H. Freese, P.J.P. Gogan, and M. Kotzman (Eds). 2010. *American Bison Status, Survey, and Conservation Guidelines 2010*. Gland, Switzerland: IUCN.

Gates, C.C., R.O. Stephenson, H.W. Raynolds, C.G. van Zyll de Jong, H. Schwantje, M. Hoefs, J. Nishi, N. Cool, J. Chisholm, A. James, and B. Koonz. 2001. National Recovery Plan for the Wood Bison (*Bison bison athabascae*), National Recovery Plan No. 21, Recovery of Nationally Endangered Wildlife (Renew). Ottawa, Ontario.

Government of Canada. 2000. *Canada National Parks Act*, S.C. 2000, c. 32. http://laws-lois.justice.gc.ca/PDF/N-14.01.pdf.

Government of Canada. 2002. *Species At Risk Act*, S.C. 2002, c. 29. http://laws-lois.justice.gc.ca/eng/acts/S-15.3/FullText.html.

Harper, W.L., J.P. Elliot, I. Hatter, H. Shwantje. 2000. *Management Plan for Wood Bison in British Columbia*, BC. Victoria, BC: Ministry of Environment, Lands and Parks.

Hayes, C., and S. Allen. 2007. Cooperative Management of National Parks and Historic Sites: Priority Areas Identified Towards Developing Best Practices for Aboriginal Boards and Parks Canada, 2007 Conference Report. http://www.nsi-ins.ca/english/pdf/Learning%20From%20Cooperative%20Management%20Conference%20Report.pdf.

Heffner, T. 2008. "The Role of Post-Glacial Lakes in the Pre-Contact Human History of Southwest Yukon Territory: A Late Drainage Hypothesis." *The Northern Review* 29: 85–115.

Henry, D., A. Landry, T. Elliot, L. Gorecki, M. Gates, and C. Chow. 2008. *State of the Park Report, Kluane National Park and Reserve of Canada*. http://dsp-psd.pwgsc.gc.ca/collection_2009/pc/R63-365-2008E.pdf.

Hobbs, R.J., D.N. Cole, L. Yung, E.S. Zavaleta, G.H. Aplet, F. Stuart Chapin III, P.B. Landres, D.J. Parsons, N.L. Stephenson, P.S. White, D.M. Graber, E.S. Higgs, C.I. Millar, J.M. Randall, K.A. Tonnessen, and S. Woodley. 2009. "Guiding Concepts for Parks and Wilderness Stewardship in an Era of Global Environmental Change." *Frontiers in Ecology and the Environment*, E-View pre-print, Dec 2, 2009. http://www.treesearch.fs.fed.us/pubs/34151.

Holling, C.S. 1978. *Adaptive Environmental Assessment and Management*. New York, NY: John Wiley and Sons.

Larter N.C., A.R.E. Sinclair, T. Ellsworth, J. Nishi, and C.C. Gates. 2000. "Dynamics of Reintroduction in an Indigenous Large Ungulate: The Wood Bison of Northern Canada." *Animal Conservation* 4: 299–309.

Larter, N.C. and D.G. Allaire. 2007. *History and Current Status of the Nahanni Wood Bison Population,* Department of Environment and Natural Resources Government of the Northwest Territories, File Report No. 136. http://www.nwtwildlife.com/Publications/FileReports/FileReports/136.htm.

Lee, K.N. 1993. *Compass and Gyroscope: Integrating Science and Politics for the Environment*. Washington, DC: Island Press.

Lotenberg, G. 1996. *History of Wood Bison in the Yukon: A Re-evaluation Based on Traditional Knowledge and Written Records*. Whitehorse, YT: Yukon Dept. of Fish & Wildlife.

Lotenberg, G. 1998. *Recognizing Diversity: An Historical Context for Co-Managing Wildlife in the Kluane Region, 1890–Present*. Whitehorse: Parks Canada.

Ludwig, D., R. Hilborn, and C. Walters, C. 1993. "Uncertainty, Resource Exploitation and Conservation: Lessons from History." *Science* 60: 17–36.

Meagher M. 1989. "Evaluation of Boundary Control for Bison of Yellowstone National Park." *Wildlife Society Bulletin* 17: 15–19.

Nadasdy, P. 2003. *Hunters and Bureaucrats: Power, Knowledge, and Aboriginal-State Relations in the Southwest Yukon*. Vancouver: UBC Press.

Natcher, D.C. and S. Davis. 2007. "Rethinking Devolution: Challenges for Aboriginal Resource Management in the Yukon Territory." *Society and Natural Resources* 20: 271–279.

Natcher, D.C., S. Davis, and C.G. Hickey. 2005. "Co-Management: Managing Relationships, Not Resources." *Human Organization* 64(3): 240–250.

Noss, R.F. 2001. "Why Restore Large Mammals?" In *Large Mammal Restoration, Ecological and Social Challenges in the 21 Century*, edited by D.S. Maehr, R.F. Noss, J.L. Larkin, 1–22. Washington, DC: Island Press.

Parks Canada. 2004. *Kluane National Park and Reserve of Canada Management Plan April, 2004.* Parks Canada, Ottawa, ON.

Parks Canada. 2010a. *Kluane National Park and Reserve of Canada Management Plan April, 2010*. http://www.pc.gc.ca/pn-np/yt/kluane/plan.aspx.

Parks Canada. 2010b. *Ecological Integrity*. http://www.pc.gc.ca/eng/progs/np-pn/ie-ei.aspx.

Parks Canada. 2010c. *Kluane National Park & Reserve of Canada Five-Year Management Plan Review and Update 2010, Newsletter #2 – February 2010*. http://www.pc.gc.ca/pn-np/yt/kluane/~/media/pn-np/yt/kluane/pdfs/knpr_newsletter_no2.ashx.

Parks Canada. 2010d. *Species at Risk, What is Parks Canada's Role?* http://www.pc.gc.ca/nature/eep-sar/itm1/eep-sar1e.aspx.

Peek, J.M., D.G. Miquelle, and R.G. Wright. 1987. "Are Bison Exotic in the Wrangell-St. Elias National Park and Preserve?" *Environmental Management* 11(2): 149–153.

Penikett, T. 2006. *Reconciliation: First Nations Treaty Making in British Columbia*. Vancouver, BC: Douglas and McIntyre.

Plumb G.E., P.J. White, M.B. Coughenour, and R.L. Wallen. 2009. "Carrying Capacity, Migration, and Dispersal in Yellowstone Bison." *Biological Conservation* 142: 2377–2387.

Prato, T. 2006. Adaptive Management of National Park Ecosystems. *The George Wright Forum* 23(1): 72–86. http://georgewright.org/231.prato.pdf.

Rutherford, M.B., M.L. Gibeau, S.G.C. Clark, and E.C. Chamberlain. 2009. "Interdisciplinary Problem Solving Workshops for Grizzly Bears in Banff National Park, Canada." *Policy Sciences* 42(2): 163–187.

Sanderson, E.W., K.H. Redford, B. Weber, K. Aune, D. Baldes, J. Berger, D. Carter, C. Curtin, J. Derr, S. Dorbrott, E. Fearn, C. Fleener, S. Forrest, C. Gerlach, C. Gates, J.E. Gross, P. Gogan, S. Grassel, J.A. Hilty, M. Jensen, K. Kunkel, D. Lammers, R. List, K. Minkowski, T. Olson, C. Pague, P.B. Robertson, and B. Stephenson. 2008. "The Ecological Future of the North American Bison: Conceiving Long-Term, Large-Scale Conservation of Wildlife." *Conservation Biology* 22(2): 253–266.

Sandilands, C. 2010. "The Cultural Politics of Ecological Integrity: Nature and Nation in Canada's National Parks, 1885–2000." *International Journal of Canadian Studies* 3940: 161–189.

Slocombe, D.S. 2001. "Climate and Other Sources of Change in the St. Elias Region." In *Global Change and Protected Areas*, edited by G. Visconti et al., 61–70. Dordrecht, NL: Kluwer Academic Publishers.

Stephenson, R.O, S.C. Gerlach, R.D. Guthrie, C.R. Harington, R.O. Mills, and G. Hare. 2001. "Wood Bison in Late Holocene Alaska and Adjacent Canada: Paleontological, Archaeological and Historical Records." In *People and Wildlife in Northern North America: Essays in Honour of R. Dale Guthrie*, edited by S.C. Gerlach and M.S. Murrray. Fairbanks: University of Alaska Fairbanks, BAR International Series 2001.

Stevenson, M.G. 2004. "Decolonizing Co-Management in Northern Canada." *Cultural Survival Quarterly*, Issue 28.1, Spring 2004. http://www.culturalsurvival.org/publications/cultural-survival-quarterly/canada/decolonizing-co-management-northern-canada.

Wagner, F.H., R. Foresta, R.B. Gill, D.R. McCullough, M.R. Pelton, W.F. Porter, and H. Salwasser. 1995. *Wildlife Policies in the US National Parks*. Washington, DC: Island Press.

Walters, C.J. 1986. *Adaptive Management of Renewable Resources*. New York, NY: McGraw Hill.

Westley, F.R., and P.S. Miller (Eds). 2003. *Experiments in Consilience: Integrating Social and Scientific Responses to Save Endangered Species*. Washington, DC: Island Press.

White, G. 2005. "Cultures in Collision: Traditional Knowledge and Euro-Canadian Governance Processes in Northern Land-Claim Boards." *Arctic* 59(4): 401–414.

Wildlife Collision Program. 2010. *Wood Bison in Canada*. http://www.wildlifeaccidents.ca/bisonhomepage.htm.

Wilkinson, K.M., S.G. Clark, and W.R. Burch. 2007. *Other Voices, Other Ways, Better Practices: Bridging Local and Professional Environmental Knowledge*. New Haven: Yale School of Forestry and Environmental Studies. http://environment.yale.edu/publication-series/5335.

Wright, G. 1992. *Wildlife Research and Management in the National Parks*. Chicago, IL: University of Illinois Press.

Yukon Environment. 2010. *Yukon Wood Bison Management Plan*. http://www.Yukon Environmentm.ca/mgmtplans/bisonplan/yukon.php.

Yukon Wood Bison Technical Team. 2009. *Management Plan for the Aishihik Wood Bison Herd in Southwestern Yukon: 2010–2020*. Yukon Department of the Environment, Whitehorse, Yukon, Draft Six.