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12

Ecological Restoration in the Canadian Rocky Mountains: Developing and Implementing the 1997 Banff National Park Management Plan

Clifford A. White and William Fisher

Banff National Park: Overview and management history

Introduction

A little over a century ago, the cultures of hunter-gathers that had occupied the Canadian Rockies for over ten millennia were rapidly replaced by an industrial culture advancing from both the Pacific and Atlantic Oceans. The government of Canada established large areas of national parks yet, within a few decades, long-term ecosystem states and processes were dramatically altered. The Bow Valley of Banff National Park (BNP) (see Figure 12.1) is the birthplace of Canada's national park system, established in 1885. It is also the busiest area of any Canadian national park, and one of the most developed landscapes (see Figure 12.2) within any national park in the world (BBVS, 1996). Due to historical development patterns, the Bow Valley holds a transcontinental railroad, the four-lane Trans Canada Highway, two large towns (Banff and Canmore), and another very busy visitor service centre (Lake Louise). Several million people per year pass through the BNP on the highway, and many utilize the national park trails and roads.

Yet, possibly because it is adjacent to large areas with lower development, the BNP is still utilized by a full assemblage of large native mammals with the exception of bison (*Bison bison*). Key indicator species for Rocky Mountain montane ecosystems include humans, wolf (*Canis lupus*), grizzly bear (*Ursus arctos*), black bear (*U. americanus*), elk (*Cervus elaphus*), bison, beaver (*Castor canadensis*), trembling aspen (*Populus tremuloides*) and willow (*Salix* spp.). Processes include human-caused wildlife mortality and displacement, human- and lightning-caused fire, predation and herbivory (see Figure 12.2).

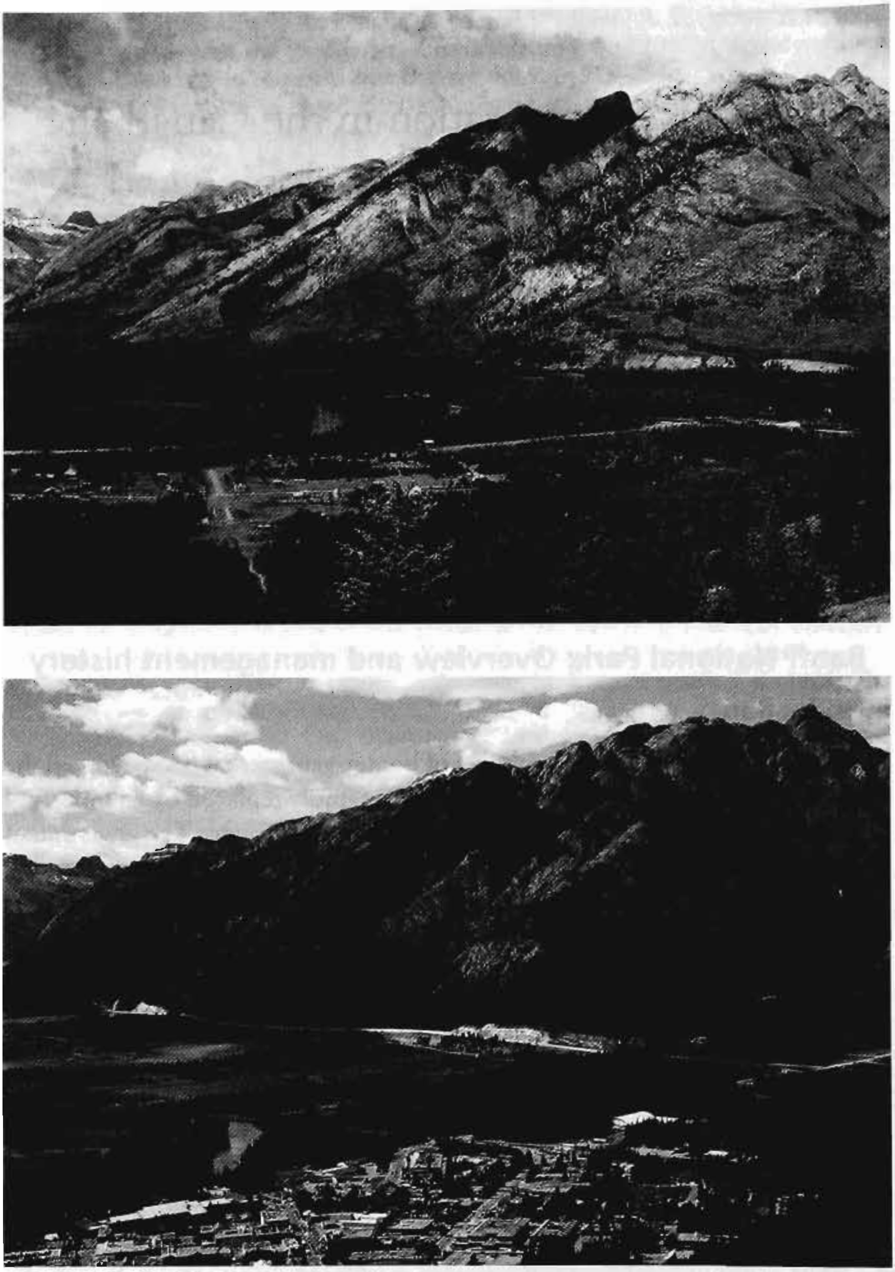


Figure 12.1 Banff townsite area of the Bow Valley, Banff National Park in 1902 (*top*) and 1997 (*bottom*)

Note: Riparian areas in the early photograph show willow and white spruce communities. Uplands sites are dominated by grasslands, shrub lodgepole pine, aspen thickets and isolated Douglas fir that resulted from frequent fires. The recent photograph illustrates the effects of fire suppression, highway construction and the urban development of Banff townsite, which has constricted wildlife movement to narrow corridors.

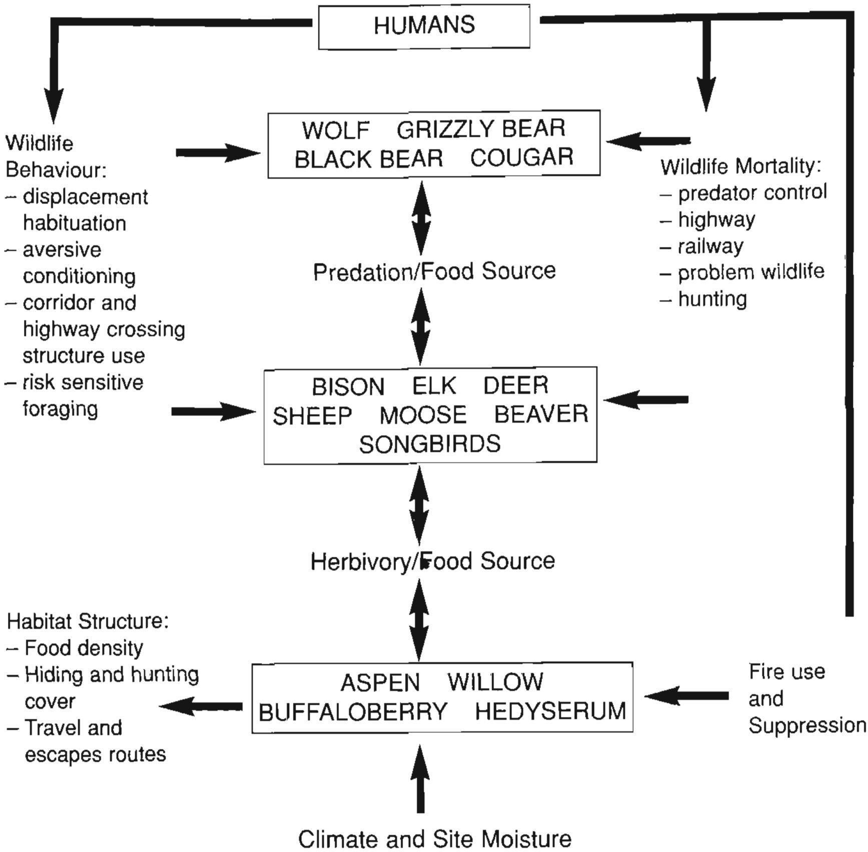


Figure 12.2 Montane ecosystem indicator states and processes for Banff Bow Valley

Source: Parks Canada (2002)

Management of this suite of species and processes has been difficult in BNP (BBVS, 1996; Hebblewhite et al, 2005) and particularly controversial in Yellowstone National Park (Huff and Varley, 1999; Ripple et al, 2001), Jackson Hole, Wyoming (Clark, 1999; Hessl, 2002) and Rocky Mountain National Park, Colorado (Hess, 1993; Baker et al, 1997) in the western US. Of great concern is the decline in abundance of palatable browse species, such as willow and aspen, due to high ungulate herbivory levels when combined with the restoration of the long-term regime of relatively frequent fires (White et al, 1998).

In this chapter, we describe landscape-level management in BNP, focusing on the Bow Valley. We first provide a brief synopsis of evolving ecosystem and national park management paradigms. Next we describe a recent ecosystem restoration programme that involved four broad components:

1 developing working or knowledge evaluation groups from a wide-range of stakeholder interests;
2 encouraging consilience by providing working groups with multidisciplinary knowledge;
3 advising decision-makers with potential outcomes based upon interdisciplinary advice;
4 implementing actions through an adaptive management approach with monitoring and feedback to stakeholders, scientists and managers.

We describe application of this process to ecosystem management in Banff, using as an example the restoration of long-term predator/prey interactions disrupted by modern human land use in the montane ecosystem. We conclude with opportunities for future interdisciplinary research and adaptive management.

National park management history

National park management in North America has ranged from policies that encouraged intensive terrestrial and aquatic ecosystem husbandry of select species for direct human benefit (for example, facility protection from fire, wildlife viewing and fishing), to more ecological science-based policies that evolved from a natural regulation objective that minimized any human intervention, to a more biologically focused objective, termed ecological integrity. Each of these policies has been based on prevailing scientific paradigms for trophic interactions in ecosystems, and has been applied to biological conservation in the BNP.

Tourism development and resource husbandry (1880s–1960)

Most North American national parks were established to develop tourism for economic benefit (Bella, 1987). In the case of Banff, the federal government initially kept most lands under public ownership to remove unregulated development around the hot springs, while working with the Canadian Pacific Railway company to develop tourism activities for visitors to the company's Banff Springs Hotel (Hart, 2003). The elimination of forest fires was important to protect forests, buildings, stock fences and bridges. Timber harvesting was encouraged in many areas to provide fuel breaks from fires and a local source of building materials and mine props (Nelson and Byrne, 1966). Park wardens killed predators such as wolves, cougars (*Felis concolar*) and coyotes (*Canis latrans*) (Jones, 2002) to increase populations of ungulate species most easily visible to tourists such as elk, bighorn sheep (*Ovis canadensis*), white-tail deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionas*). From 1944 to 1969, domestic stock grazing management guidelines were utilized to determine culling levels for BNP's elk herd. Additional extensive development for tourism during this period included high-speed highways and mechanized ski areas (BBVS, 1996).

Natural regulation (1960s–1980s)

By the 1950s, the ecological roles of predation, herbivory and fire were increasingly appreciated, and scientists recommended adoption of 'natural regulation' policies. Predator control ended in Yellowstone National Park by 1950 and in BNP by 1965 (Jones, 2002). Elk culling stopped in both parks by 1970. Similarly, progress towards letting lightning fires burn began in the national parks of the western US in the 1970s (Pyne, 1995). A 'bottom-up' hypothesis for ecosystem function was the main scientific paradigm underlying natural regulation policy (Kay, 1998). Key tenets of natural regulation included:

- Predators generally remove only the weak and the infirm individuals (doomed surplus), thus in areas such as Yellowstone and the BNP where wolves were rare or absent, they could be regarded as 'non-essential adjuncts' (Cole, 1971).
- Vegetation and climate regulate ungulate populations at ecological carrying capacity (Caughley, 1979) where herbivore impacts may be relatively high in contrast to levels specified by range management guidelines.
- Humans were perceived to have a relatively insignificant long-term role in ecosystem function, particularly related to fire frequency (Johnson et al, 1995; Pyne, 1995), or hunting effects on populations of ungulates (Huff and Varley, 1999).

Ecological research on natural (for example, non-human) systems dominated. In the absence of cultural understanding, observed large-scale changes, such as declining in-park fire frequencies or wildlife population change, were often attributed to non-human factors such as climate change (Johnson and Larsen, 1991).

Ecological integrity and the long-term range of variability (after 1990)

A current primary mandate of national parks in Canada is to maintain or restore ecological integrity. Parks Canada Agency (2000) states that:

> *an ecosystem has integrity when it is deemed characteristic for its natural region, including the composition and abundance of native species and biological communities, rates of change, and supporting processes.*

A useful approach to evaluating ecological integrity is the historical or long-term range of variability (Landres et al, 1999; Morgan et al, 1994). The principles of the paradigm are: first, current ecosystems are the product of past conditions and processes; second, spatial and temporal variability in disturbance regimes are a vital attribute of ecosystems; and third, maintenance or restoration of long-term ecosystem states and processes will conserve biodiversity (Landres et al, 1999). The approach requires interdisciplinary scientific research to test predictions for the long-term condition of indicators defining ecosystem states and processes (for example, Kay et al, 1999). In many landscapes, careful, unbiased assessment of humans' past effects will be important (Kay and White, 1995). Humans may have been an important long-term ecological factor. For this reason, herein we avoid using the phrase 'natural range of variability' (Landres et al, 1999) because this describes a preconception of long-term conditions that may not be applicable to many ecosystems.

Some key questions related to this hypothesis include: how do top-down processes, such as predation and herbivory, interact with bottom-up processes such as climate change and fire? Can large carnivores be restored in modern

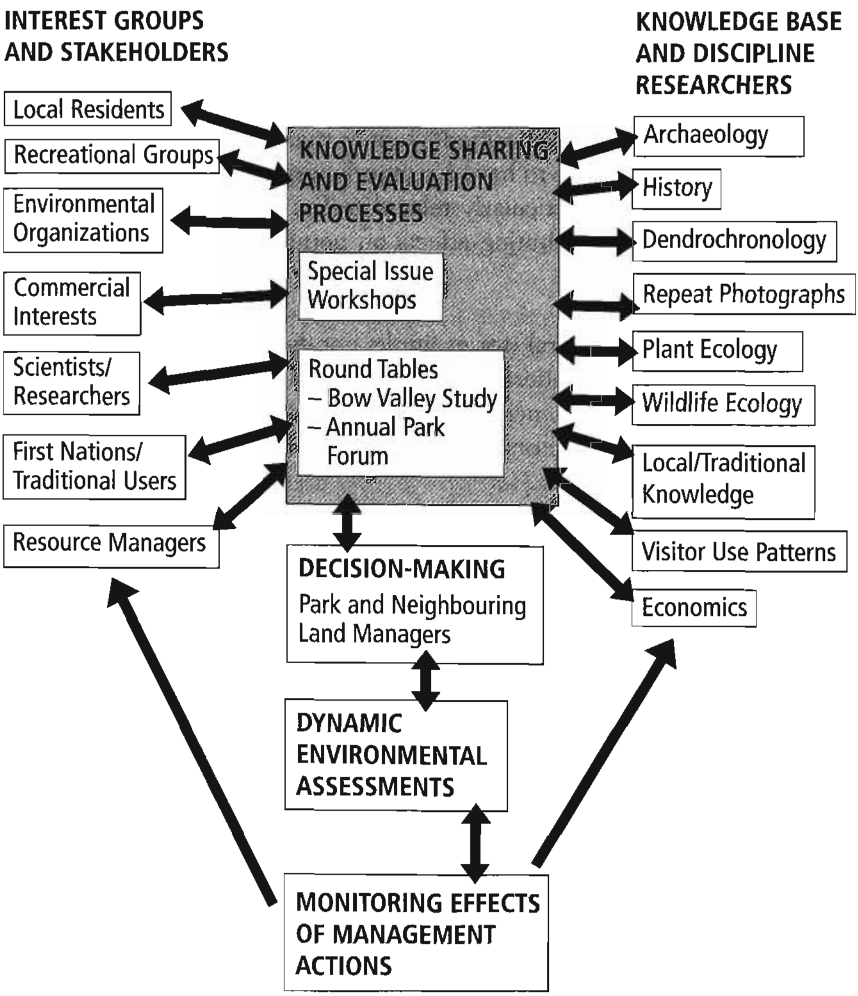


Figure 12.3 A model of collaborative and decision-making processes that guided ecosystem restoration in the Banff Bow Valley (1994–2004)

landscapes to population levels where the long-term predation process is functional? To what degree do modern human influences, such as highway-caused wildlife mortality and habitat fragmentation, impact the ecosystem? Where or when should historic human influences such as hunting and burning be restored? Where restoration actions such as highway mitigation, corridor restoration or prescribed burning appear necessary, how should they be prioritized and implemented?

Collaboration and interdisciplinarity in park planning

The paradigms for national park management described above were dominated by a current individual discipline or objective. Early park development was driven by economic development, resource husbandry by forestry and range management, and natural regulation by ideas then current in wildlife management. The concepts of ecological integrity and ecosystem management encourage broader citizen participation (Cortner and Moote, 1999). But how can this be facilitated, when academic research is increasingly specialized and interest groups are increasingly polarized? Reviews of the BNP experience (for example, Draper, 2000; Hodgins et al, 2000; Jamal and Getz, 1999; Jamal et al, 2002; Wight, 2001; Zinkan and Syme, 1997) suggest a multiphase process (see Figure 12.3). First, it is essential to develop collaborative processes with stakeholders with a broad range of interests. Second, these groups need to be supported with a wide range of knowledge. Third, these groups need to provide decision-makers with recommendations based upon consilience developed through a collaborative social learning process. Fourth, actions initiated by managers should be implemented adaptively with feedback to both researchers and stakeholders. We describe each of these phases in more detail below.

Stakeholder collaboration and a future vision

As Canada's first and most developed national park, BNP has the mixed blessing of both great affection from many Canadians, but also great economic dependence on the tourism industry. Further, because the park includes a town and is close to the city of Calgary, local knowledge is abundant. These factors encourage strong citizen participation from many sectors of society (see Figure 12.3). Although Parks Canada has a long history of public participation and education, one of the strongest initiatives occurred during the Banff Bow Valley Study (BBVS) from 1994 to 1996 (BBVS, 1996). The minister responsible for Parks Canada mandated (BBVS, 1996) that:

> *The Banff Bow Valley Study will be a comprehensive analysis of the state of the Bow Valley watershed in Banff National Park. The study will provide a baseline for understanding the implications for*

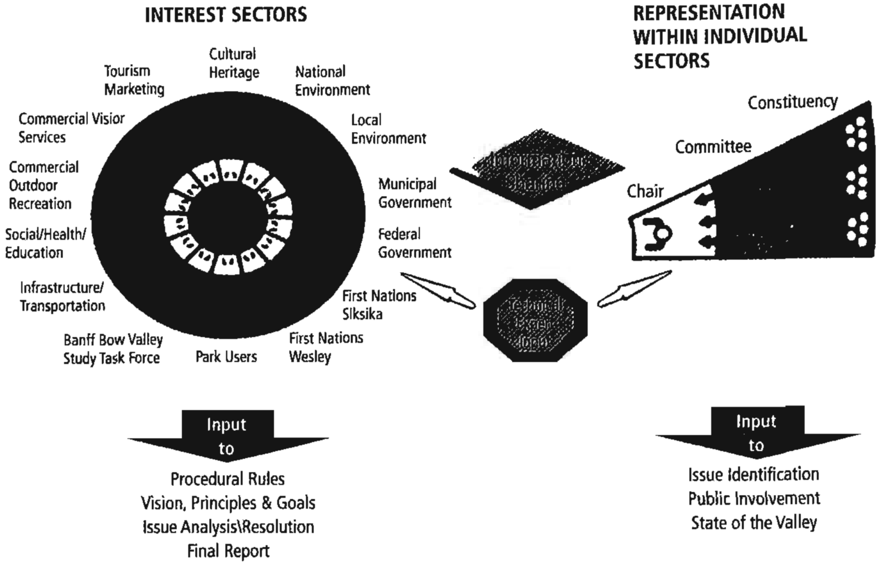


Figure 12.4 The Banff Bow Valley Study round table process

Source: BBVS (1996)

> *existing and future development and human use, and the impact of such on heritage resources. The study will integrate environmental, social, and economic considerations in order to develop management and land use strategies that are sustainable and meet the objectives of the National Parks Act.*

The core working group for the BBVS was an interdisciplinary task force and secretariat (BBVS, 1996). The study's first objective was to develop a vision and goals for the valley, which was achieved by assembling a round table (see Figure 12.4) representing a broad range of interests, and informed by information from many disciplines (Hodgins et al, 2000; Ritchie, 1999). Ultimately, the vision statement developed by the round table guided direction for the overall park management plan, as stated by Parks Canada (1997):

> *Banff National Park reveals the majesty and wildness of the Rocky Mountains. It is a symbol of Canada, a place of great beauty, where nature is able to flourish and evolve. People from around the world participate in the life of the park, finding inspiration, enjoyment, livelihoods, and understanding. Through their wisdom and foresight in protecting this small part of the planet, Canadians demonstrate leadership in forging healthy relationships between people and nature. Banff National Park is above all else a place of wonder, where the richness of life is respected and celebrated.*

The practice of involving interest groups to develop and refine goals, and to advise park managers, continued after the BBVS with a round table discussion of park management directions and progress held at an annual park management forum. Further, several groups of stakeholders, experienced in the process of collaboration, continued to participate in shared decision-making processes, including the Banff Townsite Elk Advisory Committee, the Montane Science Advisory Group and the Lands Adjacent to the Town of Banff Advisory Committee.

Multidisciplinary knowledge

Quality information is required to feed a stakeholder review process. Although ideally it would be best if knowledge could be integrated and synthesized prior to presentation to stakeholders (that is, interdisciplinarity), in practice most research is quite specialized and is analysed and peer-reviewed under the paradigms prevalent in the individual disciplines (Endter-Wada et al, 1998). Thus, information available to stakeholders is most frequently provided in parallel streams, best termed 'multidisciplinary' (Balsiger, 2004). For the BNP example, we describe several disciplines that provided the most relevant information for the montane ecosystem (see Figure 12.3).

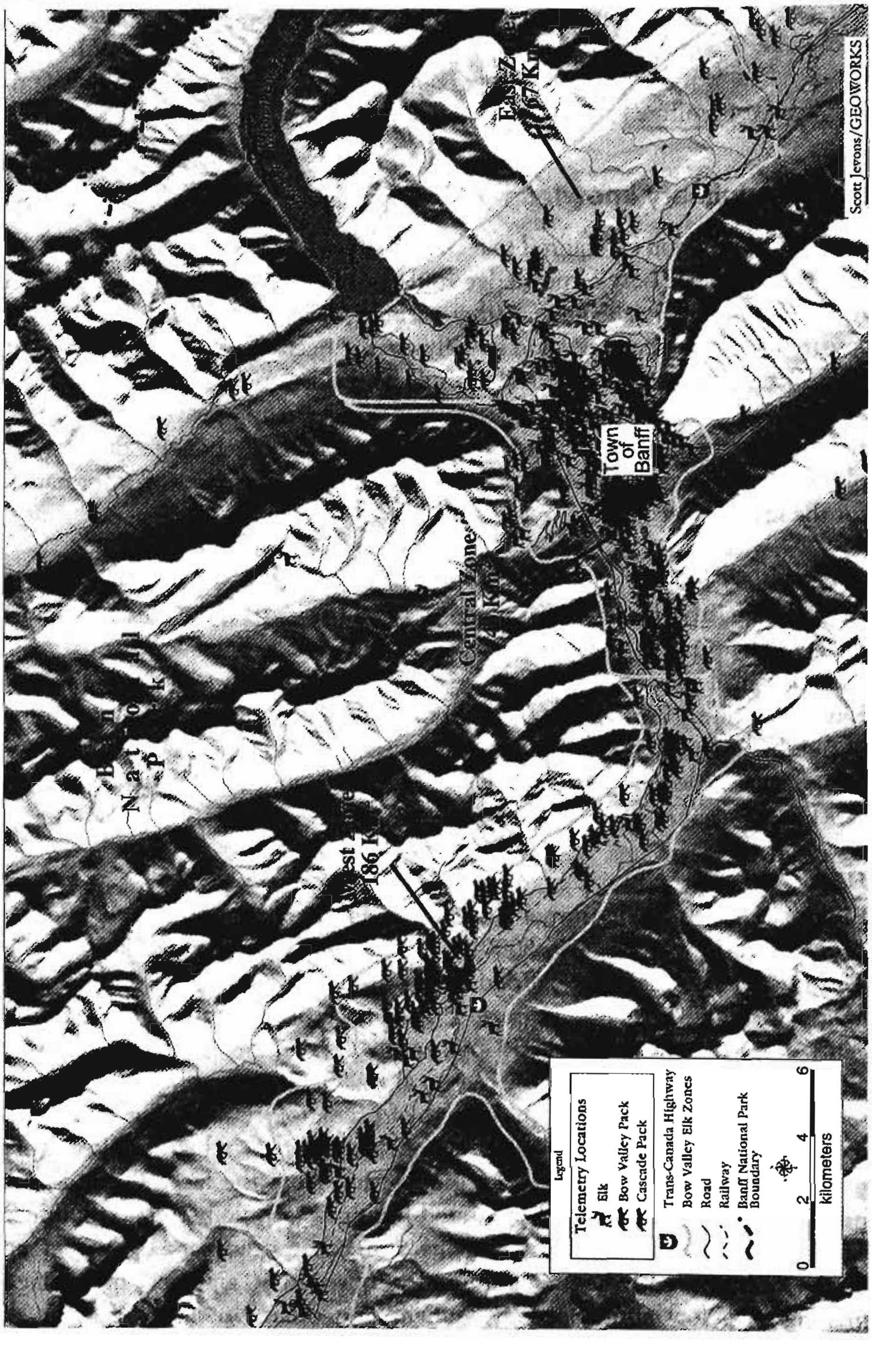
Archaeology

After the Pleistocene glacial recession (c.11,000 years BP), the area was immediately occupied by humans (Fedje et al, 1995). Faunal remains from archaeological sites on the east slope of the Canadian Rockies (summarized by Kay and White, 1995; Kay et al, 1999) have the following relative composition of number of individual bone specimens: bison (47 per cent), bighorn sheep (39 per cent), deer (7 per cent), elk (7 per cent), moose (*Alces alces*, <1 per cent) and goat (*Oreamnos oreamnos*, <1 per cent).

History

First-person explorer journal accounts from the Rockies for the period 1792–1872 (Kay et al, 1999, 2000) report generally low wildlife abundance. The relative number of recorded species hunted in the Rocky Mountains area was: bighorn sheep (54 per cent), bison (16 per cent), moose (12 per cent), goat (8 per cent), elk (5 per cent), deer (3 per cent) and caribou (*Rangifer tarandus*, 2 per cent). Kay et al (1999, 2000) attribute these long-term relative abundances to the effects of predation refuges. Bighorn sheep maintained populations due to refuge on steep slopes and cliffs. Bison were probably maintained by periodic immigration from the large Great Plains population to the east, which migrated hundreds of kilometres to minimize predation rates from wolves, humans and other predators (White et al, 2001). Elk apparently had few refuges from predation, and were maintained in long-term low abundance by humans and other predators (Kay et al,

Figure 12.5 Wolf and elk telemetry points around Banff townsite (1997–1999)



1999, 2000). Broad cultural changes related to European settlement resulted in further increases in human hunting rates of wildlife. In the Banff-Jasper area of the Rocky Mountains, the last bison sign was observed in 1859, and elk were reported as extremely rare by 1900 (Woods, 1990). In 1918 and 1920 a total of 235 elk from Yellowstone National Park were translocated to Banff (Woods et al, 1996).

Fire frequency research

Tree-ring studies indicate that long-term fire intervals in the Canadian Rockies may have been relatively short (<50 years) with low intensities on low-elevation valley bottoms (Tande, 1979; White, 1985). Fires may have been larger, less frequent and had higher intensity (flame length) and severity (depth of burn) at middle and higher elevation forests (Hawkes, 1980; Johnson and Larsen, 1991). This pattern of fire frequency, intensity and severity maintained a diversity of vegetation patterns (Rhemtulla et al, 2002; White et al, 2005) including savannah-like forests (see Figure 12.1, top) in the montane eco-region (Tande, 1979), and a patch-dynamic system in the subalpine (Johnson and Larsen, 1991). On the east slope of the Canadian Rocky Mountains, historic fires appear to have mostly been started by First Nations people, and later by early settlers and railroads. Evidence for the potential past significance of human ignition on the east slopes includes analysis of fire causes for the period 1880–1980 (White, 1985) and the low occurrence of lightning and lightning-caused fires on the east slopes compared to the west slopes (Wierzchowski et al, 2002). Further, dendrochronology studies show that past fire scars are mostly located in the dormant and early-wood sections of lodgepole pine (*Pinus contorta*) tree rings, not in the late wood (White et al, 2001). This suggests that most historic burning prior to 1880 occurred before or after the peak period of midsummer lightning occurrence, and was thus probably human-caused.

Wildlife ecology

Intensive research on wildlife occurred in conjunction with highway construction and after the Bow Valley of BNP was recolonized by wolves in 1985 (Paquet et al, 1996; Woods, 1990). Highway fencing reduced human-caused wildlife mortality (Clevenger et al, 2001, 2002; Woods, 1990) but due to wolf predation elk populations declined substantially in areas >5km from Banff townsite (Hebblewhite et al, 2002, 2005). However, near the town, intensive human development use and narrow wildlife corridors restricted carnivore movements (Duke et al, 2001), reducing predation rates in this area. By 1997, over 400 elk were concentrated in and around the town (McKenzie, 2001), surrounded by a 'halo' of wolves and other predators (see Figure 12.5). Long-term research on these trends indicated that natural regulation hypotheses that predators did not significantly influence Rocky Mountain ungulate abundance could be in error (Hebblewhite et al, 2005). Moreover, modern human use patterns in national parks could dramatically alter the predation process when

unhunted elk become habituated to high human use levels, and thus obtain refuge from wary predators (White et al, 1998).
Researchers also intensively investigated grizzly bear population dynamics and habitat use in BNP and adjacent areas (Gibeau et al, 1996). These studies demonstrated a dramatic decline in the number of human-caused bear mortalities after food waste storage was improved (Benn and Herrero, 2002). Grizzly bear densities are highest in areas that have relatively low human use and include recently burned habitats (Gibeau et al, 2002; Hamer, 1996, 1999). In the 1990s, grizzly bear use was relatively low in the Bow Valley near the Trans Canada Highway (Chruszcz et al, 2003; Gibeau et al, 2002) except for near Lake Louise, where bears were frequently observed on ski runs cleared through mature forest (Gibeau et al, 1996).

Vegetation ecology

Repeat photography indicated that, historically, aspen and willow communities were lightly browsed and frequently burned (White et al, 2004), browse levels are now much higher, and conifer cover has increased dramatically (see Figure 12.1). Browsing studies show that, where elk densities were high (>5 elk per km^2), herbivory removed all tall willows, with negative effects on beaver and some songbird species (Hebblewhite et al, 2005; Nietvelt, 2001). Even at only moderate elk densities (>2 elk per km^2), herbivory levels were high enough to prevent aspen growth to >1m in height (White et al, 2003).

Human dimensions

Recognition that not just the footprint of development, but high levels of human use in general, could influence ecosystem processes such as predation led researchers to detailed computer mapping of human use levels (BBVS, 1996; Komex International, 1995). Detailed social science research developed understanding of use patterns including the timing of use, motivations for visitation and types of facilities used, and the social effects of forest and fire management programmes (for example, BBVS, 1996; McFarlane et al, 2004; Mountain Parks Visitor Survey Partnership, 2004). This knowledge was important to formulate feasible management alternatives. The local, regional and national economic benefits of the tourism and transportation industries in Banff are massive. Detailed research and modelling occurs periodically to quantify general regional patterns and trends (for example, Alberta Economic Development and Tourism, 1994; Cornwell and Cotanza, 1996). Commercial stakeholders are acutely aware of finer time and spatial scales of visitor use levels and expenditure patterns.

Collaboration and knowledge synthesis

The BBVS (1996) began the process of integrating knowledge by using the round table (see Figure 12.4) to critique a 'State of the Valley' compendium of information on ecological, economic and social systems (Pacas et al, 1996). Over a period of 10 months, the round table worked through various drafts to obtain a final acceptance of this report by all sectors (Hodgins et al, 2000). The BBVS task force, and to a limited extent the round table, guided an 'ecological outlooks project' (Green et al, 1996), which integrated several knowledge disciplines to evaluate potential outcomes of future development scenarios in the BBVS.

Each of the many disciplines described above provided some tentative evidence that Rocky Mountain montane ecosystems probably developed under a regime of long-term low human use levels, with associated anthropogenic hunting and burning patterns (Kay et al, 1999). Thus current high human use levels, with displaced predators, ungulates habituated to humans due to no hunting, and minimal anthropogenic burning, were a radical change from the long-term range of variability (White et al, 1998). However, the weight of evidence within each field of study on its own was insufficient to convince monodisciplinary researchers or peer reviewers to make this conclusion. In the absence of this integration, park management had largely continued to be guided by a mix of traditional economic development and natural regulation paradigms, assuming that development levels were not yet at a crisis point, predators were 'non-essential' adjuncts in montane ecosystem function, and that eventually an escaped lightning fire would rejuvenate vegetation.

The societal will to interpret and act on new evidence occurred when broadly based collaborative groups (for example, the BBVS round table and Banff Elk Advisory Committee) reviewed the multidisciplinary results and concluded that wildlife distribution and herbivory patterns around the town of Banff (see Figure 12.5) showed that the long-term range of variability was seriously disrupted by a major change in current versus long-term human land-use patterns (for example, from few hunter-gatherers to high densities of ecotourists). Ultimately, it was likely that the threat by aggressive elk to human safety triggered action. Local residents, who were dealing daily with the risks of human-habituated elk by carrying hockey sticks and slingshots, provided significant input to this stakeholder consensus! The Banff Bow Valley Study round table and task force, and subsequent special issue stakeholder groups used this common understanding to provide managers with numerous recommendations for restoring ecological integrity in montane ecosystems (BBVS, 1996).

Outcomes: Adaptive implementation of the 1997 Park Management Plan

The 1997 BNP Management Plan was a progressive response to the BBVS (1996) recommendations (Draper, 2000; Hodgins et al, 2000). The plan provided guidance for several restoration programmes described below. Recognizing the complexity of these projects, screenings required by the

Canadian Environmental Assessment Act were approved by park managers with the provision that:

- intensive monitoring programmes were in place;
- results of these programmes would be reviewed annually in collaborative processes including science workshops, advisory group committee meetings and the annual park planning forum;
- park managers adapted annual work plans for projects based on monitoring results and stakeholder review.

Highway mitigation

The high-speed Trans Canada Highway bisects the Bow Valley (see Figure 12.1b). Traffic volumes near Banff townsite increased from an average of about 8000 vehicles/day in 1982 to nearly 15,000 vehicles/day in 1994. Upgrading to divided four-lane standard was completed for 45km in BNP between 1979 and 1998, and required a comprehensive wildlife mitigation programme including fencing and 24 wildlife crossing structures (Clevenger and Waltho, 2000; Clevenger et al, 2001, 2002; Forman et al, 2003; McGuire and Morrall, 2000). Initially, the structures were mainly designed to facilitate ungulate crossings. However, stakeholder consultations for the Phase 3A (km 27–45) environmental assessment recommended greater attention to large carnivore crossings, and this, in combination with recommendations from the BBVS task force, led to construction of two large wildlife overpasses across the highway in this area. Subsequent monitoring has shown that these overpasses, in combination with wide underpasses (>50m) best facilitate highway crossings by wolves and grizzly bears (Clevenger et al, 2002).

Wolf recolonization

Wolves were eliminated from the southern Canadian Rockies by 1914, but recolonized BNP during a period of high ungulate abundance in the late 1930s (Cowan, 1947). A regional carnivore control programme again eliminated wolves from BNP in the 1950s, and consistent pack activity did not occur in the Bow Valley for nearly 30 years (Holroyd and Van Tighem, 1983). In 1985, the valley was again recolonized, probably due to dispersal from the nearby Red Deer Valley (Paquet et al, 1996). Management actions to assist recolonization included closures near den site areas, temporary restricted speed zones on roads through wolf activity centres, highway mitigation and wildlife corridor restoration. Wolf abundance and distribution was an icon indicator for stakeholders in many collaboration processes (Jones, 2002). Issues requiring resolution included the proposed fencing of the Banff townsite area to reduce elk avoidance of wolves (BBVS, 1996), supported by pro-wolf interests, versus no fencing with elk relocation, supported by town residents.

Human use management and wildlife corridor restoration

Human interference with wildlife movement around the town of Banff has been a long-term concern (BBVS, 1996). Environmental mitigation for a new housing subdivision on the edge of Banff townsite included permanent closure to human use of a wildlife movement corridor around the south perimeter of the town on Sulphur Mountain in 1997 (Golder and Associates, 1994). The BNP Management Plan (Parks Canada, 1997) required relocation of facilities including government and community stables, a small airstrip and a military cadet training camp out of the wildlife movement corridor around the north perimeter of the town below Cascade Mountain (Duke et al, 2001). East of the townsite, wildlife crossings over hydropower canals and penstocks were restored, and portions of the Minnewanka Road were closed in the winter. Additional human-use guidelines implemented after 1997 to minimize disturbance to large carnivores included mountain-biking restrictions on Bryant Creek, winter private vehicle use closure of the golf course, and extension of a summer closure of the middle Spray Valley (Parks Canada, 1997, 1999). Parks Canada worked with neighbouring land-management agencies to develop wildlife-corridor management guidelines for the whole Bow Valley (Bow Corridor Ecosystem Advisory Group, 1998, 1999). The Lands Adjacent to the Town of Banff Advisory Group continues to adapt and refine trail use in this area.

Human-use management issues remain controversial (Cooper et al, 2002; Petersen, 2000) regarding the reduction of human use on some trails to levels (<100 groups per month) recommended for grizzly bear security areas (Gibeau et al, 1996, 2001). Long-term collaboration between stakeholders, land managers and researchers (both social and ecological) will be required to develop consensus on potential management actions in order to conserve grizzly bears (Herrero et al, 2001). The 2003 amendments to the 1997 BNP Management Plan continue to refine principles for human use management and a revised decision-making framework for the conservation of grizzly bears.

Elk management strategy

The high concentration of elk near Banff townsite (see Figure 12.5) became a serious public safety concern in the 1990s (McKenzie, 2001) and also caused high herbivory impacts on montane willow and aspen communities (Hebblewhite et al, 2005; Nietvelt, 2001; White et al, 1998). The BNP Management Plan (Parks Canada, 1997) provided direction to 'restore predator-prey relationships' and 'restore vegetation communities to reflect the long-term ecosystem states and processes'. As described above, restoration of wildlife corridors increased predation rates near the town. In addition, Parks Canada relocated 217 highly human-habituated elk out of the park in 1998, 1999 and 2000 to reduce elk–human conflicts and herbivory impacts (Parks Canada, 1999). After 2001, an aggressive aversive conditioning programme with herding dogs was used to move elk out of the townsite area (Kloppers et al, 2005). The project was guided by an annual meeting of the Montane Science Workshop consisting of both scientists and stakeholders. Recommendations from these sessions were forwarded to the Elk Management Advisory Committee, and from this group on to the park superintendent. The Bow Valley elk population declined from >800 (1988), to <500 by 1998 to <200 by 2002. By 1998, willow growth began to exceed 1m in height throughout most the area (Hebblewhite et al, 2005; Nietvelt, 2001), and by 2004 aspen heights in many areas exceeded 1m (White et al, 2004).

Fire, forest thinning and mountain pine beetle control

The 1997 Park Management Plan required that 50 per cent of the long-term burn area be maintained: approximately 14km^2/year (Eagles, 2002). As a result, the existing burning programme was expanded, and by 2004 a total of over 170km^2 had been treated in the previous 20 years (Pyne, 2004; White et al, 2005). The general procedure for burning is to use hand or mechanical thinning to build fuel breaks where required, followed by ground or aerial ignition during periods of low fire intensity to blacken unit boundaries and, ultimately, aerial ignition of the main units during warmer and drier conditions. Prescribed burning in BNP has been done almost totally in May and September, outside the peak period of high intensity burning conditions that usually occurs in July and August (Wierzchowski et al, 2002). The timing of 'shoulder season' burns thus likely partially corresponds to the long-term, anthropogenic pattern described above (White et al, 2005). After 2002, BNP rescheduled its burning programme and conducted limited tree removals along the east boundary of the park to reduce colonization levels by mountain pine beetles (Parks Canada, 2002). Prescribed burning, cutting of beetle-attacked trees and forest thinning options are presented annually to stakeholders and scientists at the Montane Science Workshop. Recommendations from this group are provided to the Park superintendent to adapt the programme.

Banff heritage tourism strategy

Implementing the above active restoration programmes required a high level of stakeholder and general public support. The tourism industry, following the recommendations of the BBVS (1996) established the Banff Heritage Tourism Corporation with members including the Banff/Lake Louise Tourism Bureau, Town of Banff, Town of Canmore, Parks Canada, the Banff Centre (a specialized educational institution) and the Banff Lake Louise Hotel Motel Association (Wight, 2001). The corporation developed a strategy with core objectives of:

- making all visitors and residents aware that they are in a national park and world heritage site;
- encouraging opportunities, products and services consistent with heritage and environmental values;
- encouraging environmental stewardship initiatives;
- strengthening employee orientation, training and accreditation programming for sharing heritage understanding with visitors.

The programme keeps Banff's business community involved, active and aware of ongoing ecological restoration efforts, annually trains hundreds of front line staff, and awards staff and businesses demonstrating environmental stewardship (Banff Heritage Tourism Corporation, 2004).

Communications

Possibly the most important component of BNP's restoration programme is communications to stakeholders and the public. Ongoing initiatives include a 'Research Updates' series presented each spring, topic information on the Parks Canada website, presentations at numerous meetings of stakeholders and NGOs, routine reporting through local, regional and national media, and outreach programming to local schools (Parks Canada, 1997).

National and regional implications

Banff is Canada's first and busiest national park, thus new management directions here often have important implications for other national parks and protected areas. The BBVS (1996) recommendations stimulated action at a national level for new management direction. In 1998, the Canadian Minster of Heritage established the 'Ecological Integrity Panel' (Parks Canada Agency, 2000). Similar to the BBVS, this interdisciplinary task force used a series of multi-stakeholder meetings to develop a future vision and broad set of recommendations for how Canadian national parks could maintain or restore ecological integrity.

Current Parks Canada national park management guidelines now also require developing a 'state-of-the-park' document every five years. These documents should be based upon ecosystem models (for example, Figure 12.2) developed in collaboration with stakeholders and researchers. The models will be used to define a standard set of indicators for biodiversity, terrestrial and aquatic ecosystems, and human dimensions. Ecosystem models, indicators and monitoring protocols will be developed at bioregional level (for example, Rocky Mountains) to provide a standardized approach and efficiencies for monitoring and research.

Regionally, the 1997 BNP Management Plan became a model for revising the plans for adjacent Jasper, Yoho and Kootenay national parks. The background state-of-park reports for these plans all use similar ecosystem models to

BNP (see Figure 12.2). Many parks and protected areas in the Rocky Mountains are exploring solutions similar to Banff for resolving issues related to human, wildlife and vegetation interactions.

Lessons for collaboration and adaptive management

The Banff case history demonstrates the use of the recognized ingredients in successful adaptive ecosystem management and planning programmes (Clark, 1999; Cortner and Moote, 1999; Lal et al, 2001; Lee, 1993). A synergy created by a diverse and interested citizenry, informed with knowledge from a variety of sources, and interacting with scientists and managers, was the essential mechanism of an adaptive management programme that created innovative change (Hodgins et al, 2000). We conclude by discussing several important components of the BNP programme that may have application to restoration exercises in similar ecosystems.

Ecosystem restoration: Complexity, adaptive management and collaboration

The combined ecosystem-level impacts of modern human influences – such as fire suppression, highways and habitat fragmentation – are becoming increasingly recognized as very important in Rocky Mountain montane ecosystems (Baron, 2004; BBVS, 1996; Forman et al, 2003). The BNP experience showed that restoration effects on carnivores, herbivores and plants are likely to be complex, non-linear and dependent on starting conditions and neighbouring land effects. An initial analysis of response of indicators to restoration efforts to date (White et al, 2004) recommended that the maintenance and restoration of valley-bottom wildlife corridors and habitats should be the first priority in protected-area ecosystems affected by development (see Figure 12.6). If this landscape pattern is ecologically functional, fencing highways will probably result in an initial rise in ungulate populations due to reduced road-kill. This may be followed by an increasing density of more wary carnivores as road-caused mortality rates decline. At this stage, prey may utilize areas with high human use as refuges from predation, stabilizing wildlife populations at relatively high levels.

Where complete restoration occurs, and predator and prey sympatrically utilize habitats, predation may reduce ungulate abundance (Hebblewhite et al, 2005), thus reducing predator abundance. Prescribed burning to restore vegetation communities such as aspen and willow will be most successful when herbivores are limited to low densities by predation and, in long-term ecosystems, some human hunting (White et al, 1998; 2003).

The time lags and complexity in montane ecosystem change after restoration indicate that predicting and understanding the outcomes of costly mitigation action is still as much art as science. Because this is long-term, expensive work that often occurs where people live (near highways and towns), montane ecosystem restoration provides an excellent opportunity to involve stakeholders. Participatory activities may include monitoring (for example, wildlife use of crossing structures or wildlife corridors), joint scientist–stakeholder workshops, and advisory committees.

Integrating multidisciplinary knowledge with stakeholder collaboration

Sadly, true interdisciplinarity is uncommon between scientists, many of whom can barely communicate across disciplines due to isolation, jargon and perceptions of academic supremacy (Cortner and Moote, 1999). However, this integration can occur when the knowledge of multiple disciplines (for example, anthropology, history, traditional knowledge, ecology) is provided to a broad range of stakeholders (for example, park visitors, residents, First Nations and so on) with experience in civic discourse and collective learning (Clark, 1999; Shannon and Antypas, 1996).

When attempting to influence collaboration groups, scientists and other purveyors of specialized knowledge must learn to address useful problems, seek academic consensus across disciplines, develop logical predictions, communicate simply and avoid intellectual arrogance (Meffe and Viederman, 1995). In short, common sense and mutual respect are important. In the Banff case, such interactions between stakeholders, scientists and managers frequently led to deeper understanding of ecosystem change, and more innovative proposals for ecological restoration.

The long-term role of people

Interdisciplinary understanding increasingly suggests that small numbers of humans were probably an important long-term component of many ecosystems, through their activities as both hunters and burners. In contrast, today's millions of park visitors prefer to photograph wildlife against a backdrop of dense, green forests unobscured by smoke. This complete change in human-use levels and behaviour patterns is the underlying cause for many of today's ecosystem management challenges.

This was a revolutionary perspective in understanding Banff's ecosystem that, under the natural regulation paradigm, was perceived as a wilderness icon. Including people, both past and present, as active stewards of ecosystems provides a foundation for active adaptive management and participatory interest in ecological restoration programmes (Cortner and Moote, 1999). This change in perspective clearly requires engaging disciplines outside the pure natural sciences – such as anthropology, archaeology, traditional knowledge and local citizen perspectives.

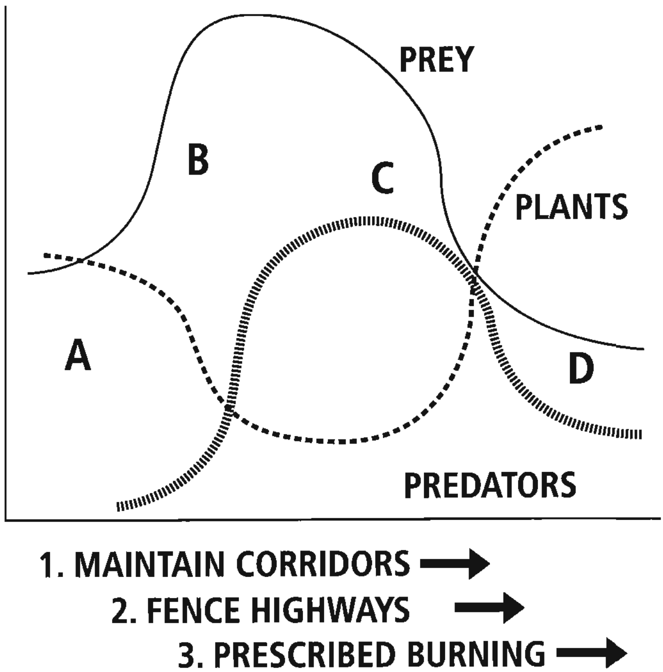


Figure 12.6 Stylized model for potential indicator response from highway wildlife mortality, habitat fragmentation and prescribed fire mitigation in montane eco-regions

Note: At A both ungulates and predator numbers are depressed by highway mortality. At B ungulates have responded to initial highway mitigation. At C, reduced highway mortality but ongoing high human use of wildlife corridors has created a prey refuge, which stabilizes ungulates and predators at relatively high numbers. At D, wildlife corridor restoration has removed the prey refuge.

Involvement of First Nations and use of traditional knowledge

If true interdisciplinary and multi-stakeholder approaches continue to guide ecological restoration, it will become increasingly important to continue to reach out to First Nations to bring their perspective and traditional knowledge into the consilience process (Parks Canada Agency, 2000). As one example, Banff National Park's prescribed burning is currently guided by modern technical standards for fire frequency and severity (White et al, 2005), but long-term burning by humans is an art that enhanced unique habitats for important wildlife and plant species (Pyne, 1995, 2004). As a second example, Banff is currently evaluating the feasibility of returning bison, once the dominant large mammal in east-slope montane ecosystems (Kay et al, 2000). This also will require not just the knowledge of modern science, but also the traditional knowledge of humans, one of bison's most important historic predators.

Conclusion

In the quarter century since 1980, the Bow Valley of Banff National Park and the adjacent province of Alberta has greatly changed. There are negative signs for the ecosystem: the resident human population has nearly tripled, park visitation has more than doubled, and the highway is twinned and busier than ever. But there are also many positive signs: wolves have returned and persisted, grizzly bear numbers are probably increasing and, largely due to the restored role of predators limiting ungulates, aspen and willow regeneration is widespread (Hebblewhite et al, 2005). Possibly most importantly, the level of citizen understanding and participation in ecosystem management issues is very high. Discourses over wildlife corridor width, the frequency of highway carnivore mortality, and the role of wildland fire in forest health take place almost daily in the newspapers, meeting rooms and coffee shops of the valley. The complexity of change over time clearly shows that ecological restoration of Canadian Rockies ecosystems will continue to be a journey of learning for stakeholders, researchers and managers alike. No discipline or interest group can claim primacy to lead this adventure into the future. All must contribute their knowledge and appreciation of this magnificent landscape to maintain it as a natural and cultural legacy for future generations.

Acknowledgements

Ideas for this paper were synthesized from four Banff case histories presented at the IRMMA conference. We appreciate the contributions of D. Dalman, H. Dempsey, S. Donelon, K. Endres, M. Hebblewhite, T. Hurd, C. Kay, D. Leighton, N. Maier, B. McFarlane, M. McIvor, D. McVetty, J. Otton, I. Pengelly, D. Petersen, B. Ritchie, J. Roulet, R. Sandford and P. Vienotte to the case histories, and of M. Price and L. Taylor for conference organization.

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13

Integrated Restoration and Rehabilitation of Powerline Corridors in Mountain National Parks in Australia

Stuart Johnston and Roger Good

Introduction

This chapter considers an area within three extensive and contiguous national parks, Kosciuszko National Park and Brindabella National Park in New South Wales (NSW) and Namadgi National Park in the Australian Capital Territory (ACT), as well as two large commercial state forests. The parks and forest lands are part of the landscape of the Snowy Mountains and Brindabella Ranges (part of the Australian Alps), the major water catchments in southeastern Australia. The project area covers six high-voltage powerline easements that traverse the mountains as an extensive corridor over a distance of some 300km. The easements are the responsibility of TransGrid, a state-owned corporation that operates and manages the NSW high voltage electricity transmission system. One of TransGrid's primary activities is to maintain transmission-line easements to ensure the safe and reliable supply of electricity for the state of NSW. In particular, these activities involve the ongoing management of vegetation to ensure suitable clearance from the powerlines. As the easement corridors of this project occur within and dissect national parks and forests, they are a major management consideration for both the power transmission agency (TransGrid) and the national parks and forestry land management agencies (see Figure 13.1).

The project

In early 2001, as part of vegetation maintenance programmes, contractors cleared extensive areas of native vegetation along two transmission-line easements traversing the three national parks. As a response, a project was initiated in June 2001 to rehabilitate excessively damaged areas and to identify