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Science Fiction or Science Fact?

The Grizzly Biology behind Parks Canada Management Models

by Barry Cooper, Jason Hayes, and Sylvia LeRoy

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Executive summary

The movement in North America to preserve natural areas and wildlife species has embraced the new crisis discipline of conservation biology. Supported by tax dollars and generous government grants, and by vocal and effective international environmental interest groups and lobbyists, conservation biology has had a distinct impact on the management of Canada's national parks. The basis of conservation biology is the "fundamental shift in ethics" (Gibeau 2000: 49) toward a new understanding of what natural resources and parks are for. Even so, because conservation biologists employ the language and concepts possessing considerable phonemic overlap with other branches of wildlife science, conservation biology appears similar to standard or ordinary wildlife biology. Only when the end purposes are brought into focus do the differences between the two appear.

This Critical Issues Bulletin separates the science and politics of wilderness conservation by analyzing the basis of new models of park management. In particular, we examine the science that supports the "mission-oriented" research of the Calgary-based Eastern Slopes Grizzly Bear Project (ESGBP). As the central organization conducting grizzly research in southwestern Alberta, the ESGBP has had a significant impact on the management of Canada's Rocky Mountain national parks. This report examines their use of data and computer models in the management of grizzlies and of protected areas. Among the things we found:

- Grizzly bear conservation is being used to justify the expansion of Parks Canada policy to areas far beyond park borders. Recent amendments to Canada's National Parks Act and the brand new Species at Risk Act (SARA) give new legislative and regulatory weight to this preservationist prerogative.
- While no one questions the importance of managing grizzly populations carefully, reports that Alberta grizzlies are suffering from a "progression of extinction" are misleading. Much of the confusion owes to the misuse of common terms such as "extinction" and the distinction of geographically defined sub-populations.
- Canada's national parks are not "islands of extinction" for grizzly bears. Contrary to the claims of fear-mongers, the population of grizzly bears within the Rocky Mountain national parks is not remotely limited or depressed by genetics. Since 1988, the estimated number of grizzly bears in connected populations outside the national parks has nearly doubled—an increase of approximately 2% to 3% a year.
- Management decisions regarding Canada's national parks are made in the absence of valid and reliable wildlife biology. In the language of computer models used to predict the long-term viability of grizzly bear populations, any human presence in the ecosystem is directly linked to grizzly bear "extinction." This has prompted policy recommendations calling for radical restrictions on human access to parks and recreation areas in the Rocky Mountain area.
- Grizzly bear habitat models fail to distinguish between the mortality risk caused by a hunter and that caused by a hiker, which leads to the contention that any human presence in a "carnivore management unit" will reduce the effectiveness of the grizzly bear habitat.
- The benchmarks being used to determine core "security areas" for grizzly bears have been progressively expanding as ESGBP researchers confine their study to those most sensitive to human presence ("wary bears").
- Parks Canada has responded with expensive initiatives to restore the "ecological integrity" of the parks, including $24.6 million to terminate existing commercial leases in Canada's national parks.

With conservation biologists and interest groups promoting radical environmental policies playing increasingly important roles in the management and extension of government protected areas, it is prudent to note concerns that such policies may not reflect either the diversity of legitimate public interests or the best long-range management policies. So long as Canada's national parks are defined as de facto grizzly habitat and human use is automatically considered to be a disturbance to it, the push to limit human enjoyment of natural areas is bound to increase. Eventually Canadians will be able to enjoy their wilderness, parks, and recreation areas only in some ethereal sense of deriving remote and virtual comfort from the knowledge that they exist. Thus, we make the following recommendations:

- We recommend that ESGBP's entire raw data set, modeling software, and parameters be placed in the public domain, not least of all because their research has been substantially funded by federal and provincial tax dollars.
- The results of computer simulations predicting the "extinction" of grizzly bear populations in the central Rockies should not be used to guide any actual management regimes until the data, the assumptions, and the methodology are reviewed by independent modeling specialists.
- Future use of habitat models should be constrained by the necessary inclusion of a cost/benefit analysis to determine if the implementation of the model findings will cause greater damage to provinces, regions, or communities than alternative management actions.
- These models should only be used as one of a group of tools in a broad suite of land and wildlife management tools. No single tool should play as determinative a role in the management of Canadian National Parks.
- Parks Canada should renew its commitment to both human use and environmental protection of the parks.
- Parks Canada should define and provide specific guidelines for the implementation of the precautionary principle. The current ambiguity surrounding its definition and preservationist tenor to its past application requires that a coherent framework be applied and implemented.
- Parks Canada's "ecosystem management" approach should not be used to expand its management prerogatives beyond national park boundaries. Likewise, any strategies of "adaptive management" must be tempered with the need for legal and administrative certainty for park visitors and service providers.

The issue that we take with conservation biology is not that its practitioners have preconceived opinions. Rather, we believe it is reasonable to expect that research claiming to be scientific, that is funded by tax dollars, and that has a direct impact on the management of publicly owned lands would be carried out in such a way that the biases of researchers have limited influence on their findings. Credible, independent peer-reviewed science, along with a broad suite of management tools and developing technologies, can provide the necessary apparatus to understand bear biology and models. When this understanding is rooted in a management approach that emphasizes individual responsibility, choice, and the education of bears and humans, both populations will be better served

Introduction

In both Canada and the United States, federal parks and wildlife agencies have been in the vanguard of popular trends in wilderness conservation. Environmentalists protesting the anthropocentric thrust of modern social values look to government-run parks and protected areas as core refuges of pre-Columbian environmental integrity. For a select group of biologists, these protected areas provide a closed laboratory for wildlife research and experimentation. For radical environmental interest groups as well as for some scientists, the centralized structure of federal parks and land management agencies also provide attractive opportunities to influence policy and gain organizational funding (LeRoy and Cooper 2000). Recently, concern over the role of interest groups in public lands management has led to a healthy and lively debate over issues of bias and the application of weak methodologies to research projects (Chase 1987, 1995; Jones and Fredricksen 1999; Kay 1995). Further concerns exist over the use and predictive capabilities of computer-based population models.

The US experience

Controversy over interest-group politics buttressed by an activist, not to say ideologically deformed, science has been well documented in recent critiques of public lands management in the United States. Given its beauty, delicate ecosystems, important wildlife populations, and its status as America's first national park, Yellowstone has long been the centre of debate about the application of science in park management in that country. According to Alan Fitzsimmons, former policy advisor to the US Department of Interior, "long-standing interest in the area plus the predominance of federal lands in the region—millions of acres of national forest surround the park—make the area a very attractive testing ground for new paradigm ideas" (Fitzsimmons 1999: 70). Foremost among these "new paradigm ideas" have been theories about ecosystem management, natural regulation, and ecological integrity.

Devastating fires

In the summer of 1988, an estimated 249 fires burned across 1.4 million acres in the area of Yellowstone National Park. This included 45 fires that began in the park and five that started outside and moved in (Franke 2000). One third of the park was left in charred devastation after officials made the early decision to let the fires burn in the name of "natural regulation." This "hands-off" approach to the management of public lands resulted in dense, degenerate, or over-mature forests that encouraged the massive fires in Yellowstone National Park to begin with (Fretwell 2000; Nelson 2000). The same policies were responsible for fires that burned throughout Arizona and Colorado in the summer of 2002 (Ibbitson 2002) and constitute the long-term result of misconceived strategies of species management and protection (Chase 1987, 1995; Kay 1997).

Spotted owls

The campaign to limit harvesting in the "old growth" forests of the Pacific Northwest likewise drew attention to the integrity of science in federal wildlife management policy. These efforts were successful when the spotted owl (*Strix occidentalis*) was listed under the Endangered Species Act. Highly focused research on the population viability (i.e., the number of owls necessary to maintain species persistence) of spotted owls was commissioned, which then was used to ensure the owl was listed as an endangered species, despite concerns over the integrity of the research design and over the absence of a traditional, independent, and reputable scientific peer review (Chase 1995). As activist Andy Stahl explained it, "the Northern Spotted Owl is the wildlife species of choice to act as a surrogate for old-growth protection, and I've often thought that thank goodness the spotted owl evolved in the Northwest, for if it hadn't we'd have to genetically engineer it. It's the perfect species to use as a surrogate" (Bourret 1999).

This controversy raised additional questions about the relationship between environmental activists and their allies in the scientific community. It turned out that these concerns were well founded. A 1988 US Federal Claims Court ruling determined that the US Forest Service arbitrarily, capriciously, "and without rational basis," employed faulty data relating to spotted owl habitat to stop logging activity in a Californian forest. According to the presiding judge, forest supervisor John Phipps "justified reliance upon known biased results because he believed that any bias would err in favour of maintaining owl habitat and canceling the proposed timber sale" (Wetsel-Oviatt Lumber Company, Inc. *v.* The United States 1998). In his testimony before the US Senate Committee on Energy and Natural Resources in October 2000, Forest Service Deputy Chief Jim Furnish later stated that such claims relating to the Northern Spotted Owl in Oregon, Washington, and California had resulted in damages paid by government of over US$32 million (Furnish 2000).

Wolf recovery

Similar controversy accompanied the 1987 plans of the US Fish and Wildlife Service for wolf recovery in the northern American Rocky Mountains (an area including Yellowstone, northwest Montana and central Idaho). According to the US Fish and Wildlife Service (USFWS), 300 wolves would be needed (100 in each of three recovery areas) to restore wolves to the level of recovery mandated under the Endangered Species Act. Curious as to how the USFWS arrived at that number, Dr. Charles Kay, wildlife biologist at Utah State University, filed a request with the USFWS under the Freedom of Information Act. Their reply indicated that the USFWS recovery targets had been established with little or no supporting scientific evidence, leading Kay to conclude that "all the government's wolf recovery reports, population models, and studies regarding possible impacts on big-game hunting are arbitrary and capricious. They represent not science but a masterful job of deception" (Kay 1996: 3–5).

"Lynxgate"

Another group of American Federal and Washington State wildlife biologists in the employ of the US Forest Service made international headlines in late December 2001, when one of them alleged that a federally funded study of the Canadian lynx (*Lynx canadensis*) included fraudulent data. These bureaucrats had submitted hairs from captive lynx allegedly in order to mislead and bias study results toward finding the presence of the endangered lynx in the wild. If the alleged hoax had gone undetected, the falsified presence of these hairs would have led the Environmental Protection Agency (EPA) to impose restrictions on human use, including major closures in Wenatchee and Gifford National Forests in Washington State, in order to protect what would then have been considered critical lynx habitat. The biologists defended their actions by arguing that the lab charged with identifying previously submitted samples provided "screwy" results (Glick 2002: 3). Accordingly, they "independently decided to test the men and women in white coats by sending them hairs from captive lynx," which ought to be seen as "control samples." Although the biologists admit that they "did not follow the chain of command" and that the lynx study did not require or allow the use of "control samples," they nevertheless claimed, "there was no collusion." A Forest Service investigation cleared them of criminal charges but prompted a congressional investigation of the scandal, along with a review by the General Accounting Office of the national lynx inventory process (Hanson 2002; Malfi 2002). Whether a deliberate conspiracy, or simple misunderstanding of the rules, the approach and the findings of these biologists were brought into disrepute.

As claims and evidence of fraud and misdirection have mounted, taxpayers have become disillusioned and now regularly question the headlines and stories that accompany the continuous warnings of environmental crisis. Charges of abused science, weak methodologies, unreliable computer models, and bias ensure wilderness protection remains controversial. At the same time, the existence of government funding in both the United States and Canada creates a presumption not just of stability, which is necessary for long-term research, but of legitimacy. Accordingly, where independent scrutiny later unearths evidence of fraud and abuse of public trust, government efforts and the overall move toward intelligent conservation-based management regimes have been severely damaged.

Canadian controversies

Unfortunately, Canadian land and wildlife agencies have not been immune to such controversies. A recent debate has taken place concerning the viability of the wolf population in and around Algonquin Provincial Park in Ontario. The debate is rendered more complicated by assertions that the Algonquin population is in fact a subset of the rare and endangered red wolf—even though most scientists consider the alleged subspecies to be a hybrid of the common gray wolf and coyote (Roy *et al*. 1996; Reich *et al*. 1999; see also Allendorf *et al*. 2001). Nonetheless, environmental interest groups are now demanding an immediate ban on the killing not only of wolves but of coyotes as well because "it is difficult to distinguish between a coyote, an Eastern Canadian [Algonquin] wolf and a coyote-wolf hybrid" (Earthroots 2002: 10). Similarly, logging operations were shut down in the "Great Bear Rainforest" of British Columbia when environmental activists and some wildlife biologists argued that the forested area was home to the rare Kermode, or "Spirit Bear"—even though evidence suggest that the local population of bears so identified was a genetic anomaly rather than a unique and endangered species (Blood 1997; Marshall and Ritland 2001). Moreover, properly managed logging operations improve bear habitat.

Lucrative bear research

Environmental activism and wildlife research have also become a growth industry in southwestern Alberta, particularly in the Canmore area east of Banff National Park. Controversy over tourism and commercial development in the Banff-Bow Valley corridor during the late 1980s and early 1990s, along with media attention to "charismatic megavertebrates," namely grizzly bears and wolves, allowed environmental interest groups to capture public attention and push for action by the federal government. In 1994, the federal government commissioned the $2.6 million Banff-Bow Valley Study (BBVS). Part of the study involved identifying "keystone species" to serve as "indicators" of the ecological health of the area. Of the several indicator or "icon" species studied, including aspen, elk, and wolf, none has generated as much public attention or attracted so many research dollars as the study of the grizzly bear (*Ursus arctos horribilis*) (Banff-Bow Valley Study 1996: 95). In the words of grizzly bear researcher Stephen Herrero, focusing attention on grizzly bear protection within the national parks as the first step in a large-scale wilderness conservation strategy "would also attract new money for habitat conservation in ecosystems surrounding national parks" (Herrero 1994: 10). Herrero's prediction has clearly come to pass: since 1994, more than $10 million has been spent on ecosystem research in the Bow Valley, including more than $2.24 million in the year 2000 alone (Watt, 2001). These estimated dollar amounts are probably too low because they are based on questionnaires administered only to researchers currently working on projects in the Bow Valley. The hundreds of thousands of dollars contributed every year by agencies for ecosystem research and management through full-time staff and operating budgets are not included (Watt 2001: 3), nor are other monies spent by private individuals.

Grizzly research at Parks Canada

Many researchers capitalized on residual momentum from the BBVS, the continuing flow of tax dollars available for their studies, and consistent media and interest-group publicity. As the chief advocates of grizzly research in the area around Banff, known as the Central Rockies Ecosystem (CRE), the Eastern Slopes Grizzly Bear Project (ESGBP) was a central player in the BBVS. The ESGBP "was initiated in 1994 to address the urgent need for scientific information about the cumulative effect of human development and activities on grizzly bears" in the eastern slopes of the Rocky Mountains (ESGBP 1999a). During the first eight years the project has existed, ESGBP researchers have produced a series of reports, theses, and papers on grizzly bears and bear management in the CRE. Parks Canada has provided funding and sought the opinions of these biologists when updating management plans for the mountain national parks, even though few of these papers have been peer reviewed (see Appendix B, page 46).

ESGBP work has been billed as the model for integrating science and policy in land use management. ESGBP publications praise their own ability to influence Parks management and alter its policies (Herrero *et al*. 2000: 3). As the Project Highlights page on the ESGBP Web site notes, the work ESGBP researchers completed for the Banff Bow Valley Study (Gibeau *et al*. 1996) was subsequently used to establish the central objectives of the 1997 Banff National Park Management Plan (Parks Canada 1997). These objectives are:

- to restore habitat by limiting human activity and eliminating existing trails;
- to restore and secure habitat on surrounding lands;
- to reduce the number of grizzlies killed by human activity to less than 1% of population annually;
- to establish a new human use management plan;
- to manage park as bear habitat; human use will be judged according to the modeled impact of various activities on the "habitat effectiveness" of each "carnivore management unit;"
- to apply the precautionary principle in all management decisions.

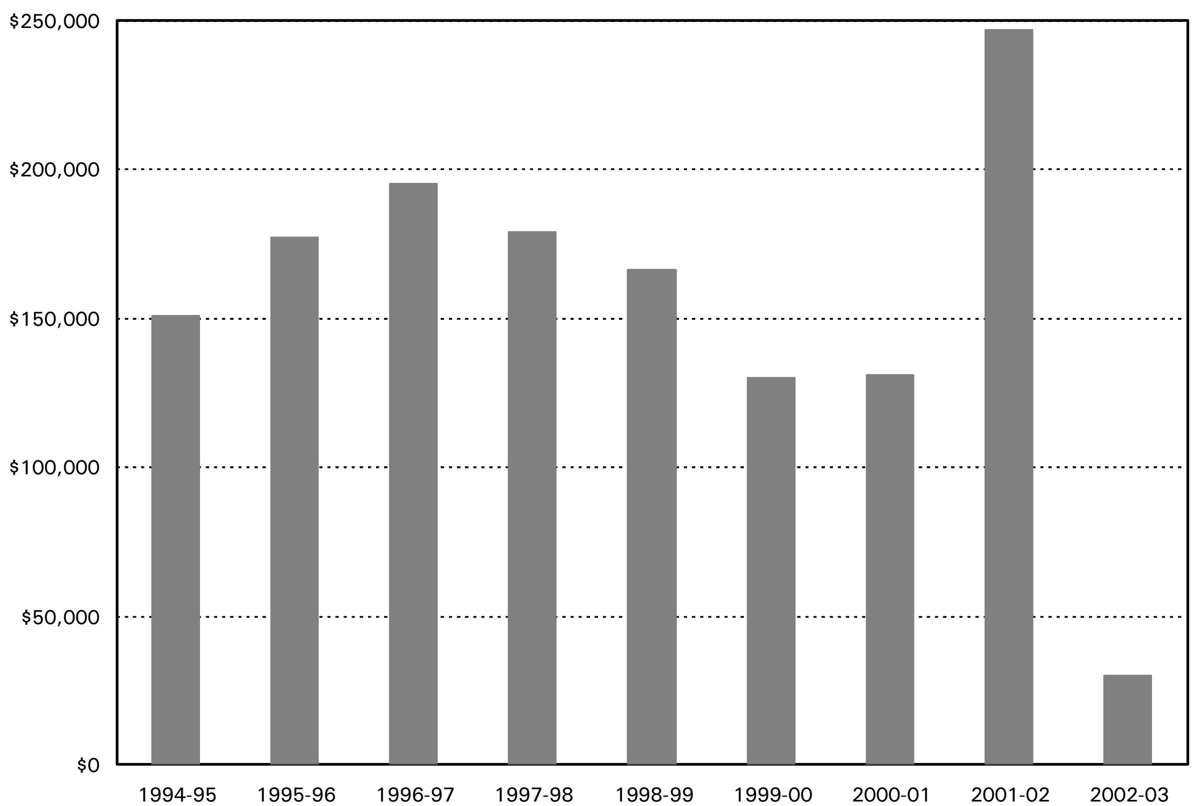
Unfortunately, portions of this research agenda have been plagued by persistent concerns about its scientific validity. For example, the objective of "restoring habitat" already assumes that habitat is in need of restoration. A second concern is focused on the impact of the strategic alliances some researchers have forged with the agencies and lobby groups that support their work. These concerns are intensified when one examines the links between research, funding agencies, and the administrative and regulatory bodies that have the duty of acting upon wildlife research in the implementation of public policy (Ray and Guzzo 1990; Jones *et al.* 2000; LeRoy and Cooper 2000; Shelton 2001; Tremblay 2001). Among the organizations undertaking research in the Banff-Bow Valley area, the ESGBP is noteworthy because it enjoys a unique and intimate bond with Parks Canada and its bureaucratic decision-making apparatus. For example, Dr. Mike Gibeau has been both a principal researcher for the ESGBP and, at the same time, a Parks Canada warden (Banff Centre 2001).

Strategic alliances

Despite this clear relationship, the ESGBP claims to have "no formal links to policy or management decisions although it has had significant influence in this regard" (Herrero *et al*. 2000: 3). The absence of formal links, however, has facilitated the establishment of strong and effective informal ones. Reflecting a commitment from federal Heritage Minister, Sheila Copps, to develop "formal connections with universities and other science-based agencies" (Copps 2000), more than half of ESGBP's yearly budget requirements were met by direct funding from Parks Canada between 1994 and 2002 (Herrero *et al*., 1998; Parks Canada 2001a). To date, this funding has amounted to $1.4 million (see figure 1). On the other side of the ledger, ESGBP publications claim they "have had significant success in seeing . . . our most important research findings translated into [national parks] policy and management actions" (ESGBP 1999).

When ESGBP researchers cultivate close professional ties with wealthy and well-organized environmental interest groups such as the Canadian Parks and Wilderness Society (CPAWS), when ESGBP research and publications receive regular praise and support from these same interest groups, and when ESGBP researchers

Figure 1: Direct funding of the Eastern Slopes Grizzly Bear Project (ESGBP) by Parks Canada



Note: ESGBP funding for 2002/2003 was provided through the Parks Canada Species at Risk Recovery Fund.
Source: Parks Canada, Access to Information Request. See Appendix for detailed ESGBP budget contributions.

are regularly featured in CPAWS articles and co-sponsored seminars (CPAWS 2000a, 2000b; Gibeau 2001), there is reason to be concerned with the appropriateness of the relationship among the ESGBP, interest groups, and Parks Canada.

Federal grants and contributions by Parks Canada and other government departments appear to have closed the loop and cemented the relationship between a specific and highly focused kind of wildlife research, federal government bureaucracies, and the environmental lobby. For instance, between 1994 and 1996, the same period during which CPAWS played a prominent role in BBVS round-table discussions, the interest group received $33,000 in direct transfers from Parks Canada (Government of Canada 1995: 10, 1996: 10). Given this disproportionate financial support transferred to this one group (CPAWS represented only one of 14 interest sectors involved in the round table), it is hardly surprising that the perspective on park use supplied by tourism and tourist services was under-represented (Ritchie 1999: 109). Even the BBVS Task Force was forced to acknowledge that the study's final conclusions were limited by major data gaps with respect to human use and economic activity (BBVS 1996: 392; see also LeRoy and Cooper 2000: 23–34).

A more recent example is the $234,000 federal contract awarded to CPAWS through the federal government's $96.5 million Voluntary Sector Initiative. According to a Voluntary Sector Initiative (VSI) Backgrounder of March 20, 2002 (Voluntary Sector Initiative 2002), funding has been approved to enable CPAWS to act as the lead organization in the "Heritage Policy Development for Greater National Park Ecosystems" project. According to the VSI, this "project is designed to enhance the ability of the voluntary sector to effectively participate in policy development for greater park ecosystems" (Voluntary Sector Initiative 2002). Reflecting the recommendation of the Ecological Integrity Panel to have the federal government initiate "studies of habitat protection opportunities outside park boundaries in greater park ecosystems and beyond" (Parks Canada 2000b: 9-9), CPAWS has been partnered with Parks Canada to help establish the government policy agenda. Conflict of interest charges were recently raised when it was discovered that Parks Canada's chief scientist is married to the CPAWS national director in charge of the VSI-funded project (Remington 2002).

CPAWS has also been the frequent recipient of the federal government's "community animation" grants directed towards their preservationist advertising campaigns in the Banff-Bow Valley area. For example, in 1999 the group received $3,000 for their proposal to "[Heal] the Bow Valley through Community Empowerment" (Health Canada 2000: 39). This follows earlier grants of $8,500 for a CPAWS "Bow Valley Area Public Involvement Campaign," which focused on the importance of preventing further economic development in the Bow Valley corridor, and a $35,000 grant, shared with the Alberta Wilderness Association and the Federation of Albertan Naturalists, for their "Albertans for Wild Places" advertising campaign to assist local individuals and organizations in their recruitment, planning and advocacy skills (see LeRoy and Cooper 2000: 31–32).

An additional reason for concern is the relationship between CPAWS and the Canadian Heritage Department. Measured in terms of revenue, CPAWS is not the largest environmental charity in Canada. According to data compiled by Revenue Canada, however, CPAWS spends the most money on advocacy and other political activities.[1]

Compounding public concern over the conflicts of interest between ostensibly independent scientific research, a dedicated and well-funded interest group, and federal officials in Parks Canada and Canadian Heritage, is the adamantine refusal by these researchers even to consider the concerns and interests of the public that exists outside the environmental lobby. In any liberal democracy, the freedom of citizens to advocate changes to government policies is typically balanced by the freedom of citizens to disagree with the proposed changes. The time for an informed conversation, discussion, or debate over proposed policies, however, is before, not after they are implemented. Unfortunately, despite a conventional request for "interested readers to carefully examine the strengths and limitations of [their] data" (Herrero *et al.* 2000: 5), ESGBP researchers have refused to respond to critiques of their research. No credible reason has been offered for this refusal.

Political science

Concerns about the strategic alliances forged between wildlife researchers and the agencies and lobby groups that fund their work are intensified when those same scientists are publicly quoted as being advocates of a distinctly political agenda (Ray and Guzzo 1990; Tremblay 2001; Shelton 2001; LeRoy and Cooper 2000; Jones *et al*. 2000). Senior ESGBP researcher Stephen Herrero conceded years ago that "biases and values have significantly influenced the scientific or factual data" he has collected (Herrero 1970: 1148). Other more explicitly "preservationist" arguments devolve into quasi-Marxist discussions of "management [and] information subcultures," and of the "enlightenment" of conservation biologists and information specialists in contrast to the oppressive expectation of "obedience" held by managers (Mattson and Clark 2001: 202). For example, at a recent Banff conference on Human Use Management in Mountain Areas, sponsored by Parks Canada, grizzly bear biologist Dave Mattson (Mattson and Clark 2001: 227) described how a "myth of property rights" interferes with grizzly conservation strategies. Others, such as Reed Noss, one of the initiators of a new quasi-science, conservation biology, have long advocated the removal of rights to own private property and the right to access public land (Noss 1994: 3–4). Absent from this rhetoric is any recognition of the role that incentives play in protecting wildlife and wilderness and the importance of multiple use strategies for natural resource management; absent as well is any acknowledgement of the responsibilities exercised by private landowners in maintaining the integrity of ecosystems by their on-going management practices (Anderson *et al.* 1999; Anderson and Leal 2001).

The willingness of some scientists to move from wildlife biology to a focus on economic and political issues has provided several critics with evidence that their science is, in fact, subordinate to their economic and political opinions. However that may be, a broad and deep area of disagreement exists over strategies of wildlife conservation. Within this context, however, we are responding in this study to the conventional invitation noted above, to examine the strengths and limitations of the ESGBP's arguments, models, and data (Herrero *et al.* 2000: 5). As Dr. David L. Garshelis recently argued, "there are few places where biologists admit to not knowing whether a bear population was increasing, decreasing, or stable, yet the reality is that there are few places where we really *do* know for sure how bears are faring . . . I believe that ultimately we, as bear biologists benefit—because bears benefit—by critically examining the basis of our knowledge and admitting our foibles and uncertainties" (Garshelis 2002: 4).

Objectives of this study

The benefits of admitting these uncertainties extend to the concerned public, whose rights, opportunities, liberties, and livelihood are affected by government wildlife conservation policies. To date, however, debates over appropriate conservation policies in and around the mountain national parks have been distorted by a failure to acknowledge the extent of genuine scientific disagreement over approaches to grizzly bear biology and protection strategies. We propose, therefore, to review existing scientific literature in order to analyze and appraise the grizzly bear research that is being used to support models of park management on the eastern slopes of Alberta's Rocky Mountains. In particular, we will examine:

- Conflicting assessments of the current and historical status of grizzlies in Alberta. Special attention will be paid to the problems related to measuring geographically determined subpopulations.
- The assumptions, reliability, and recommendations of an ESGBP-led Population Habitat and Viability Analysis (PHVA) and use of the VORTEX computer simulation model to predict the probability of grizzly bear extinction.
- Parks Canada's cumulative effects assessment measures, in particular their ESGBP-derived habitat effectiveness modeling and security areas analysis.
- The methodology and applications of ESGBP's behavioural distinction of bears as either "wary" or "habituated."
- The use of the precautionary principle, both in grizzly bear research and as the basis of Parks Canada policy.

Finally, we will review the policy alternatives for managing large carnivores such as grizzly bears in and around Canada's Rocky Mountain national parks. Many environmental groups, conservation biologists, and park managers have begun to urge that Alberta grizzly bears can only be saved from predicted extinction by preserving a vast tract of unbroken territory that covers almost 1.2 million square kilometres of public and private land from Yellowstone National Park to the Yukon (Harvey 1998). While we do not dispute the common-sensical observation that bears need adequate habitat, our findings suggest that increasingly extensive closures and restrictions are neither necessary nor wise.

Grizzly biology

Creating a crisis

Rhetoric about an impending and severe environmental decline, repeated warnings of a "progression of extinction" (Gibeau 1998: 241; Canadian Parks and Wilderness Society 2000b), threats of famine and flooding as a result of global warming, and declines in biodiversity (Commission for Environmental Cooperation 2001) are powerful tools in the battle for public support. They are so powerful, in fact, that some influential scientists justify the use of scare tactics as a means of encouraging public acceptance of stringent environmental regulations. As Stephen Schneider, a Stanford University climatologist and advisor to the Clinton-Gore administration, argued several years ago, at a time when very little data was available, "we have to offer up scary scenarios, make simplified dramatic statements, and make little mention of any doubts we may have. Each of us has to decide what the right balance is between being effective and being honest" (quoted in Schell 1987: 47). In 1999, biologists Brian Bowen and Stephen Karl prompted a heated debate in the pages of *Conservation Biology* over the misuse of science to promote conservation goals in the "geopolitical taxonomy" of the black sea turtle (Karl and Bowen 1999; Pritchard 1999; Grady and Quattro 1999; Shrader-Frechette and McCoy 1999; Bowen and Karl 1999). After one reviewer compared conservation to a war in which "it is acceptable to tell lies to deceive the enemy," Bowen and Karl responded with the following question: "Should legitimate scientific results then be withheld, modified, or 'spun' to serve conservation goals?" Continuing with the war analogy, Bowen and Karl laid bare the deep tension between science and advocacy in conservation:

> The advocates are combatants on the front line, the fighter pilots that take the struggle to enemy territory. Scientists are the support troops, providing the materials and information that can be brought into battle. Front-line strategy may include propagandizing: if advocacy organizations want to retain a dubious taxonomy, that decision lies outside the purview of scientific investigation. The support personnel should not, however, be pressured into making false reports. (Bowen and Karl 1999: 1015)

If some scientists are willing to abandon their commitment to intellectual honesty in order to be more "effective" in the sense that they can impose their beliefs on the rest of society, it is only prudent that those who suffer the impact of this activity carefully examine the alleged facts and data as well as the logic of the proposed legislation. As Kristin Shrader-Frechette and Earl D. McCoy point out in their response to the controversy about the black sea turtle, "in cases of conflict in conservation biology, as in virtually all cases in professional ethics, the public has the right to know the truth when human or environmental welfare is at issue" (Shrader-Frechette and McCoy 1999: 1012).

Accordingly, before accepting assertions that "swift and in some cases, drastic, management action is needed if we are to stem grizzly bear extinction within the [Central Rockies] ecosystem" (Gibeau 1998: 241), it would be prudent to see if the claim of impending "extinction" is accurate. That is, are Alberta's grizzly bears really on the brink of extinction? And, is it therefore essential to build grizzly populations to levels as high as the 100,000 individuals that, for example, the Sierra Club claims once roamed the lower 48 American states? In Canada, meanwhile, the newly established Bow Valley Grizzly Bear Association (BVGBA) claims that Alberta's grizzly population once numbered between 9,000 to 16,000 bears. This interest group is currently using these estimates to bolster their efforts to upgrade the status of grizzly bears to "threatened" as well as to have Parks Canada incorporate a "strong and effective 'grizzly bear conservation strategy'" into 2002 revisions of Banff National Park's Management Plan—a plan already structured around strict grizzly bear "habitat effectiveness targets" (Bow Valley Grizzly Bear Alliance 2002; Parks Canada 1997). Others cite nineteenth-century estimates that put the contemporary grizzly population in Alberta at 6,000 bears (Herrero 1992) as grounds for sustained recovery efforts, even though scientists also state that "the accuracy of this historical estimate remains unsubstantiated" (Kansas 2002: 8). In short, the grave claim of the Sierra Club and of other environmentalists that, "in less than three human generations, the Great Bear was dethroned from its wilderness kingdom to be confined in five island ecosystems, surrounded by still-rising tides of human development" (Wilcox and Ellenberger 2000) deserves to be examined, not as revealed doctrine but as testable hypothesis.

Conservation versus preservation

When entering either scientific or policy debates over wildlife protection and management, researchers, environmentalists, and policy professionals have a responsibility to define clearly their terms of reference. Central to any discussion of wildlife management and, more generally, of environmental issues is a clear distinction between "conservation" and "preservation." By convention, "conservation" allows for multiple licit uses of the natural environment by the human community. Abuse or overuse is limited by weighing the needs, desires, and interests of other inhabitants of a particular area or, indeed, of the earth at large. Despite disagreements over the actual balancing mechanisms, there is an understanding that human needs are not necessarily subordinate to non-human concerns, which are, of course, expressed by humans, and are not automatically considered a threat to the environment. Rather, humans are seen as a part of their environment, possessing a responsibility to manage and steward the land and the creatures that live on it. In the extended conversation regarding the environment, conservation is often seen as synonymous with terms such as sustainable use, or multiple use, stewardship, and more recently, environmental management. This understanding of conservation as a means of balancing human use of natural resources with ecological sustainability is both moderate and limited in its expectations.

An excellent example of conservation-based management exists in the original designation of the Canadian mountain national parks. Banff, Jasper, Yoho, and Kootenay were created to fulfill what has traditionally been known as a dual mandate, namely protection and use. "The logic was obvious: in order to be enjoyed by future generations, the land had to be protected. It was to be protected in order to be enjoyed" (LeRoy and Cooper 2000: 9). A recent court decision, *Tobler v. Canada (Min. of Env.)* [1991], further justified a conservation-based, dual view of our national parks. Tobler, a Swiss tourist, brought a negligence action against Parks Canada after being mauled by a grizzly during a visit to Banff National Park. In his decision, Mr. Justice Cullen found that Section 4 of the National Parks Act (the wording of Section 4 is unchanged in the revision of the Parks Act of October 20, 2000) presents the public with an invitation to enter national parks. Furthermore, under the *Crown Liability Act* (1985) and the Alberta *Occupiers' Liability Act* (1980), Parks Canada was held to be the occupier of the national parks. Justice Cullen's ruling showed that Parks Canada "owed a duty to take reasonable care to ensure the park was safe to the public" (*Tobler v. Canada*: 642). Justice Cullen's decision clearly indicates that Parks Canada is, through legislation and practice, providing a visitor-oriented environment. Furthermore, the National Park Management Plans all regularly repeat the statement that our national parks are "A Place for Nature . . . A Place for People." The present and historical provision of visitor-based recreation opportunities and environmental protections reinforces the concept of a dual mandate (Parks Canada 2000a: 2–5).

In contrast, a concern for "preservation" has come to imply a view of nature that requires fundamental changes in the psychological, the pragmatic, and the spiritual approach to nature that humans typically and traditionally have taken. According to this view, individual rights, human preferences, human populations, and human use of the environment must be severely curtailed in order to preserve ecological integrity (EI). Without such changes, it is claimed that animals (Regan 1983, 1987) and future generations (Partridge 1990) will be dispossessed. These claims are often supported by the fear of imminent extinctions—both human (Wilson and Peter 1988; Wilson 1989) and non-human (Gibeau 1998). In the words of Troy Merril and frequent ESGBP collaborator Dave Mattson: "conservation of grizzly bears is about more than saving bears . . . It is about feeling shame at slaughtering wolves and bison to protect livestock and [to] increase sport hunting opportunities" (Merril and Mattson 1998: 110). The ability of traditional liberal and democratic governing structures, to say nothing of markets, to protect biodiversity is also questioned (Wood 2000). Proposed remedies invariably require that human use of natural resources and natural areas be heavily regulated. The new regulated environment invariably requires the wholesale reconceptualization of legal and moral rights to property.

Wildlife biologists who are concerned with preservation in this sense almost without fail also accept the need for fundamental and wide-ranging changes. In response, they have created a new quasi-scientific "crisis discipline," conservation biology in order to blend genuine science with advocacy so as to influence public policy. In their own words, the field is goal-driven (Noss 1994) and mission-oriented (Soulé 1985). Some conservation biologists have drawn the conclusion that they are compelled by their commitments to advocate fundamental and extensive changes to lifestyles, legislation, management schemes, and public policy. The growing restrictions to human use and enjoyment of Canada's national parks provide the most obvious evidence that the preservationist philosophy has been accepted by Parks Canada.

Perhaps the most important actualization of the agenda of conservation biology has been to expunge the "dual mandate," which embraced both conservation and enjoyment, from the Parks Canada mission. This shift to an exclusive concern with "preservation" was made clear when the federally appointed Panel on Ecological Integrity, which released their report on Canada's national parks in March 2000, declared that "a proper reading of the National Parks Act of 1930 reveals that . . . there was no dual mandate" (Parks Canada 2000b: 2–5). In the twinkling of an eye, therefore, the Panel on Ecological Integrity reversed the plain meaning of the words in the 1930 Parks Act and gave them the very opposite sense to what, in fact, they conveyed. By no stretch of the imagination is this a "proper" reading of the Parks Act of 1930. Supplanting the traditional dual mandate are the vague notions of ecological integrity (EI) and "ecosystem management," which has become a term of art that requires Parks Canada to extend their influence on private and provincial land use decisions far beyond park borders (Parks Canada 2000b: chap. 9).

Legislating protection

An appraisal of the science and the scientific language undergirding public policy is important because policy decisions can be made on the basis of misleading information. Such decisions will have the same kind of long-range economic and ecological impact as those made on the basis of sound and accurate information. For example, one of the first problems encountered when discussing wildlife management and recovery plans is that of reaching a common definition of what constitutes a species. While a standard biological definition of a species may be based on common characteristics and reproductive behaviour, it has become commonplace to broaden the definition to include geographically defined populations and subspecies, which are themselves further divided "based on variations and behavior such as darker feathers, more spots or different nesting behavior" (Jones and Fredricksen 1999). The grizzly bear (*Ursus arctos horribilis*), for instance, is actually a subspecies of brown bear (*Ursus arctos*), "one of the most widely distributed terrestrial mammals, with a current range spanning a variety of habitats in the lower-middle to high latitudes of Europe, Asia, and North America" (Waits *et al.* 1998: 409). While "a classic example of taxonomic oversplitting" proposed to describe the geographic variants of North American brown bears as over 90 subspecies, current classifications count between two and seven subspecies (Waits *et al*. 1998: 409).

It was ultimately through a process of redefinition that the grizzly bear has come to be classified as two distinct species listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Since this redefinition occurred in 1991, Canada's new "prairie population" was been designated "extirpated," which is to say, wiped out locally, while the "non-prairie population" remains of "special concern," despite the fact that there are over 26,000 grizzly bears in Canada and its area of occupancy has remained relatively stable over the past 20 years (COSEWIC 2002). It is noteworthy that the COSEWIC category of "special concern" (the lowest of five "at risk" categories) does not mean that the number of animals belonging to a "special concern" species is below acceptable levels. Rather, it means that the "special concern" species is deemed to have *characteristics* that make it particularly sensitive to human activities and natural events. This does not mean that a species is threatened with extinction but that it is threatened with becoming threatened with becoming extinct—a rather remote "threat."

Despite well-documented problems with the American Endangered Species Act (see, for example, Stroup 1995; Jones and Fredricksen 1999), the environmental lobby, certain conservation biologists, and sympathetic politicians have long advocated federal legislation to protect Canadian species deemed to be at risk. In absence of such legislation, federal parks and protected areas have long been seen as strategic centres from which to protect species by influencing land-use decisions beyond park boundaries and on what advocates call a "landscape scale." This was clearly the objective of ESGBP, as explained by lead researcher Stephen Herrero as far back as 1994: "I suggest we take advantage of the protected core areas offered by existing national parks and some adjacent reserves, and try to build outward from them ecosystem management strategies and other mobile species viability" (Herrero 1994: 10). In this example, a "landscape scale" simply meant extending the regulatory authority of parks administrators beyond the park boundaries.

Nonetheless, Herrero maintained his concern that "a lack of common objectives set by law, such as exists for the grizzly bear in the contiguous United States under the Endangered Species Act would still be a handicap" to protect viable grizzly bear populations and the ecosystems they inhabit (Herrero 1994: 19). In absence of such legislated objectives on a "landscape scale," the influence of the federal parks service would be strategically important because, as Herrero said, it would be possible to "build outward" from the "protected core" to areas outside the parks that could be incorporated into "ecosystem management strategies."

On June 11, 2002, however, the Canadian House of Commons passed bill C-5, "An Act respecting the protection of wildlife species at risk in Canada" (also known as the Species at Risk Act, or SARA). The two most recent versions had died on the Order Paper. Although SARA only applies to species within federal lands and waters, the "ecosystem management" advocated by many conservation biologists and centralized land management agencies could give the federal government extra leverage to influence decisions about land use and development far beyond their legal jurisdiction. If a species is listed as being as "special concern" (as the grizzly bear is under current COSEWIC assessment), section 65 compels the federal Environment Minister to prepare a management plan for the species and its habitat. To date, federal wildlife management, protection, and recovery plans have primarily fallen within the mandate given to Parks Canada. This should be of serious concern to private landowners familiar with the flood of litigation initiated by well-funded environmental interest groups in the United States (especially when Canadians are not afforded constitutional protection from such "takings"). Thus, the science and politics involved in parks management planning may provide useful insight into how the debate over the interpretation and application of Canada's Species at Risk Act will unfold.[2]

Drawing boundaries

The first challenge in ascertaining the real status of species considered to be at risk is determining the appropriate scale of study and assessment. At present, the "ecosystem concept" and the notion of (cumulative) environmental impact assessments inform government land use planning within the national parks. While the ecosystem concept (and related mapping exercises) may give the illusion of a logically bounded ecological and geographic area, there are, in fact, very clear limits to its usefulness, both in science and policy. Ecosystem and similar "biome" approaches "are vague and their application, to date, has been largely arbitrary . . . As a result, 'biome' and 'ecosystem' boundaries are largely a matter of scientific opinion" (White *et al.* 1995: 11). In the words of geographer Allan Fitzsimmons, "[t]he ecosystem concept, while quite useful within the realm of science from which it was borrowed, is inappropriate as a geographic guide for public policies. Instead of introducing science into public policy, use of the ecosystem concept interjects uncertainty, imprecision, and arbitrariness" (Fitzsimmons 1994). It is necessary, therefore, to be cautious in using such terms because the realities to which they refer are so unclear.

The ESGBP study area, "defined by a particular arrangement of local plants and animals" is the Central Rockies Ecosystem (CRE), distinguished from the Crown of the Continent Ecosystem to the south and the Jasper and Kootenay regions to the north and the west. The CRE is defined as a area of 42,000 square kilometres encompassing Banff National Park, Kananaskis Country, and adjacent private and provincial lands in both Alberta and British Columbia, which, as an ecological unit, is said to have "significant but not complete closure" (Herrero *et al.* 2000). As described in the *Atlas of the Central Rockies Ecosystem*, borders are hazy and "there are no hard and fast boundaries. And as soon as the species of focus changes, so does the geographic scope. For instance, if wolves are selected as indicators of ecosystem extent, the 'ecosystem' expands to cover the entire Canadian Rockies and beyond" (White *et al.,* 1995: 11).

Just as attempts to draw clear boundaries around ecosystems are often arbitrary, many of the attempts to categorize a portion of the grizzly population turn out to be inappropriate. Recent estimates, based on an assessment of habitats and grizzly bear densities across the CRE, have determined that at the low end of the scale, about 450 grizzly bears inhabit this area (Herrero *et al.* 2000; Jalkotzy 2000). Other estimates suggest that the CRE grizzly population may be as high as 670 to 696 bears but is most probably about 600 (Leighton 2001: 3). An isolated "Banff population" of between 60 and 80 grizzly bears has also been singled out in ESGBP research, with only the most conservative, which is to say, smallest, estimate being used for park planning purposes. Unfortunately, this distinction of a specific park population is both misdirected and misleading. As Banff naturalist Doug Leighton has observed, "the greatest obstacle to discussions of the 'Banff National Park grizzly population' is that it does not exist" (Leighton 2001: 6). The reason is obvious: with the individual ranges of many grizzly bears in the eastern slopes of the Canadian Rockies encompassing several hundred square kilometres, the notion that a population of grizzlies will exist wholly within the artificial, humanly defined boundaries of a park is unrealistic.

Leighton's remark accords with the statement of wildlife biologist Dr. Ray Demarchi that "grizzly bears exist in the Rocky Mountains of Alberta's Eastslope, not as an isolated group but as perhaps a loosely defined subpopulation of part of a very large metapopulation that occurs from somewhere around Butte, Montana in the South to the Arctic Ocean in the north" (pers. comm. with Jason Hayes, April 3, 2002). The nonexistent "Banff population" is, in fact part of a CRE population connected to what Dennis Demarchi (1994) called the Shining Mountain Ecoprovince population, some 6,000 bears strong. The Shining Mountain Ecoprovince, in contrast to both the restricted CRE population and the entirely artificial Banff population, approximates the actual grizzly range from Butte to the Arctic. This encompasses two provinces, parts of two territories, and all or part of five American states.

Predicting extinction

Sensible conservation plans are further compromised by the way in which many environmental groups and conservation biologists have used the term "extinction." The word is so thoroughly embedded in the English language that any dictionary can use "extinct" and "animal" together and readers immediately understand its application to situations such as the passenger pigeon or the dodo bird. Therefore, when a scientist proclaims a species to be extinct, the general, dictionary, and common-sensical understanding is that it has been wholly removed from the earth. When a scientist publishes that "swift, and in some cases, drastic management action is needed if we are to stem grizzly bear extinction within the [Central Rockies] ecosystem," reasonable readers understand this to mean that grizzlies are on the brink of disappearing. In fact, of course, it would be impossible for human beings in the central Rockies to cause the complete removal of the reproductive ability of grizzlies as a species. The worst that could happen would be local extirpation: grizzlies would no longer occur in the wild, in this narrowly defined area.

At a 1999 workshop arranged to assess the long-term viability of grizzly bears in the central Rockies, ESGBP researchers thoroughly muddled the conventional terms of analysis and discussion by providing their own, idiosyncratic definition of "extinction." The group used the technique of population and habitat viability analysis (PHVA), which, like the slightly simpler population viability analysis (PVA), is a computer simulation exercise that predicts probability of species extinction under a number of different scenarios, using data on the life history, ecology, and management of various species. Assessments can include considerations such as "habitat management, captive breeding (if appropriate), genetic factors (if appropriate), life history, status, threats, geographic distribution, education and information, other conservation efforts, human demography, research, and any other component deemed necessary" (Beardmore and Hatfield 1996).

For the ESGBP-led simulation, "extinction" was equated with "the probability of population decline below current levels," an occurrence properly referred to as "quasi-extinction probability" (Herrero *et al.* 2000: 9). They concluded that, "under this definition, modeling efforts indicate that the population is not secure: the provincial goal of maintaining or increasing the population above today's numbers is not likely to be met under current conditions" (Herrero *et al.* 2000: 9). The change in the meaning of a commonly understood word is all the more surprising—not to say misleading—because of the widespread use of well-known technical terms as population decline, extirpation, or local extirpation.

While PVA and PHVA have the potential to provide considerable insight into the complexities of wildlife management, these tools face the same constraints as other long-range predictive models such as those used to predict climate change. Since its development in the 1980s, there has been substantial scientific disagreement concerning both the validity and the reliability of PVA and the inherent limitations of the computer software programs used to model them (Dennis *et al.* 1991; Taylor 1995; Ludwig 1999; Brook *et al.* 1999; Fieberg and Ellner 2000). In 1999, Brook *et al*. tested the reliability of six common PVA software packages (GAPPS, INMAT, RAMAS-Age, Stage and Metapop, and VORTEX) by retrospectively testing the historical data of over 20 long-term population studies. They found that extinction and recovery probabilities predicted by these models did not reflect actual population fluctuations nor were they able to predict accurately future population abundance (Brook *et al*. 1999).

The reliability of the data and the nature of the assumptions that guide and structure the analysis are also open to challenge. According to Ludwig, "the confidence intervals are so wide that the analysis provides little or no information about the magnitude of extinction probabilities" (1999: 298). By adding a habitat component to the analysis, the unreliability of PHVA is compounded, a point that was noted by participants in the ESGBP-led workshop who "expressed concern at the number of 'guessed' parameters used as input to VORTEX, and/or a desire to explore the importance of 'uncertainty' in our knowledge of grizzly bear biology" (Herrero *et al*. 2000: 43).

While it is conventional in the use of computer modeling processes to extend projections several decades into the future, workshop participants were agreed that a simulated duration of at least a century would be appropriate for grizzly bears, although "simulating a population for more than 100 years incorporates higher levels of uncertainty into the assumptions. (Even 100 years may have a significant amount of associated uncertainty)" (Herrero *et al*. 2000: 37). There are, thus, two conflicting requirements: to be useful to the PHVA process, the simulation should run for a century or so; but, by so doing, the inherent and significant uncertainty of the projections is unavoidable because of the small size of the data set. As Fieberg and Ellner (2000: 2040) have noted, "reliable predictions of long-term extinction probabilities are likely to require unattainable amounts of data."

Are Canada's parks "islands of extinction"?

The tenets of conservation biology are regularly used as the basis for assertions that Canada's parks are "islands of extinction." These notions are advanced on the grounds that "small, isolated populations of animals are vulnerable to natural catastrophe, genetic inbreeding, and other phenomena that accelerate the local extinction of species" (CPAWS 2002). Parks Canada has accepted these opinions as valid (Parks Canada 2000b: chap. 9). This has given the question of genetic viability a tremendous importance in assessments of viable grizzly bear populations and the habitat needed to sustain them. The image of "islands of extinction" is reflected in the scientific concept of "inbreeding depression," which refers to the average decrease in genetic fitness an individual suffers as a result of inbreeding. Inbreeding is conventionally defined as the mating of biological relatives that could cause loss of heterozygosity. While scientific concern over the "evil effects of close interbreeding" is often traced back to Darwin over a century ago, inbreeding is actually harmful only when the level of deleterious genes is high. As Simberloff *et al*. (1992: 496) remind us, "it is important to bear in mind that a loss in genetic fitness need not endanger a population … It is not axiomatic that inbreeding, even if it should lead to inbreeding depression, is a major threat to small populations, relative to other threats." Paetkau *et al*. reached a similar conclusion:

> [T]he relative importance of inbreeding in conservation biology remains contentious because the effects of close inbreeding are difficult to identify and measure in natural populations and because factors such as the population's history, the rate in decline in population size, and the chance of fixation of deleterious alleles [the alternative sets of genes contained within each cell] can play roles that are important but difficult to quantify. (1998: 419–20)

In the PHVA simulation exercise previously discussed, there was concern over the limited number of maternal genetic lines that might possibly cause a decrease in the genetic fitness of grizzly bears in the central Rockies:

> [I]n the CRE population, we know that there is a high degree of relatedness among individuals (same mitochondrial DNA tracing back to a single female). This parameter *may not lead to a large impact* on the simulation result because if a population is highly inbred it is usually already in trouble due to other demographic factors. (Herrero *et al.* 2000: 39; emphasis added)

Mitochondrial DNA (MtDNA), however—entirely distinct from the major part of the genetic structure—is automatically passed down as a distinct unit through the female line. As biological anthropologist James Paterson explains:

> MtDNA has no capability of providing information on inbreeding—that issue must be solely restricted

> to the "nuclear DNA," which is inherited from both parents. Hence MtDNA is irrelevant to the issue. This genetic system only varies through the accumulation of random mutations in the Mt genome. (pers. comm. with Barry Cooper and Sylvia LeRoy, July 24, 2002)

Nevertheless, the PHVA uses evidence of a strong MtDNA line to support "the more conservative approach [which] would be to assume that inbreeding does in fact impact demographic rates" (Herrero *et al*. 2000: 39).

Including inbreeding depression as an input parameter, even though "the model by default assumes that inbreeding depression does not act to reduce fitness" (Herrero *et al.* 2000: 39), deserves critical scrutiny. In order to input this concern over inbreeding depression into the PHVA simulation, the ESGBP researchers used the median inbreeding depression data from a study of 40 small captive populations in zoos in Scandinavia and applied it to the modeling process as their "baseline" data. Reviewing the pedigrees of zoo populations, Laikre *et al*. (1996) did indeed find that inbreeding depression had an impact on this limited population. But how the genetic limitations of a zoo population related in any significant way to the genetic limitations of grizzly population of the central Rockies was not explained. In fact, there is no scientific reason to think that the study of 40 small captive populations in Scandinavian zoos can supply "baseline" data that has any relationship to the situation that CRE grizzlies confront.

Furthermore, the simulation used what is conventionally understood in wildlife biology and population genetics to be evidence of genetic dominance, namely a single matrilineal heritage, to suggest that a "highly inbred" population is "usually already in trouble."[3]

This assumption ignores the fact that grizzly populations that have this "same mitochondrial DNA tracing back to a single female" are in fact examples of *healthy* matriarchal lines that have asserted dominance over a group of home ranges. With females naturally possessing smaller home ranges than males, basic population biology explains that genetic drift within these populations occurs by the movement of dominant males whose home ranges cross the ranges of these mother-daughter ranges. Bunnell explains the consequence of genetic drift:

> For recently isolated populations of about 50 animals, 30 to 200 generations would be required on average to fix or lose one allele. The time span within which a permanent shift in gene frequency may occur thus varies broadly from about 15 years (some insects, rodents and insectivores) to 1,400 years (bears). (1978: 277)

It is essential to note that Bunnell is referring to the effects of inbreeding and loss of heterozygosity on relatively small (50 animals) and isolated populations. Thus, with genetic drift affecting the viability of an isolated population, it could take up to 200 generations or 1,400 years to see a permanent shift in gene frequency. However, the central Rockies grizzly population is neither small, at 400 to 600 individuals, nor is it isolated when assumed rates of immigration are as high as 10% across the continental divide (Herrero *et al*. 2000: 38). Furthermore, recent population estimates (Banci *et al*. 1994) indicated the "Cool Dry Mountain" population, living in the central Rockies south into Montana, was 930, the "Cool Moist Mountain" population living north and west of the central Rockies, was 2,450, which connects to the "Cold Moist Mountain" population of 2,940, which has connections to the remainder of the continental population. There is, therefore a *potential* genetic diversity from over 6,000 bears available to the central Rockies population. This coincides with Demarchi's description of the Shining Mountain Ecoprovince. The CRE grizzlies are not, therefore, genetically isolated.

ESGBP researcher M.L. Gibeau (2000: 27) has also acknowledged that the central Rockies study area "does not contain a closed population." Indeed, his study area contained a grizzly population that he assumed "has a significant degree of genetic exchange" (Gibeau 2000: 46). Furthermore, his study of the genetics of bears in the central Rockies cited Allendorf (1983) and Allendorf and Servheen (1986), which "suggested that adequate gene flow would be maintained with immigration of at least one successfully breeding individual per generation" (Gibeau, undated). This same basic biology has been noted by other experts as well. Clevenger, for example, observed that "a conservation geneticist would say one adult male grizzly crossing [the Trans-Canada Highway] per grizzly bear generation (every 13 years) would be sufficient to stave off isolation effects and imperiling genetic diversity ... a wildlife ecologist would hope for a bit more" (1999: 2). Likewise Leighton notes that:

> From 1994–1998, all 3 radio-collared adult males plus unknown numbers of other adult males crossed in only 5 years. These recent male crossing

> rates are then already sufficient—as suggested by the documented "abundant genetic variation"—and will probably improve as the bears learn about the new crossings and the trails leading to them. (2000: 48)

When one considers the abundant immigration assumed for the parameter inputs of the VORTEX model (Herrero *et al.* 2000: 38), there does not seem to be a realistic concern associated with genetic limitation of this population.

Moreover, the fragmentation of grizzly bear populations in North America does not mean they will become extinct. Mills and Allendorf (1996: 1514), for example, note that "there may be merit in maintaining isolated populations so that more alleles can be retained in the entire population." This is supported by data from the island population of Kodiak bears (*Ursus arctos middendorffi),* which indicate that "populations well under the size recommended for long-term conservation can persist and thrive for thousands of years" (Paetkau *et al.* 1998: 418).

Finally, numerous studies have asserted that brown bears are highly mobile and can disperse hundreds of kilometres, but "the first comprehensive Mt DNA sequence analysis of brown bears from across their current range in North America" found that geographic patterns of genetic variation ("phylogeographic partitioning") "may have been the result of a combination of the following: (1) separation and genetic divergence of brown bear populations in glacial refugia during the climatic fluctuations of the Pleistoscene, (2) multiple migrations of brown bears into North America from Asia, and (3) low levels of female dispersal" (Waits *et al.* 1998: 413). In other words, geographic patterns of genetic variation, whether termed genetic isolation or differentiation, were not caused by the modern human encroachment into grizzly bear habitat but rather occurred naturally, over the course of thousands of years. The alarming claims of "extinction," which have prompted calls to create massive and continuous protected habitat to connect grizzly bear populations from Yellowstone to Yukon, are, therefore, highly unconvincing.

The status of Alberta's grizzlies

Conflicting reports of the status of the grizzly population underline the division in scientific methodology and assumptions used in the study of North American grizzly populations. There are many reasons for these divergent status reports. One reason: "Assessments of bear populations often are based on records of dead animals and trends in habitat availability. These data produce dubious indications of population trend" (Garshelis 2002: 1). Yet another reason for uncertainty comes from differences in where the boundaries circumscribing grizzly populations are drawn. Notwithstanding the claims of ESGBP researchers concerning the "progression of extinction" of grizzlies in Alberta's central Rockies—in conventional language, a population decline—other reports indicate that the number of grizzlies in the area is not only stable but growing significantly.

In January 2002, the Government of Alberta and the Alberta Conservation Association released a status report on the grizzly bear population that described an annual growth rate of 2% to 3% per year on provincial lands (Kansas 2002: 12) (see figure 2). This indicates Alberta's grizzly population has risen a dramatic 46% over the past 14 years. There are an estimated 841 grizzly bears on provincial lands, in addition to national park populations conservatively estimated to be between 175 and 185 bears. Jasper National Park is home to between 100 and 110 bears; conservative estimates (used for park planning purposes) set the Banff grizzly bear population at 60 bears; the most recent available estimate for Waterton Lakes National Park is 15 bears. Altogether, the combined park and non-park population is between 1,016 and 1,026 bears (Kansas 2002: 12).

Mortality rate for grizzly bears

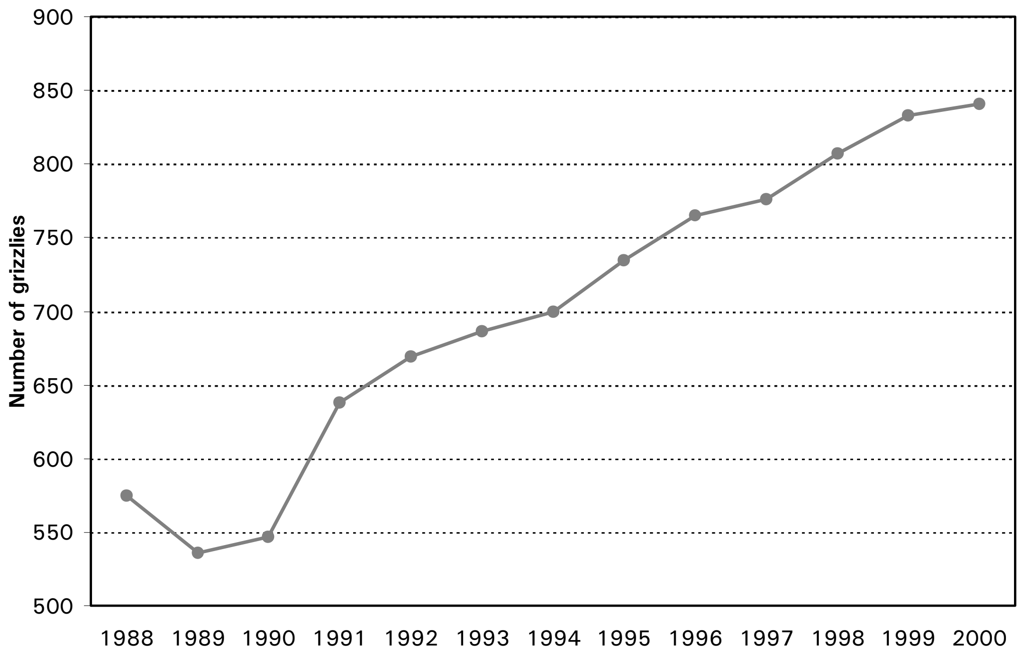
A question of great significance for ascertaining the population growth rate is the mortality rate for grizzly bears. Wildlife managers in Alberta, British Columbia, and the Yukon have accepted a 4% mortality rate "as a conservative estimate of the maximum sustainable mortality for grizzly bear populations, including kills from all sources" (Banci *et al*. 1994: 133). Kansas (2002: 10) writes that "[6%] to 6.5% is considered to be the scientifically acceptable human-caused mortality rate above which mortality would cause a population decline." Yet even employing the more conservative 4% rate, bears in the CRE are still well below the acceptable levels of mortality; with 11 natural deaths and 1 death with an unknown cause, the total known losses in Banff from 1984 to 2001 were 1.7 bears per year (31 in 18 years) (see figure 3). This amounts to 2.9% of 60 bears (the conservative estimate used in Parks Canada management planning), or 2.2% of 80 bears, depending on which "Banff population" estimate is used (Leighton 2000: 12).

The questionably designated "Banff population" is currently thought to include between 60 and 80 grizzlies in Banff National Park, approximately the same as the 1974 estimation of 55 to 85 bears (Herrero 1994: 12). Even using the lower boundary, the loss of 1.7 bears per year equates to 3.1% of 55 bears, still well below the maximum 4% boundary. Moreover, the rate of loss of 1.7 bears per year for Banff alone should be combined with the losses in the other mountain parks, because bears roam across park boundaries. Adding in the population estimates from Yoho and Kootenay, which range from 10 bears (Herrero *et al*. 2000: 28) to between 21 and 31 (Herrero 1994: 12), the mortality rate for bears of all ages killed by all causes is between 1.5% and 2.4%, which is probably the *lowest* grizzly mortality rate in southern Canada (Banci *et al*. 1994: 138).

Furthermore, McLellan (1991: 53) has indicated that "exceptional" populations in the prime habitat of the Flathead Valley, British Columbia have seen annual growth rates as high as 8%. Woods states that

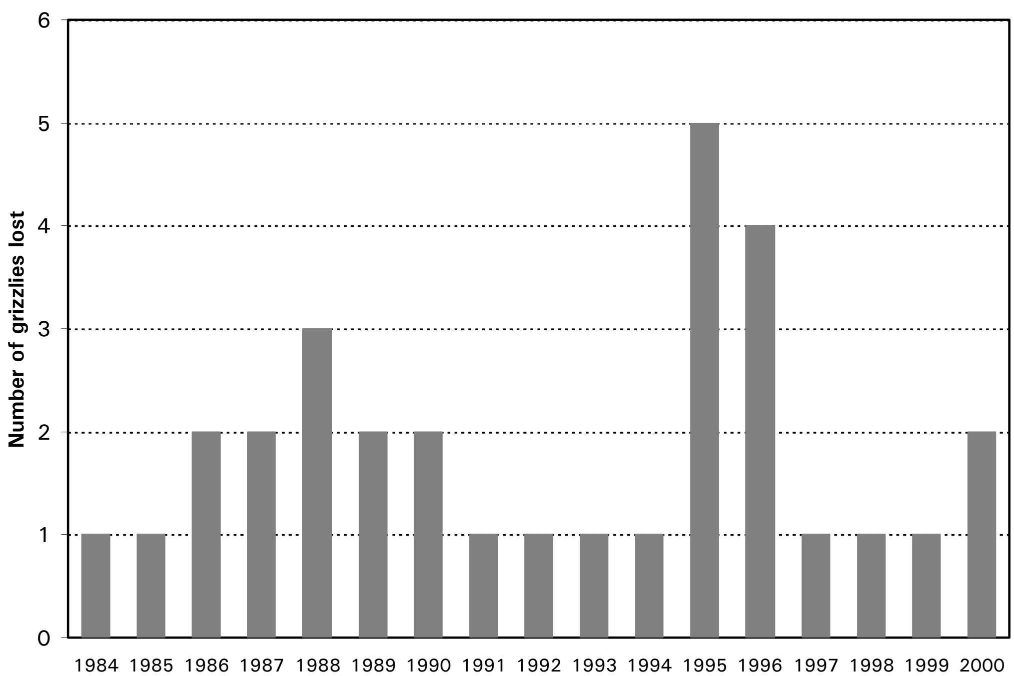
> during the past 25 years we believe that grizzly populations in the Kootenay region of BC (exclusive of the region's four National Parks) have increased . . . by as much as 50%, from approximately 1,350 to 2,000 bears . . . the actual (not minimum, which is used in setting hunting seasons) may exceed 2,500 bears.[4] (1991: 97)

Figure 2: Grizzly population in Alberta (excluding national parks), 1988–2000



Source: Kansas, 2002: 12.

Figure 3: Losses of grizzly bears in Banff National Park, 1984–2000



Note: Losses include accidental killing or translocation of problem wildlife, highway or railway deaths, legal and illegal harvest, research-related deaths, natural deaths, and deaths of unknown cause.
Source: Leighton, 2001: 38.

Amazing growth such as this has not gone undetected. Anecdotal evidence of increasing populations is continually reported (Shelton 1994, 1998, 2001) and even the ESGBP researchers have recently been compelled to admit that the overall grizzly population in the central Rockies is currently "stable" (Gibeau 2001, 2001a).[5]

The importance of a burgeoning population in British Columbia to Alberta's grizzly population is significant. Herrero *et al*. (2000: 38) assume immigration rates as high as 10% from British Columbia's Kootenay region to the southeast region of the CRE in Alberta, and a 5% immigration rate between the northwest and northeast CRE populations. Such consistent immigration from the growing number of grizzlies in British Columbia, means that concerns over extirpation appear unwarranted. Even with these encouraging numbers, a prudent recognition of low rates of fecundity and recovery on the part of wildlife managers is reasonable. There is, however, additional evidence to indicate that the prospect of even a local extirpation of grizzlies in the central Rockies is remote.

In Europe, for example, heavily hunted and managed brown bear populations have rebounded from near extirpation. Despite hunting pressures and the nearly ubiquitous human presence in Norway and Sweden, Dahle reports that brown bears (*Ursus arctos)* in Sweden have grown from "about 100–150 individuals in 1930 . . . to about 1,000 [in 1999], despite the fact that bears have been legally hunted with a quota system since 1947" (1999: 11). Janik (1997) indicates that brown bear populations recovered from less than 60 individuals to 600 in the western Carpathian Mountains of Slovakia. Additional and more compelling evidence that grizzlies can repopulate their range where appropriate conditions exist is available from Yellowstone National Park. American and ESGBP researchers both agree, "the Yellowstone situation is analogous to the three Canadian mountain parks" (Gibeau 1998: 237). Considering the Yellowstone population, which lives in similar habitat conditions but has the added difficulty of being a relatively isolated population with heavier human impacts, it is significant that the number of bears has increased from "200 or fewer" in 1975, when they were listed as threatened, to "an estimated minimum 400–600" (Servheen 2000). Notwithstanding disagreement about the actual number of bears in Yellowstone, even conservative estimates calculate a stable or slowly growing Yellowstone population (Pease and Mattson 1999). The evidence from Europe, Yellowstone, and non-park lands in Alberta and British Columbia indicates that, given sufficient habitat, minimized mortality, and consistent recruitment, which is to say births that survive to reproductive age, grizzly populations will increase. This regenerative ability (albeit slow and delicate) is present in the CRE population.

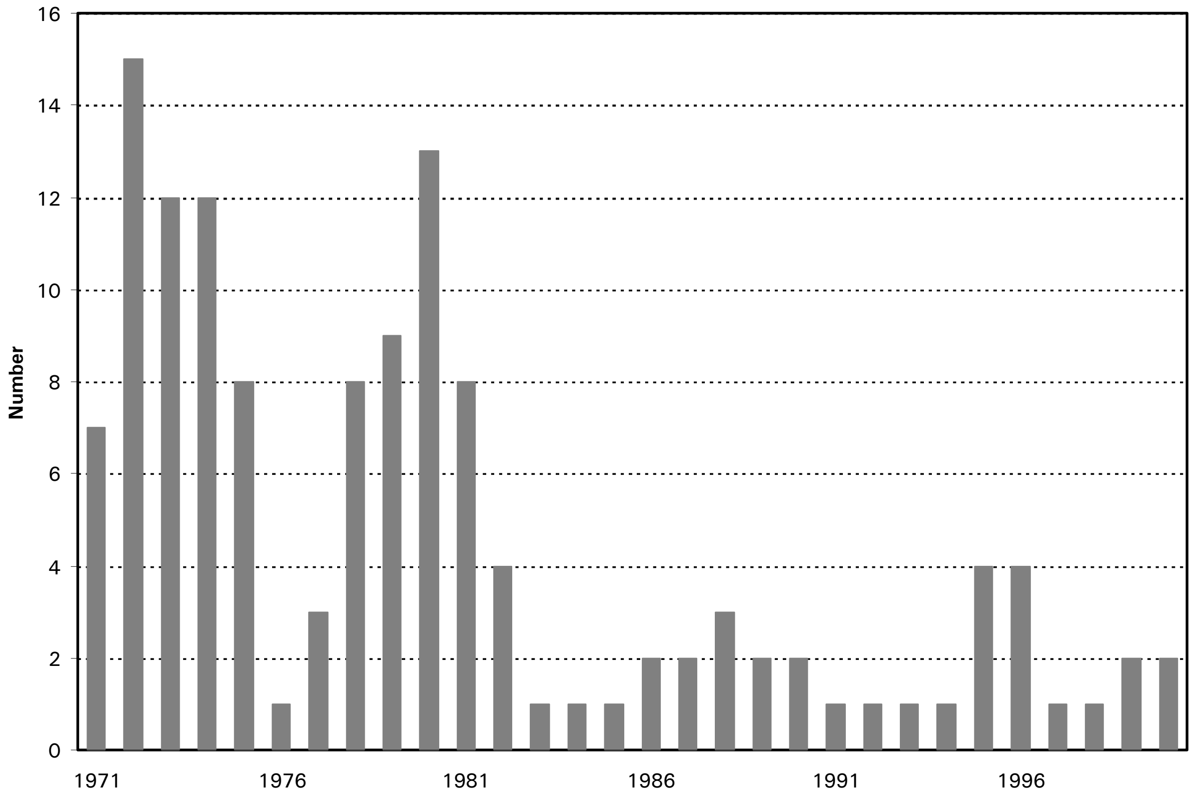
Human populations and the mortality rate of grizzly bears

Nonetheless, a persistent theme in ESGBP research is that an increasing human population in the central Rockies is putting undue stress upon grizzly populations. This link between human population and grizzly bear mortality has been used to justify extensive trail closures and restrictions on human use in and around Banff National Park, Canmore, and Kananaskis Country. Garshelis, however, points to a fatal flaw in this line of reasoning:

> Increases or decreases in levels of human exploitation may not necessarily result in attendant changes in [wildlife] population size. An increasing population may continue to increase in the face of heightened exploitation, whereas a declining population may continue to plummet despite reduced exploitation. (2002: 10)

Much of the data on grizzly bear mortality comes from ESGBP researcher Byron Benn (1998), who investigated CRE grizzly mortalities within the central Rockies. However, when reviewing the grizzly bear deaths specifically caused by humans, it is evident that these data fail to indicate a statistically predictable pattern. Therefore, using the entire data set to estimate "average" values for the entire period (i.e., from 1971 to 1996) would provide findings that were out of context, misleading, and an incorrect representation of the current impact of human activity in the mountain national parks. The spikes in the 1970s and 1980s, in particular, would bias (on the high side) predictions of future grizzly mortality (see figure 4). Leighton (2000: 89) argues that the use of this type of broad averaging has led to an exaggerated picture of recent grizzly deaths caused by humans. By including the exceptionally high data, one arrives at a figure of 2.92 bears killed each year between 1971 and 1995 (Gibeau *et al*. 1996). However, the average rate for the period from 1991 to 1996 was 0.8 per year. Moreover, Benn (1998: 37) indicated that the quality of the pre-1981 data is highly questionable. His database includes statistics for 32 Banff

Figure 4: Losses of grizzly bears in national parks of the Central Rockies Ecosystem (CRE), 1971–2000



Note 1: Losses include accidental killing or translocation of problem wildlife, highway or railway death, legal and illegal harvest, research-related deaths, natural deaths natural deaths, and deaths of unknown cause.

Note 2: National Parks of the Central Rockies Ecosystem (CRE) are Banff, Yoho and Kootenay.

Source: Benn (1998); Leighton (2001). Benn data has been adjusted to eliminate duplicate recording of one dead bear (1981) and to recognize that two translocated bears (1995) remained within the ecosystem.

Park bears that were "deduced": 12 for 1973, 12 for 1974, and 8 for 1975. In fact, "deductions" of this nature make accurate calculations impossible. Moreover, even if "deduced" bear deaths were included to obtain averages for the entire study period, it would still be necessary to examine management actions during those time periods to determine the *reasons* behind the wildly fluctuating numbers of bear deaths ascribed to human activity. That is, the reason for the deaths needs to be put into a time-series or historical context. If specific management techniques or environmental factors played a significant role in the fluctuating mortality rate over time, then the mortality rate should be interpreted in light of that information.

Management techniques have, in fact, played a significant role in grizzly mortality and a more detailed examination of the history of the interaction between humans and grizzlies can clarify and account for the mortality rate spikes of the 1970s and 1980s. Since the end of the last ice age, human populations have both hunted grizzly bears and competed with them for food (Herrero 1970, 1989; Kay 1994; 1995; Kay and White 1995; Kay *et al.* 1999). As a result of this competition, grizzlies have been both a revered symbol of North American wilderness and a feared and hated competitive nuisance. Ignorance of grizzly biology along with the "man-against-nature" view of the world that typified the nineteenth and early twentieth century ensured a systematic mismanagement of North American grizzly populations. However, by the mid-twentieth century, park managers changed their opinion that grizzlies were pests or hazards to be removed from as many wild areas as possible (Wagner 1994; Burns 2000), and focused instead on reducing human impacts on grizzly populations. This direction in management schemes provided the impetus for promoting viable populations of grizzlies as appropriate park policy.

As it turns out, high rates of grizzly mortality in the 1970s and 1980s were directly related to the closures of park and adjacent municipal garbage dumps. For many years, a significant proportion of the grizzlies in and around the mountain national parks foraged for food in garbage dumps (Herrero 1985, 1989; Benn and Herrero 2000; Leighton 2000, 2001). When the dumps closed, an easily available food source rich in calories was suddenly removed from the diet of many mountain park grizzlies. It seems that the dumps had artificially increased the carrying capacity of the area and allowed bears that would have been unable to compete under natural conditions to prolong their lives. When the dumps closed, the carrying capacity dropped causing "a sudden famine and major social stress on the bear population" (Leighton 2001: 11). Similarly, Shelton notes:

> When the grizzly population reaches maximum-phase, you will see a sharp decline in the survival rate of cubs because of density dependent cub killing by dominant males, and the total bear population will start to be influenced by the [food] resource. (2001: 195)

These bears, trained to rely on human garbage as a significant source of food and largely incapable of surviving in the wild, now had to find new sources of human food. Therefore, they turned to the closest available sources they could find, the towns and human habitations that had supplied the dumps. It was this sudden influx of food-conditioned, hungry bears, into towns and onto highways that brought about the high mortality rates seen in the 1970s and 1980s.

Park, wildlife, and municipal managers had the unfortunate and unenviable task of dealing with the often violent and destructive behaviour of bears that had avoided traffic hazards and arrived in urban settings. After the removal of these "dump habituates," mountain park grizzly populations were likely below a natural carrying capacity. Fortunately, as noted above, reports from the governments of Alberta and British Columbia indicate that the bears killed during the adjustment following the dump closures have been replaced.

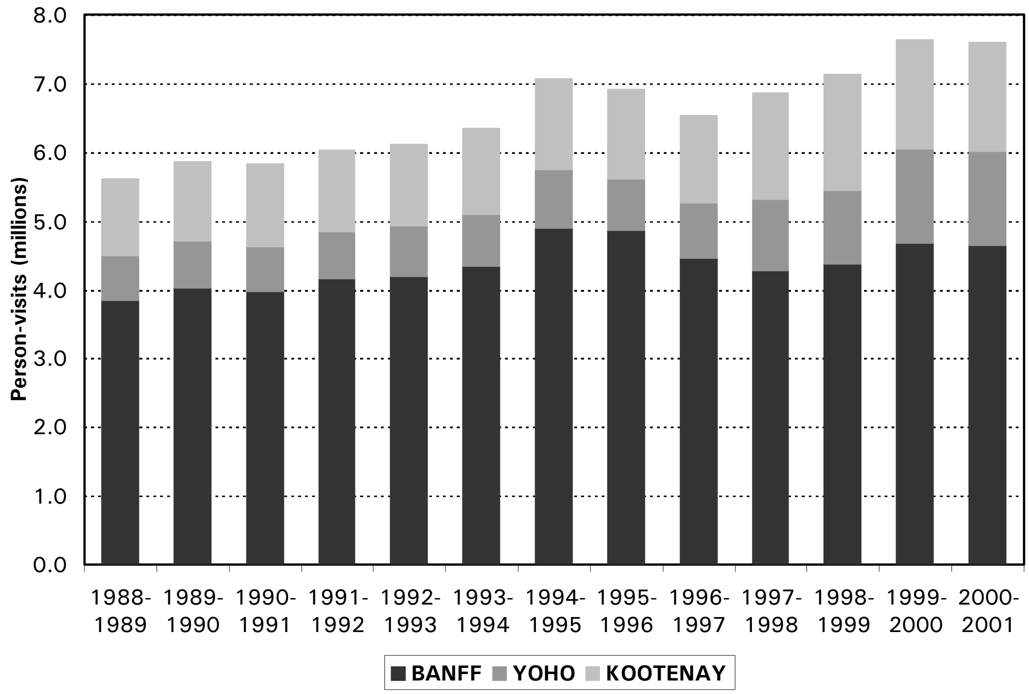
Despite the lack of statistically sound evidence to link human populations to the mortality rates of grizzly bears, the simple presence of humans is assumed by ESGBP researchers to have a negative impact on grizzly habitat (Gibeau 1998; Jalkotzy *et al.* 1999; Herrero *et al.* 2000: 63l). With the uncritical and unquestioned acceptance of "recent estimates" of a sustained 4% annual rate of growth in the human population over the next decade in Springbank, Cochrane, Banff, and Kananaskis, ESGBP research assumes this growth will translate into a 4% increase in human use of the parks and then predicts this use will result in a 4% increase in the mortality rate for adult female grizzlies and eventual "extinction" of grizzlies—the meaning of "extinction" having been changed to "the probability of population decline below current levels." The empirical and logical links in this argument, however, are weak, and the assumption that a 4% increase in the human population must lead to a 4% increase in park use, which in turn will lead to a 4% increase in the mortality of female grizzly bears is not justified by the evidence. (See figures 5 and 6.)

The ESGBP-led Population Habitat and Viability Analysis (PHVA), for instance, involved simulations running with estimated rates of mortality set at 4%, 6%, and 10%. The latter values are wildly unrealistic given that "expectations from field data" indicated a much lower adult female mortality rate (Herrero *et al*. 2000: 41–42). No information from modeling runs based on the more realistic expectations based on field data was published.

On the basis of the assumption that human populations and grizzly populations are inversely related (Herrero *et al.* 2000: 37, 42), participants in the PHVA workshop developed three scenarios to examine the "adverse impact" of humans on grizzly populations "if mitigation measures are not taken." Thus, scenario A (status quo management) describes the 4% increase in human population and the corresponding 4% increase in adult female grizzly mortality. Scenario B claims that with "moderate mitigation efforts" adult female mortality would still increase, although at a lower rate (2%). Scenario C contemplates "aggressive mitigation efforts [that would] actually lead to a *decrease* in adult female grizzly bear mortality despite the increased human population" (Herrero *et al*. 2000: 42, emphasis in original). Under these scenarios, park managers are left with the black and white choice between almost certain grizzly "extinction" in options A and B (Herrero *et al*. 2000: 50) and "aggressive mitigation." The conclusion is obvious: only by introducing aggressive mitigation measures, can park managers save the bears.

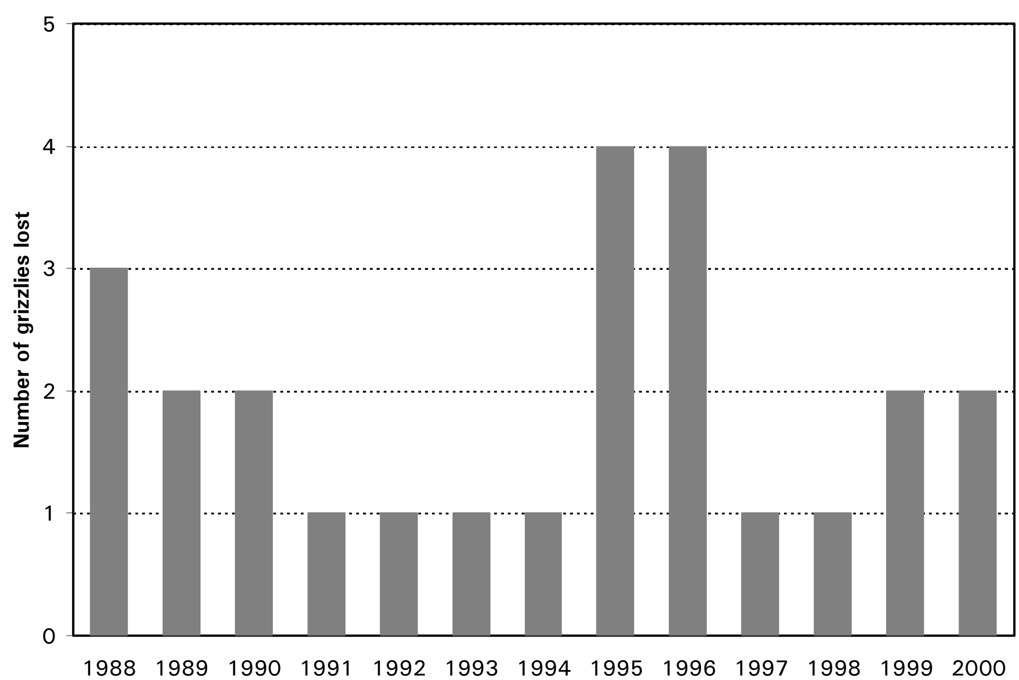
Nevertheless, working on the assumption that the conditions of scenario A (4% human population growth and corresponding 4% increase in adult female grizzly mortality) will persist, the authors of the report are grim in their conclusions, claiming that "even with our best efforts the model clearly demonstrates that a 2% decline would result in a population collapse within a few decades, especially for the east slopes subpopulation" (Herrero *et al.* 2000: 11). The proposed solution? "Restoration

Figure 5: Visits to national parks of the Central Rockies Ecosystem (CRE), 1988–2001



Note 1: National Parks of the Central Rockies Ecosystem (CRE) are Banff, Yoho and Kootenay.
Source: Parks Canada, 2001.

Figure 6: Losses of grizzly bears in national parks of the Central Rockies Ecosystem (CRE), 1988–2000



Source: Leighton 2001.

scenarios must be developed within a decade and must be implemented for at least a decade to reverse this trend." The level of restoration, to be achieved by road and trail closures, and restrictions and relocation of human activity, is set at 2% per year.

The eastern slopes subpopulation

The small sample size used to calculate grizzly bear mortality rates casts further doubt on the reliability of modeled outcomes (Herrero *et al.* 2000: 21). Because of the small sample size, a death rate was calculated directly from the few deaths of radio-collared bears. This meant using a calculation based on a model with few explanatory variables, a simplification that ultimately compromises the validity and reliability of the models. Accordingly, the authors of the report were forced to conclude that the "rate of death as denoted for this analysis *may not be* highly related [to the] death rate directly calculated from fates of radio-collared bears" (Herrero *et al*. 2000: 22, emphasis added).

There are additional problems with the input parameters of the PHVA simulation. Considering an event such as a massive berry crop failure (predicted to occur about once a century), it was assumed that 50% of the grizzly bear population would not survive, because females would cease reproducing and more frequent contacts between humans and bears would result in high bear mortality or removal (Herrero *et al.* 2000: 40). Three simulations were then run through the VORTEX model, in which these catastrophes occurred once every 100 years, once every 50 years, and never.

Given that "extinct" has been redefined to mean population decline, this parameter all but *ensures* the model will predict "extinction" in any modeling run that assumes a catastrophic event every 50 or 100 years. That is, there is a guarantee built into the model of a 100% risk of a decline in population size below the current number of animals. If the decline happens early in the simulation, the population may be able to recover; if the decline happens late in the simulation, the probability of "extinction" is assured.

Female grizzlies—a critical element

Another important measure of the health of grizzly bear populations is the status of female grizzlies. ESGBP researchers rightly argue that the adult female grizzly acts as the reproductive engine of the population and "is the most critical [element in] population viability" (Knight and Eberhardt 1985; Gibeau 2000: 4). When that engine is tuned up and running well, the entire population benefits, and the evidence from the central Rockies clearly indicates a flourishing adult female cohort. A recent ESGBP report (Herrero *et al*. 2000: 29) indicates that pooled data from Benn (1998) and Gibeau *et al.* (2001: 127) showed a 90% survival rate for eastern CRE adult females and a 95% survival rate for western CRE adult females. This report also indicates that analysis of ESGBP data from 1993 to 1998 shows a 99% survival rate for adult females (Herrero *et al*. 2000: 30).

A reasonable reading of the evidence compels the analysis that a 90 to 95%, and for the most recent past, a 99% survival rate, for adult females, is very good. When this survival rate is added to growing numbers of grizzlies outside of the national parks (Alberta Sustainable Resource Development 1999; Kansas 2002: 12), and assumed immigration rates of up to 10% from the growing British Columbian portion of this population (Banci *et al*. 1994; Herrero *et al*. 2000: 30), the argument that recruitment rates are stable or increasing and mortality rates are decreasing appears well founded.

The standard measure of the annual geometric growth rate of a population is called a "lambda" (λ) measure, a measure of the finite rate of population increase. If λ is above unity, the population is increasing; below unity, it is decreasing. For example, if $\lambda = 1.04$, the population is growing at 4% during the time period sampled (Morrison and Pollock 1997). The preliminary calculation of λ for the CRE population is $1.00 \pm .01$, which indicates that the CRE grizzly population is stable (Gibeau 2001a). Accordingly, the answer to the question whether Alberta grizzly bears are really on the brink of "extinction," can be unequivocally answered in the negative. As a consequence, the need for "aggressive mitigation efforts" in order to reduce female grizzly mortality does not exist. It is thus reasonable to conclude that current management efforts have been successful.

The persistent reliance on "conservative" estimates biases the results of the computer simulation elsewhere as well. For instance, "reproductive senescence," which is the age at which breeding activity ceases, was "conservatively estimated to be 20 years" by ESGBP researchers (Herrero *et al.* 2000: 40). This may, in fact, be the mean age of senescence but it is impossible to tell because there is no information provided in support of this figure—other than it was chosen "conservatively." In fact, there are some well known examples of older bears continuing to breed. In the fall of 2000, for instance, Banff's oldest known female grizzly (Bear #33) was alive with cubs at 25 years of age (Gibeau and Herrero 2001; Leighton 2001).

Likewise, by using "conservative" estimates the maximum number of offspring is arbitrarily reduced. The section notes, "bears with 4 cubs have been recorded in the Rockies. However, this is extremely unlikely, and 3 cubs is a more realistic maximum value." (Hererro et al. 2000: 40). There is no question that a more realistic value of cubs is 3. However, the input parameter for the model does not stipulate the "realistic number of cubs;" it stipulates the "maximum number of cubs." With this downgrade, the effect is an enhancement of the threat of the "extinction" of grizzlies.

New ESGBP reports of the status of grizzly bears in the central Rockies appear to heighten this threat (Herrero 2001; Gibeau 2001a). After having reached their goal of collecting "at least 100 reproductive years of data regarding adult female grizzly bears" (Herrero 2001: 1–2), ESGBP researchers calculated that the λ for Eastern Slopes grizzlies was between 0.99 and 1.01. Apparently, the fluctuating bases of ESGBP λ values were the result of incomplete data on the timing of 16 of 24 litters. That is, the cycles of 16 bears were not fully documented during the study period: some began before the study; others have continued after it. Thus, some of the ESGBP's data cells are empty, which degrades the data set. Litter intervals have a direct impact on λ calculation. Initially, ESGBP researchers extrapolated from the 3.4 year mean interval calculated from their field observations of 8 complete intervals to 3.8 years to account for the incomplete intervals. In 1999, ESGBP publications reported a 4.0 year litter interval (0.24 reproductive rate for λ: $[1.9/4.0]/2 = 0.24$) (Herrero and Gibeau 1999). From 2000 until 25 January 2001, they reported an interval of 4.4 years (0.22 reproductive rate for λ). As Leighton (2001a: 2) has noted, despite the fact that no new field data were gathered between 25 January and 10 March 2001, the reported litter interval is now five years ($1.88/5.0 = 0.38$, or 0.19 for λ). This means that the population studied by the ESGBP suffers under the unusual burden of having the highest "mean litter interval" of any North American grizzly population. In fact, these grizzly litter intervals outstrip all other populations noted in this paper by a full two years.

Some simple calculations raise a few additional anomalies. Moving from the 3.4-year interval indicated by field data to the 5-year interval requires that the remaining "16 intervals . . . average 5.8 years—71% longer than the known data suggests for bears living in the same area" (Leighton 2001a: 3). To help explain this 1.6 year jump in the length of the intervals, ESGBP researchers employed a procedure developed by Dr. D. Garshelis to correct for a perceived upward bias of 2%. But this procedure was developed, not to correct for mean litter intervals, but for difficulties "in calculating mean age of first reproduction" (Garshelis *et al.* 1998; Herrero 2001: 6). As Leighton (2001a) again correctly notes, an assumption of this nature normally requires independent scientific review, to determine whether removing 2% of population growth is scientifically sound. This missing 2% could reflect a growth rate of 1% to 3% for the CRE grizzly population, which is similar to the growth rate noted by provincial biologists (Alberta Sustainable Resource Development 1999; Kansas 2002). In any event, even if one agreed to accept all the changes in methodology, along with the new assumptions regarding λ calculations, the CRE grizzly population is still shown to be stable.

One conclusion, at least, seems overwhelmingly obvious: the current management programs in the mountain national parks are meeting the requirement of Section 8(1) of the Canada Parks Act that ecological integrity be maintained or restored with respect to grizzlies. There is no question that the existing practices are sustaining a viable grizzly population. Census data indicate that although human population levels in the main centers of the Bow Valley are increasing, they are doing so at levels well below those used in ESGBP modeling exercises. The most recent statistics indicate that visitor rates to the four mountain parks are stable or decreasing and, even when they do increase, the ESGBP's claims that increasing human use results in increasing grizzly mortality rates is specious because it equates human use with human impact. Both Alberta and British Columbia grizzly populations are (on the average) growing and even ESGBP researchers acknowledge that the grizzly population of the central Rockies is currently stable. The European and Yellowstone populations indicate that populations can be restored if given the proper habitat conditions and protection from excessive human-caused mortality such as existed during the 1970s and 1980s. Willfully ignoring evidence of population stability and the law of diminishing returns as it applies to management of the CRE grizzly population is *prima facie* evidence of ideologically driven research rather than scientific investigation.

Models versus reality

At the outset, participants of the 1999 ESGBP-led PHVA workshop were concerned that the complexity of the PHVA process and the technical sophistication of the models might mean that they would be unintelligible to managers and legislators (Herrero *et al.* 2000: 16). Notwithstanding this concern about the PHVA simulation results, they were endorsed as a sound scientific base for the nearly three pages of recommended closures and restrictions:

> These recommendations are based on scientific observation of grizzly bear behaviour and requirements for survival of the population. We strongly believe there is an adequate base of scientific information on which to base good management decisions that will increase the probability of long term grizzly bear persistence. (Herrero *et al*. 2000: 79)

Given the extensive costs and unanticipated consequences of the recommended management solutions, it is highly questionable that the apparently concrete outputs produced by the models, along with the accompanying policy recommendations, could be accepted by legislators and managers before the simulated results are empirically validated.

We will close this review of the PHVA simulation results by recalling the advice of the author of the VORTEX population model, Dr. Robert Lacy. Park and land managers, government representatives, wildlife and conservation biologists would all do well to heed Lacy's warning before applying it their management plans.

> A final caution: VORTEX is continually under revision. I cannot guarantee that it has no bugs that could lead to erroneous results. It certainly does not model all aspects of population stochasticity, and some of its components are simply and crudely represented. It can be a very useful tool for exploring the effects of random variability on population persistence, but it should be used with due caution and an understanding of its limitations. (Lacy, undated)

While not every recommendation in the PHVA requires restriction or reduction of human activity, with three pages of recommended closures and restrictions on human use, and the promise of more to come, the trend of suggested policy development is evident.

Models for park management

Cumulative effects assessment

The use of statistical modeling to test management techniques is an effective tool for improving overall management plans. When applied correctly, habitat and population models can be helpful in evaluating the consequences of human land uses on bear populations. It is well known, however, that "the output of . . . models is only as good as the input . . . [which] could prove disastrous for bear conservation if the models are inappropriately applied or used without valid data" (Schoen 1990: 150). Even though computer models can be powerful management tools, their effectiveness depends on the quality of the data, on the assumptions built into the model, and on the general soundness of methodology used. For this reason, the cumulative effects models used by ESGBP researchers and Parks Canada to determine the amount and quality of habitat needed to secure a viable grizzly bear population in and around the national parks deserve careful scrutiny. Federal and provincial laws increasingly require analysis of the cumulative effects of various land uses and management activities as part of the environmental assessment process. The governing idea is that, although individual impacts or activities may be minor, they become collectively or cumulatively significant. Cumulative Effects Assessment (CEA) for grizzly bears is an integral part of biological evaluations prepared for projects proposed within grizzly recovery areas and now figure prominently in regulatory hearings for energy and recreational development proposals in Alberta and elsewhere. Unfortunately, the accuracy of environmental impact assessments (EIAs), especially in terms of the cumulative effects of many small disturbances is notoriously low. According to Kumar *et al*. (1993: 160) "the average accuracy of quantified, critical, testable predictions in EIA for Australia is only 44%."

Habitat effectiveness targets

The Habitat Effectiveness (HE) model used by the ESGBP researchers is designed to assess the quantitative and qualitative effects of human actions on grizzly bears and their habitat. It has become the chief means of evaluating the predicted impact of various human activities on what is now seen primarily as grizzly bear habitat (Gibeau 1998; Jalkotzy *et al*. 1999; Gibeau 2000; Herrero *et al*. 2000) and allegedly shows that CRE grizzlies are on the road to extinction. Gibeau, for example, claims that "with continued erosion of grizzly bear habitat in what is supposed to be core refugia hanging in the balance, time is clearly not on the park manager's side" (1998: 235).

The HE model was based on a standard US Department of Agriculture (USDA) cumulative effects model (CEM). The American CEM was intended to be "just one of the many tools used to review potential effects" of management and policy (USDA Forest Service 1990: 1). It has become, however, the most important and sometimes the only tool for grizzly management in Banff, and thus for human use in the park as well. Even though the CEM is superior to the HE model used by the ESGBP researchers, respected scientific groups such as the National Wildlife Federation have still criticized it as deficient and in need of improvement and refinement. France (1994: 524), for example, stated that the development of this CEM is distinctive because "some of the research has been unspeakably expensive and produced results of questionable worth." The questionable results have been rendered more questionable still by "minor changes" Gibeau (1998: 236) made to the USDA model.

Mortality risk index eliminated

The "minor" alterations to which Gibeau referred constitute about half of the modeling apparatus, including mortality risk estimators. In the original USDA model, habitat effectiveness is one of two main outputs, and a mortality risk index is the second. As Leighton (2000) observed, the original American model "could distinguish between a hiker and a bear hunter . . . [because it] assesses the 'risk of bear mortality associated with human activities.'" However, as Benn (1998: 14) noted, ESGBP omitted any determination of mortality risk coefficients, leaving it as "future work."

In fact, subsequent ESGBP work (Herrero *et al*. 2000: 63), has not tackled the postponed question of lethality. The issue of lethality is important for the obvious and common-sensical reason that a habituated bear that either flees or ignores human presence coupled with benevolent non-hunting human users will face a mortality threat significantly lower than that it faces when encountering bear hunters. That is, if bear mortality risk is a function of the rate of human contact *and* lethality, if lethality risk is low, then so is mortality risk.

This proposition results in the formula:

Mortality = f ((human encounter rate)
(lethality of encounter))

or $M = f\ (H \times L)$.

However, in ESGBP research, this formula is immediately modified to

$M = f\ (H)$,

apparently on the grounds that "as access expands, human beings exploit it, which leads to the decline of bear populations" (Herrero *et al*. 2000: 63). This last statement assumes a lethality risk of $L = 1$, which means that human presence in an ecosystem necessarily leads to population declines through increased mortality.

In reality, matters are not so simple: all humans are not bear hunters. In a 1996 paper published in the journal *Conservation Biology,* Mattson *et al.* describe the complexities involved in modeling grizzly bear mortality caused by humans. Beginning from the hypothesis that "human-caused grizzly bear mortality is determined by the rate of encounter between humans and grizzly bears and the probability that such an encounter will result in a grizzly bear's death," the authors go on to detail the numerous variables that would influence the lethality of an encounter:

- human population numbers;
- concentration of humans in the area;
- behaviour of humans, influenced by any number of individual and cultural factors;
- grizzly bear population numbers;
- distribution of dominant bears within that population;
- distribution of bear food;
- behaviour of grizzly bears, depending on the level of their aggressiveness and whether or not they are food-conditioned (Mattson *et al*. 1996: 1014–15).

While falling short of weighting the differential effects of these conceptual variables, this detailed description of the complex nature of the interactions between humans and bears shows that the HE model used by ESGBP researchers is fatally flawed. Without the ability to assess the difference between a hiker, a hunter, and park visitor driving down the road at 70 kilometres per hour, the model ignores a vital risk assessment obvious even to someone unschooled in grizzly biology. There is no reasonable comparison between the risk posed to a grizzly by a hunter, actively pursuing a bear, and that posed by a hiker, out for a weekend jaunt in the mountains. Absent mortality-risk coefficients, however, the two are treated equally by the ESGBP model.

To compensate for this deficiency in the model, ESGBP researchers have used "human disturbance," by which they mean human presence, as a primary means of deriving habitat effectiveness values. As Leighton says, this method of rating disturbance levels is "hopelessly simplistic" (2000: 25). A key assumption in stratifying human use is that it must be either high or low: "High use was defined as more than 100 vehicles or people/month, low use was defined as under 100 vehicles or people/month" (Gibeau 1998: 237). The USDA CEM used 80 as the division point between high and low but in neither model was there consideration or argument regarding the notion that 100 (or 80) users per month may be too low to serve as a division point; there was no consideration given to the possibility of moderate levels of use. Thus high use amounts to more than three users a day; low is three or less.

As a result of this bivariate stratification, nearly all areas in the national parks that allow human use will receive a *de facto* "high" human disturbance rating, which biases HE modeling coefficients toward a low habitat effectiveness rating. Once four users drive through on a highway or hike on a trail in one day, a maximum impact has been made on grizzly habitat. According to this logic, four hikers or 4,000 hikers per day would have the same impact on the grizzly population. Given that Parks Canada safety information very sensibly encourages park visitors to hike or bike in groups of three or more or, in restricted bear areas, six or more (Parks Canada 2000c), basic human safety standards will ensure that HE levels will not be met. When Parks Canada applied the ESGBP formulations of habitat effectiveness to Banff Townsite (HE = 48.6) and the Village of Lake Louise (HE = 46.6) (Parks Canada 1997: 44), the implication became particularly clear: in order to achieve the HE targets of 60 or above, the human population and development will have to be significantly reduced or eliminated.

The use of ESGBP HE targets as a model for park management reinforces the notion that human presence is a "disturbance" that is necessarily damaging to bears. As Jalkotzy *et al*. wrote:

> levels of human use on trails appeared to affect habitat use in the vicinity of trails. For example, bear use of habitat close to the heavily used trail to Boulder Pass and Deception Pass, a trail in open terrain, typically occurred in late September only after human use of the trail declined from high summer levels. Even at low [human] use levels, crepuscular or nocturnal feeding along these trails was the norm. (1999: 8)

According to the argument made earlier (as well as a common-sensical interpretation of the information included in this quotation), for whatever reason, the bears used the trail in the evening or at night and humans used it during the day. Such dual use might be considered a good thing since both bears and humans can use the same space at different times. Even if bears used the trail less during the day *because of* human presence, it does not follow that dual use, by bears and humans, is harmful to bears—or to humans.

The "working assumption" of the ESGBP researchers, however, is that "as access expands, human beings exploit it, which leads to the decline of bear populations" (Herrero *et al*. 2000: 63). The policy implication of that assumption is clear: restrictions on human use are necessary whenever bears are inconvenienced. Thus Gibeau noted that, "disturbance can influence bear use through actual displacement and change in use patterns reducing the time available for a bear to use an area (e.g., 24 hour to nocturnal use only)" (1998: 237). For both ESGBP advocates and Banff National Park management (Parks Canada 1997: 43), human use is either to be allowed, restricted, or removed based on desired habitat effectiveness of each Carnivore Management Unit (CMU). This reflects ESGBP recommendations that "all land use decisions will take place within the context of cumulative effects models that utilize grizzly bears as key indicators" (Herrero *et al.* 2000: 10). To date, ESGBP research has been the primary factor in deciding what constitutes "desired habitat effectiveness" (Herrero *et al.* 2000: 3) and, as a result, disturbance, which is to say, human use, is always secondary to bears in the strategy of parks management.

Jalkotzy *et al.* (1999) defend using bears as the primary and, in effect, the only, determinant of park management strategy by stating that "drastic changes in human use" and "significant changes to human land use patterns are required in the Lake Louise area to reverse these trends" of grizzly habituation and mortality (1999: 93). Such a reversal would allow habitat effectiveness ratings to approach the numerical targets for HE set out in the 1997 Banff Management Plan (Parks Canada 1997: 44). Reducing human use to the minimum necessary to keep the ski area in repair and reducing still further the impact of humans on a popular hiking area with a historic destination lodge, such as Skoki, might or might not meet some arbitrary habitat effectiveness target. The cumulative effects of the several layers of assumptions, however, have introduced a remoteness and abstract quality to the numerical targets. It is not at all clear what they have to do with the actual behaviour of real humans and real bears on the ground in Banff National Park.

Current restrictions on human use, however, are already very near the point of diminishing returns when considered in light of even the most simple cost/benefit analysis: massive closures would be needed throughout Banff to increase habitat effectiveness by even a small amount. However, research and policies continue to recommend that "legislation to restrict/close access" be passed, and that "physical blockage" be used to enforce human use strategies limiting the number of people "to under 100/month" as a means of limiting encounters between humans and bears and of meeting the habitat effectiveness targets (Herrero *et al.* 2000: 66; Parks Canada 1997: 44). Notably absent is any discussion of whether those targets need to be reconsidered. They are simply accepted without question along with the consequence that human use must be eliminated to ensure the targets are met.

Focus on "wary bears"

The second "minor" change introduced by Gibeau to the USDA model was to focus solely on so-called wary bears. The American model considers the entire study population, not a preferentially selected sample. Probably the most important divergence between the two, however, is that the HE model used by the ESGBP researchers does not include a rational assessment of "security cover," the amount of brush, for instance, between a bear (or a deer) and a human: thick security cover gives an animal more room to hide or to escape undetected from human presence. Moreover, the ESGBP researcher collapsed the five categories of security cover in the USDA model into two on the grounds that, following "consultation with knowledgeable individuals" (here he named D. Mattson of the University of Idaho and T. Puchlerz of the USDA Forest Service), it was reasonable to conclude "that the Yellowstone situation is analogous to the three Canadian mountain parks" (Gibeau 1998: 237).

However, if the situation in Canada and the United States is analogous, then both Yellowstone and the Canadian parks ought to have been modeled using the same number of security cover categories and reasonable, assessment-based classifications. By reducing the number of categories from five to two, Gibeau drastically reduced the predictive ability of the model and oversimplified the complexity of the physical environment being modeled. Under the HE model, Banff is classed as either secure or non-secure, an "either/or" proposition with no room for variability or gradients more approximate to reality. The Lake Louise HE model (Jalkotzy *et al*. 1999) is different again; it appears to use four classes of security cover; and Gibeau (1998) did not deploy the HE model for Banff National Park. Because the 1997 Banff National Park management plan HE model was created by the privately operated Geomar consulting, it is not available for public review.

More problems

Additional problems with the HE model further reduce its usefulness. For example, the HE model attempts to compare "disturbed" contemporary habitat to an imaginary "pristine" environment, an environment uninfluenced by humanity. To attain a habitat effectiveness rating of 100%, zero human disturbance is allowed, which is precisely what ESGBP researchers claim is needed to stem "grizzly bear extinction" within the CRE (Gibeau 1998: 235). The accuracy of this alarming prediction, even when the correct term, extirpation, is substituted for extinction, is highly dubious because of the limitations of the HE model, limitations that have been acknowledged by ESGBP researchers:

> The CEM [sic] process is still under development, and the information needed to state the actual effects on the grizzly bear population (numbers of bears) is not known. *Therefore, it oversteps the bounds of the model to attempt to determine the number of bears that could be supported by restoring an area to natural conditions.* Likewise, population losses resulting from further development cannot be determined. (Gibeau 1998: 238; emphasis added)

Herrero has also noted the limitations of the habitat effectiveness model:

> No standardized means for determining habitat values has emerged; rather, in each application, available data have been interpreted and modeled. Until a consensus emerges regarding habitat quality evaluation this activity should not be regarded as firmly rooted in science. (1998: 67)

Kansas and Riddell quite properly advised of a need "to explain [scientific] processes, assumptions, strengths and weaknesses … in plain English" (1995: 6). In plain English, the HE model is unable to predict any measurable benefit of restoration or negative effects of development. Why, then, is it used at all? And, why does it play any part in the formation of park policy?

More to the point, while Gibeau acknowledged that the HE model is unreliable, he maintains that unreliability is no reason not to use it, an opinion consistent with the nature of conservation biology as a "crisis discipline" in which decisions and actions must be taken despite scientific uncertainty: "because of time constraints, conservation biologists must be willing to express an opinion based on available evidence, accepted theory, comparable examples, and informed judgment" (Gibeau 1998: 240).

This sense of crisis is palpable in what Gibeau calls the "reasonable prediction" of the model, namely that "if management practices do not change, we will continue to erode grizzly bear habitat and, if unabated, the population will become extinct" (Gibeau 1998: 240). Obviously, this remark expresses the persistent sense of crisis widely found in ESGBP literature; in order to accept the prediction as "reasonable," however, requires an unscientific leap of faith. And, there are several reasons to question the reasonableness of this prediction. First, as we have indicated, ESGBP researchers have an equivocal, not to say idiosyncratic, understanding of the meaning of "extinction." Second, the "available evidence" is based on an HE Model that is of questionable value. Third, the "accepted theory" is the mission-driven, "highly value-laden" agenda of conservation biology. Finally, his comparable examples are taken largely from other ESGBP work and other preservationist researchers.

The foregoing evidence and analysis compels the following minimal conclusion: the HE model used by the ESGBP requires serious review. There is, however, no point in reviewing the model and its application at present. Without the inclusion of adequate cover or of any mortality risk coefficients, the HE model is incapable of approximating real-world conditions. In any case, ESGBP researchers and national park managers should be using this model, after its deficiencies are corrected, only as part of a suite of management techniques. Basing human use levels on the predictions of the HE model leaves both researchers and managers in the dark and carries the regrettable implication that wildlife management decisions regarding Canada's national parks are made in the absence of valid and reliable wildlife biology.

Analysis of security areas

The other key tool now being used by Parks Canada for cumulative effects assessments is analysis of security areas. Leighton (2000: 52) described the increasingly strict definition of what constitutes a secure area in ESGBP literature from the 1996 Banff-Bow Valley Study (BBVS) to the PHVA Report (Herrero *et al*. 2000). The 1996 study called for a security area of 4.5 square kilometres. By 1998, the target had become a security area of 9 square kilometres in which "adult female grizzly bears will have a low probability of encounters with people" (Gibeau *et al*. 2001: 124). Finally, by the time a population and habitat viability analysis (PHVA) was completed by ESGBP researchers in 2000, the definition of a "secure area" had become a "9km^2 bubble [that] surrounds an adult female bear and moves with the animal around the landscape in the bear's home range" (Herrero *et al*. 2000: 73). Gibeau added that the areas involved were needed to maximize "the reproductive potential of the population" (2000: 4). This marks a considerable change from the 1997 Banff Management Plan developed a scant three years earlier, which contained only a commitment to maintaining a viable population of grizzlies (Parks Canada 1997: 21). Such security areas would also be designed to insulate bears from any human encounter, thus maintaining the wary grizzly bear behaviour that ESGBP and Parks Canada management solutions seek to maintain. Maximizing a population, however, represents quite a different goal than maintaining a viable grizzly bear population.

One conclusion to be drawn from the changes in the understanding of a security area—from bears choosing to avoid people to the moving bubble of 9-square kilometres—is that they are simply artifacts of a continually refined concept used to ensure that habitat security levels in the Banff-Bow Valley will never be good enough. The requirement of a mobile 9-square-kilometre personalized security bubble as a necessary component of a secure habitat marks a distinct rise in the perceived needs of female grizzlies. Conceptually, however, by abstracting from real-world conditions in order to create a simple formula that ignores the behavioural variability in bears, the security areas concept reflects the same defects as the HE model. Even more significantly, this notion of a moving bubble refuses to recognize that human users of these natural areas are vastly more sensitive to the needs of grizzlies than they used to be. Contemporary human populations are far more benign toward grizzly populations than they were during the 1950s and 1960s when park wardens would shoot grizzlies as "dangerous pests" whenever they came near humans (Burns 2000: 3; MacMahon 2001). Indeed, accounts of being "blessed" by a bear's aggressive embrace indicates that some contemporary encounters between bears and humans are decidedly mystical—at least from the human perspective (van Tighem 2001).

There is no disputing the fact that bears require a certain amount of space within which to live. What is open to dispute are the models used to measure the amount of space that each bear requires. Herrero *et al*. (2000: 31) demonstrate that, within the central Rockies, bear densities range from highs of 40 per 1000 square kilometres down to none. Home ranges vary in size from as little as 10 square kilometres to as high as 500 square kilometres depending on the bear and the season when measurements are taken. Within these ranges, adult female bears have average daily movement areas of 0.1 square kilometre to 4.7 square kilometres. The smaller movement and range areas are those of bears living in higher-quality habitat ranges. It is obvious that there is a wide range of habitat quality, to say nothing of different habitat requirements. Even so, ESGBP researchers confidently claim that a 9-square-kilometre moving bubble will accurately represent the habitat needs of all adult female CRE grizzlies, and secure the persistence of grizzly bears throughout the landscape (Herrero *et al*. 2000: 73, 79). They make this claim despite the fact that the 9 square kilometres would encompass as much as 90% of the entire home range of some bears during berry season. Moreover, they also admit security areas vary with bear densities, habitat productivity, and season (Herrero *et al*. 2000: 20, 31, 73).

One size does not fit all

Defending this one-size-fits-all requirement, Gibeau offered the following explanation (2000: 37–44): "much of the basis for security area analysis relies on defining the average daily foraging radius and subsequent daily area requirements for an adult female grizzly bear." He then studied Alberta and British Columbia provincial lands, Kananaskis Country, and national park lands in both British Columbia and Alberta. From these areas, he "removed areas of unsuitable habitat (e.g., rock and ice),[6] habitat within 500 m. of high human use (>100 human visits per month), and areas of insufficient size based on an average daily feeding radius (polygons <9 km^2)." The remaining lands were identified as "secure areas." In this way, nearly half (48%) of the land surface of the mountain parks was determined to be "unsuitable." The removal of "unsuitable" habitat inevitably led to the conclusion that "the ability of our National Parks to support bears has been significantly reduced by widespread human presence" (Gibeau 1998; 2000: 38). Given the methodology employed, this finding could hardly have come as a surprise.

Focus on wary bears

Only the most sensitive bears were included in the study. Throughout his study on security areas, Gibeau ignored habituated bears and focused only on "a subset of radio telemetry data from intensive tracking of wary adult female bears gathered . . . by the [ESGBP] . . . to establish a mean daily movement distance" (Gibeau 2000: 41). That is, the original research design and data collection were restricted to the activity of those bears most likely to be disturbed by, and *to move away from*, any human activity. Before beginning any measurements or data analysis, the constrained methodology ensured a biased measure, not a representative sample. The measurement methodology maximized the movement ranges to be mapped. Subsequent applications of those maxima to establish broad management recommendations for the entire CRE grizzly population is not what most biologists would consider sound science because the conclusion had been pre-established by the methodology before data were either collected or analyzed. (Further problems with the bivariate distinction between "wary bear" and "habituated bear" will be discussed below.)

Nevertheless, despite the questionable overall procedure, which used a sample of 28 radio-collared "wary" adult female bears, nearly 70% of the study area was found to be secure for the most hypersensitive individuals in the CRE grizzly population. This also means that nominally "secure" areas up to 8.99 square kilometres were not included in the study because they were seen to be notionally or conceptually "insecure" for those select "wary" bears with daily movement ranges exceeding 1.7 kilometre (i.e., those that were unable to accommodate human presence within their nine-square-kilometre security bubble). However, the remainder of the "habituated" bears that were purposefully left out of the study, continue to exist and breed in both the conceptually "secure" and "insecure" areas, thereby adding to the actual, not conceptual, overall population. This deliberate removal of a large component of the population from the modeling process for methodological reasons greatly diminishes the predictive ability of the model.

No one seriously questions the need for wildlife to have secure habitat for concealment and thermal cover. No one could question the importance of secure habitat for rearing young. However, when this reasonable and common-sensical understanding is conceptualized in such a way as to measure only the extreme tail of a normal distribution, which then is used as the basis for developing and applying management schemes to the entire population, the usefulness of the exercise is seriously degraded. At the very least, therefore, this model must be reworked to include a random sample of the entire grizzly population and not just the most hypersensitive bears. After such a sample is collected, the movement data should be separated (where possible) to recognize use based on habitat quality. Where a bear inhabits relatively high-quality habitat, as on the western slopes in British Columbia, and, consequently, has a small daily movement and small overall home range, the security area requirements could be decreased to represent the bear's actual needs. Where bears occupied habitat with marginal quality, as on the eastern slopes in Alberta, the security area requirements could be expanded accordingly. These necessary changes must be made before the security areas model will provide any valid and useful numbers for real-world, on-the-ground grizzly management.

Managing grizzly bear behaviour

A basic assumption in ESGBP research, currently reflected in the management policies of Canada's Rocky Mountain national parks, is that "fundamental to maintaining a wary, healthy grizzly bear population is managing habituation . . . and food-conditioning in Banff National Park" (Gibeau 2000: 54). Behavioural distinctions are vitally important to ESGBP research, because many of their models—including the habitat effectiveness and security areas models and accompanying policy recommendations just discussed—assume that bears belong to either one group ("wary bears") or the other ("habituated bears").

The "wary bear" label is applied to bears that avoid humans. A bear that experiences regular encounters with humans without being harmed will learn to get used to people, will tolerate them at closer distances, and may even largely ignore them. A bear that display these behavioural characteristics is considered "habituated" (Herrero 1985: 51). Food-conditioning is considered to be a special kind of habituation. Some habituated bears learn to eat human food and garbage, and associate people with food. Such bears become "food-conditioned." While food-conditioned bears are necessarily habituated to human presence, habituated bears are not necessarily food-conditioned (Herrero 1985: 51).

Simple as it may seem, there are, nevertheless, significant problems associated with a bimodal categorization of grizzlies. Primarily, classifying a complex and intelligent animal as either "wary" or "habituated" is both arbitrary and, in the case of ESGBP research, difficult (if not impossible) to replicate. Secondly, the basic assumption that human presence is damaging to grizzly survival ignores the adaptive benefits of habituation in areas (such as a national or provincial park) where the management goal is the coexistence of humans and bears. Finally, the restriction of research to so-called wary bears ensures research findings will be biased, unreliable, and of doubtful validity. This has serious implications for what is considered to be "effective" and "secure" grizzly bear habitat in and around Canada's national parks.

The problems with black-or-white behavioural categories begin at the most basic level of ESGBP research methodology:

> Based on field experience (M. Gibeau and C. Mamo, pers. observation), I then assigned a level of habituation to each female bear. Following Mattson *et al*. (1992) "bears that were known to exhibit considerable tolerance of humans were considered to be habituated." (Gibeau 2000: 6)

No specific methodology besides the connoisseurship of the ESGBP researchers is indicated or provided. Future attempts to replicate this research would be necessarily futile, because researchers would need the accumulated and particular field experience of Gibeau and Mamo.

A second problem is that, by making gross dichotomies (as was noted above with respect to changes in the USDA cumulative effects model), the result is invariably to transform aspects of reality into artifacts of a model (or, more technically, to hypostatize the concepts included in the model), which is a major categorical error (Feyerabend 1999). The philosopher Alfred North Whitehead called this mistake "the fallacy of misplaced concreteness" (Whitehead 1936).

Finally, their idiosyncratic method of labeling the behaviour of a complex and intelligent animal simply ignores extensive research detailing the ability of a bear to learn and to apply new knowledge to various situations. "Wariness" is not a tag that can be placed on a bear and left to describe its behaviour in all situations. As Herrero himself notes:

> Bears don't behave like robots. Each bear is an individual with a personality and a specific set of experiences. The outcome of experience is learning. Bears learn where to find things to eat. They learn where people are often encountered. They learn about their environment. Because of learning, each bear is able to tailor its response to a specific situation . . . The outcome of a given confrontation is the result of bringing the variable behaviour of a given bear into interaction with the much more variable behaviour of a given person. No wonder the outcome is hard to predict! (1985: 200–01)

Similarly, French explains that their intelligence allows bears to develop "individual behaviour, shaped by both experience and memory" (1999: 5).

This draws attention to the fact that habituation and wariness are not immutable qualities but simply descriptions of a bear's behaviour at a particular time and under particular circumstances. As Leighton (2000: 71) notes "a bear may appear 'habituated' beside a road and 'wary' 100 metres from it." This is supported by Craighead's research on grizzly bears in Yellowstone, which found that "the same animals that ignore human scent at the dumps are quickly alerted by it in the back country. Tolerance of man . . . is definitely linked to specific sites" (1971: 846). Even Gibeau (2000: 34), who relies on this stark behavioural distinction to back up his thesis that the presence of humans causes unsustainable rates of grizzly bear mortality, is aware that the reality of grizzly life is more complex than his bimodal categories allow. One conclusion that may be drawn is that by itself, a division of a complex behavioural repertoire into two categories—wary and habituated—is likely to produce unreliable and invalid data.

Ultimately, it is Gibeau's own findings that provide the greatest reason for avoiding the use of such broad labels to study bears. Studying how grizzly bear behaviour and habitat use is affected by various levels and distributions of human activity in Banff National Park, Gibeau found that "no [statistically] significant difference was detected in daily distance traveled . . . between wary and habituated bears." Nevertheless, Gibeau went on, "I chose to continue with the distinction between wary and habituated bears given that the statistical power indicated a high probability of committing a Type II error [the probability of rejecting a true hypothesis] and separation may provide biologically meaningful insights. Evidence is strong from other research that there are differences between wary and habituated bears" (Gibeau 2000: 8). While differences were detected between the distances traveled at night ("human inactive period") and at day ("human active period") by wary and habituated bears, "they were not statistically significant." In other words, ESGBP researchers found no statistical reason to continue with the distinction between wary and habituated—but they used it anyway. The conclusion we are told to accept is that "consistent differences in movement rates between wary and habituated adult females, although not statistically significant, further suggest the influence of humans" (Gibeau 2000: 4).

Two aspects of this observation are worth closer analysis. First, the claim that bears moved less during periods of human activity than of human inactivity carries the implication that human activity reduces bear movement. However, when the claim is looked at in terms of distance moved per hour, the opposite implication can be drawn: during the 9 hours of human activity (8 am to 5 pm) bears move 1.3 kilometres (or 140 metres an hour). During the 15 hours of human inactivity, bears move 1.9 kilometres (or 130 metres an hour)—10 metres an hour *slower* than they move during human activity. Even though comparing overall movement during a 15-hour period with overall movement during a 9-hour period is inappropriate, the conclusion, that movement is restricted by human presence in this example, is simply unsupported. The inconclusiveness of these results is compounded when one accounts for the standard deviational error inherent in radio telemetry tracking methods. While Gibeau accounts for tracking errors of ±150 metres, other field research involving similar radio relocation techniques have found errors as large as ± 250 metres (C.E. Kay, pers. comm. with Barry Cooper, February 27, 2002). Such levels of error seriously compromise study results.

A second aspect of the correlation between human activity and grizzly behavioural modification is more important. If there were no statistically significant differences between wary and habituated bears, the obvious question is: why use the distinction at all? Here Gibeau cites other research that has found differences between wary and habituated bears but he does not explain how this other evidence compensates for the lack of statistical significance in his own data. His answer is that he wished to avoid the commission of a "Type II error" and because retaining the distinction between wary and habituated "may provide biologically meaningful insights." This, however, is but a technical way of disguising an equally serious misuse of the precautionary principle.

Misuse of the precautionary principle

In common-sense language, the ESGBP researchers' concern over committing a Type II error is a way of invoking the statistical version of the precautionary principle. Concern over the probability of committing a Type II error, which, to repeat, is the probability of rejecting a hypothesis when it is true, permits them to use a statistically insignificant distinction. This is analogous to saying that humans using the central Rockies are guilty of an impact on grizzlies until proven innocent. Notwithstanding the absence of supporting statistical evidence, the claim was advanced that making the distinction between wary and habituated bears "may" provide insights; what the unsupported distinction unquestionably does provide is support for restrictions on human use as the single best way to protect "wary" grizzlies from increased mortality. In short, by presenting the recommended list of options that managers should consider and dressing that list in the scientific sounding language of probability theory, ESGBP researchers have ensured that their precautionary demands prevail over all other interests. This version of the precautionary principle "may sound reasonable in theory," write Burnett and Mitchell but "it would be disastrous in practice. One cannot prove a negative. Every food, product, and tool poses some risk of harm" (2001: 1) to humans or to the environment.

Such an understanding of the precautionary principle begins and ends with shifting the burden of proof in such a way that "prudence" will always demand avoiding a Type II error. Noss explained:

> The philosophy underlying conservation biology and other applied sciences is one of prudence: in the face of uncertainty, applied scientists have an ethical obligation to risk erring on the side of preservation. Thus, anyone attempting to modify a natural environment and put biodiversity at risk is guilty until proven innocent. This shift in burden of proof is consistent with the precautionary principle, which is gaining increased support in many professions . . . when the burden of proof is shifted from conservationists to developers, this poses serious questions about the enjoyment of private property rights, "taking" of property, and just compensation. (1994: 3)

Armed with this understanding of the precautionary principle and with such an "ethical obligation," researchers are compelled to oppose any development or human use of the central Rockies that *might* cause damage to the environment. Any person disagreeing with a concern for the possibility of damage is then given the impossible task of proving their proposed actions are "innocent" in the face of hypothetical concerns for unknown numbers of unknown species that might be impacted. All that is required to stop human use is the discovery (or invention) of a new subspecies or a "last remaining example" of a heretofore unknown ecosystem, which is itself an intellectual construct.

Prudence, properly understood, demands a clear knowledge of probabilities before invoking the precautionary principle because its application depends upon "the level of uncertainty, the direction of that uncertainty, and then particularly [on] the likely costs and benefits of different levels of action" (Lomborg 2001: 349). Indeed, if we were to "apply the precautionary principle to itself—ask what are the possible dangers of using this principle—we would be forced to abandon it very quickly" (Burnett and Mitchell 2001).

Burnett and Mitchell are correct with regard to the version of the precautionary principle advanced by Noss and his followers. A more balanced and usable concept of the precautionary principle could play a valuable role in mitigating environmental damage. In describing "a framework for applying the precautionary principle under competing uncertainties," Goklany (2001: 8), for example, sets out specific criteria, by which managers can determine the feasibility of implementing a management scheme when that scheme could have both positive and negative outcomes. He notes: "The only way to implement the precautionary principle intelligently under such conditions is to formulate hierarchical criteria and rank various threats based upon their characteristics and the degree of certainty attached to them" (Goklany 2001: 8). Goklany's criteria include:

- the *Public Health Criterion*, which includes:
  - the *Human Mortality Criterion*: the threat of death to any human outweighs similar threats to members of other species;
  - the *Human Morbidity Criterion*: non-mortal threats to human health take precedence over threats to the environment, with exceptions based on the nature, severity, and extent of the threat;
- the *Immediacy Criterion:* immediate threats are given priority over future events;
- the *Uncertainty Criterion*: threats that have a higher probability of occurring are given priority;
- the *Expectation-Value Criterion*: if threats are equally certain, those that have a higher expectation of harm are given priority;
- the *Adaptation Criterion*: available technological protection allows the discounting of potential impacts to the extent that the technology can mitigate the harm;
- the *Irreversibility Criterion:* priority is given to persistent or irreversible outcomes.

If the precautionary principle is restricted to a set of fixed and replicable criteria to indicate probable costs and benefits, it can be a useful management tool. Leaving the principle as an open-ended moral trump to any human activity ensures that it will be consistently derided and eventually abandoned.

Weighing the alternatives

The "rewilding" agenda

Conservation biology is not what its name implies—the study of life forms with an eye to their conservation. It is, rather, one aspect of a complex strategy of political, economic, and moral activity, the purpose of which is to restore and maintain a "pristine" or "wild" landscape untouched by human presence (LeRoy and Cooper 2000). In the words of ESGBP researcher, Mike Gibeau, "the focus on grizzly bears is viewed as one component nested within a much larger research agenda. That agenda seeks to apply a large carnivore conservation strategy to the Rocky Mountain Park complex as outlined by World Wildlife Fund (WWF)" (Gibeau 2000: 1). The WWF strategy is part of an even more ambitious political, economic, and biological program conventionally referred to as "rewilding."

Although it is comparatively unknown to the general public, the concept of "rewilding" is widely supported among environmentalists, their associated interest groups, and sympathetic bureaucrats and politicians. The Wildlands Project, the Yellowstone to Yukon Conservation Initiative (Y2Y), the Baja to Bering Marine Conservation Initiative (B2B), and the Adirondacks to Algonquin Initiative (A2A) are all closely linked and agree upon the desirability of "rewilding," which, according to the Wildlands Project means: "to restore diversity, and help wounded lands become self-willed again" (2000: 84). Rewilding is to be practically achieved by creating a vast network of "core" wilderness areas, surrounded by protected "buffer zones" and connected by wildlife "corridors" stretching across the continent. Proponents of these projects consider them to be the means to implement a "new paradigm" in protected areas management. A significant implication of the new paradigm is that, where existing property rights, traditional multiple use, and human enjoyment conflict with this aim, they will be subordinated to the overriding ecological purpose of allowing a wounded land to reassert its will. Even if habitat fragmentation was causing serious inbreeding depression in grizzly bears in the central Rockies (and it is not), the notion that traditional property and individual rights must be sacrificed in order to "heal a wounded landscape," and to maintain or restore habitat connectivity from Yellowstone to Yukon is worth serious scrutiny. Indeed, the anthropomorphic and, indeed, neo-pagan language that suggests a land can be wounded and possesses a will indicates that an additional agenda or purpose is being served by such a project.

On a more modest scale, but also of immediate concern, one result of employing this "new paradigm" is to expand government regulatory authority over private and leased land well beyond the specially zoned areas of Canada's national parks. In 1970, for example, Stephen Herrero argued that "it may be necessary to regulate human population density and distribution in the back country" of North American parks (Herrero, 1970: 1152). By 2000, however, Herrero's concerns were not limited to the back country of parks; he then advocated the legislative creation of "administrative flexibility" to meet habitat goals by renegotiating existing leases and tenures (Herrero *et al*. 2000: 9). Another recent paper, co-authored by a member of the federal government's Panel on Ecological Integrity, argued that "reducing the losses of large mammals in the future will require that the total area of species habitats in parks will be augmented either through the acquisition or the cooperative management of non-federal lands adjacent to parks (Landry *et al.* 2001: 20).

The campaign to have both the Cheviot mine outside Jasper and the Three Sisters Mountain Village development outside Banff stopped are excellent examples of this new approach in action. In the case of the Cheviot mine, the province established Whitehorse Wildland Park, a buffer area of 17,500 hectares (43,000 acres) between Jasper and the Cheviot mine, to mitigate the environmental impact of the mine. Although the creation of this new protected area exceeded the recommendations of the 1997 environmental impact report of the Canadian Environmental Assessment Agency and the Alberta Energy and Utilities Board, which approved construction of the mine, environmentalists still objected.[7] While initially approved in 1992, the prolonged environmental approval process for the Three Sisters Mountain Village prompted the project's initial owner to back out. Ten years later, Three Sisters has spent millions of dollars on environmental and wildlife science and design to study and mitigate the effect of their development on local and regional wildlife populations. Nonetheless, continuing pressure from environmental groups has been directed at forcing the government to withdraw its approval for the development project (Robinson 2001; Herrero and Jevons 2000). Despite the fact that these areas were already approved or were located on private land, environmental activists expected the same level of success in stopping the Cheviot mine and the Three Sisters development as they enjoyed in stopping or influencing development decisions inside the parks.

Perhaps a more significant example of the influence of those who advocate rewilding occurred in Radium, British Columbia, where, despite a serious agency-wide funding shortage, Parks Canada spent $3.6 million in July 2001 to buy up several resorts. The purchase was made in order to demolish the buildings and restore habitat connectivity for bighorn sheep in the area. Park Managers justified the expenditure by noting that local populations of bighorn sheep were suffering from human overuse of the area. In fact, the population had thrived there for decades despite human presence.[8] In fact, human presence had helped this particular population to flourish by sheltering it from predators such as cougars and coyotes. In any case, even if this particular bighorn population were stressed by human use, there are many other, more pressing species and habitat concerns. The Species at Risk database of the Canadian Wildlife Service and the COSEWIC species list do not list Big Horn Sheep (*Ovis canadensis*) as being at risk, which means that several million scarce dollars were spent to protect the habitat of a small population of an unlisted and non-threatened species, without even a rudimentary cost-benefit analysis. To add insult to expenditure, the sheep have not cooperated: instead of using the demolished sites to graze contentedly, they still prefer the lawns of the remaining hotels, notwithstanding the proximity of humans.

This should not come as a surprise to anyone who has reviewed the literature about the implementation of wildlife movement corridors in jurisdictions across North America. As Daniel Simberloff *et al*. have demonstrated, "the notion that corridors can't hurt, even if the possible biological costs could be discounted, is not necessarily always true. Much would depend on the relative costs and benefits of a proposed corridor and the alternative uses of the funds" (1992: 498). Indeed, corridors can transmit contagious diseases, fire, and other catastrophes, as well as increase the exposure of protected animals to predators, domestic animals, and poachers (Simberloff and Cox 1987). Another problem lies in the paucity of data showing how corridors are used. Where studies do exist, "that an animal uses corridors when these are present need not mean movement without them is impossible, or even less frequent" (Simberloff *et al*. 1992: 497). Finally, Canadians should learn from the example of Florida, where multi-million-dollar proposals for wildlife movement corridors have been implemented despite a lack of data on which species might use a corridor and to what effect (Simberloff *et al*. 1992: 499–500). The enormous cost of establishing wildlife corridors and other rewilding schemes necessarily precludes other conservation options, including the improved management of existing protected areas, and even the establishment of new ones.

The cost of Canada's own national park rewilding schemes is also high. By fiscal year 2000/2001, in response to the new proactive, restorative mandate handed down by the Panel on Ecological Integrity and enshrined in an amended National Parks Act, Parks Canada had spent $24.6 million to terminate commercial leases within the national parks, all in the name of ecological integrity (Parks Canada 2001b: 73). Viewed in isolation, the expenditure seems wasteful indeed. As part of a long-range strategy for a Yellowstone-to-Yukon corridor, however, it makes tactical sense (see Wildlands Project 2002).

Unfortunately, promoting this bioregional strategy by raising unfounded public concern about an "extinction crisis" among grizzly bears has unintended consequences. Among them are the serious social, political, and economic implications stemming from listing a species as threatened, either under federal or provincial legislation. This was clear in the debate over the March 2002 recommendation of the Alberta Endangered Species Conservation Committee to the provincial Minister of Sustainable Resource Development regarding the status of Alberta's grizzly population. Despite reports that Alberta's grizzly population outside the national parks has almost doubled over the past 14 years, the Committee recommended that the Minister upgrade the bear's status from "may be at risk" (blue listed) to "threatened" (red listed).[9] Such an upgrade would require recovery plans, changes to criteria for granting permits, and operating requirements for resource industries. It would also end the current limited-entry hunting activities outside the parks and have a significant impact on guides and outfitters. While Sustainable Resources Minister Mike Cardinal rejected the recommendation at the end of May 2002, the issue will be revisited after a review of the impact of hunting on Alberta's grizzly bears. On the surface. this would appear to be prudent. In fact, the Minister's decision has sparked outrage from many activists and their sympathizers who are convinced that human activity and development necessarily threatens the species.

Genuine prudence is especially appropriate where the data on which a decision is to be made are questionable. Scientists other than those advising the lobbyists of the Alberta Endangered Species Conservation Committee or the Sierra Club have questioned the historical accuracy of the claim that a hundred thousand grizzlies once roamed a pristine wilderness and the concurrent claim that declining grizzly populations are as low as 1% of their pre-Columbian numbers. They note that the daily journals of early explorers such as Lewis and Clarke provide reports wholly incompatible with the thesis of teeming masses of wildlife. Rather than finding an Eden-like wilderness with wildlife behind every tree, reviews of these journals describe explorers regularly going hungry, because of the lack of game animals (despite expending significant efforts to find and harvest them). Early records further indicate that wildlife was often found only in the buffer zones between warring First Nations. According to these journals and to the archaeological record, First Nations land management techniques and hunting skills so far surpassed what was previously thought possible that they had a significant impact on species makeup of both flora and fauna and often maintained wildlife populations at near extirpation levels in many areas (Kay 1994,1995; Kay and White 1995; Kay *et al*. 1999; Kay *et al*. 2000; Shelton 2001: 188 ff). For example, the recent discovery at a site near Cardston, Alberta of a prehistoric horse skeleton and two 11,300-year-old spearheads from which protein residue of the ancient horse has been recovered supports this thesis of "aboriginal overkill" and reinforces the view that human hunting as well as climate change at the end of the last Ice Age led to the extinction of this creature (University of Calgary 2001). Managing grizzly bears so as to maximize population counts ignores the natural and historic influence that humans have always had in shaping the landscape of North America (Flannery 2001).

Managing coexistence

ESGBP researchers have argued that maintaining a viable population of grizzly bears "is an enormous challenge . . . because of the preconceived expectation that National Parks are recreation areas for millions of people" (Gibeau 2000: 54). This "preconceived expectation," however, has a history: Canada's national parks were developed and have been managed as tourist destinations and recreation areas for over a century. Furthermore, the National Parks Act (Parks Canada 2000a, Sec. 4.1) states that the "national parks of Canada are hereby dedicated to the people of Canada for their benefit, education, and enjoyment," which constitutes a legal invitation for visitors to visit and take their recreation in those parks. The 1997 Banff Management Plan (Section 3.1: 12) calls the park a "tourist destination" and Parks Canada documents, web sites, and staff presentations all agree that the parks are "A Place for Nature [and] A Place for People" (Parks Canada 2001a).

When managing coexistence of grizzly bears and humans, there is no reason to think that a one-size-fits-all management approach will work with grizzlies any more than it does with other wildlife species or with humans. Proper research and careful thought must go into developing not just park-specific, but site-specific (and possibly bear-specific) management plans. Site-specific management plans can be designed and, in fact, have been implemented in Alaska and British Columbia to teach humans to respect the boundaries and needs of bears, and teach bears to respect the space of humans.

Proof that coexistence between bears and humans is possible even at close range can be seen in the examples of McNeil River (Herrero 1985; Shelton 2001), Brooks Camp (Alaska Outdoor Journal 2001; Shelton 2001), and Anan Creek (USDA Forest Service 1995, 2001). At all three sites in Alaska, a limited number of visitors in designated viewing areas are allowed to approach and view bears within 50 yards, a significant distance because the presence of humans or other bears within closer proximity is likely to cause a grizzly to act aggressively (Herrero 1985).

While it took over 10 years for the McNeil River bears to acquire their pattern of habituation, only two bears were killed in the process; this site has existed as a wildlife viewing area since 1973 without the need to extinguish human use. Nonetheless, a number of factors make the site unique and so an imperfect analogue to the situation in the central Rockies: "the human presence is small and predictable; the area is generally open ground where bears can see all around themselves; and the bears don't interact with fishermen, or hikers, and campers, or a nearby town or village" (Shelton 2001: 192).

First Nations peoples claim to have used the Anan Creek area for "hundreds of years" (USDA Forest Service 1995: 15). Undoubtedly, grizzlies have been using the area for just as long. Currently, the site receives up to 90 visitors per day, with as many as 25 people viewing the resident bears at a time. Yet, despite a sustained increase in human visitors to the area, there is only one recorded instance of a brown bear being killed (1991), after charging a videographer, and one other instance of a brown bear charging a Forest Service Employee (USDA Forest Service 1995: 15).

Because the grizzlies in the Brooks Camp area are "habituated but slightly aggressive" (Alaska Outdoor Journal 2001; Shelton 2001: 192), there are relatively strict rules governing use by visitors. For example, fishermen are encouraged to travel in large groups and use pepper spray when confronted by bears. Area wardens use radios to maintain contact with fishermen and have them leave the area when a bear is approaching.

Olson (1993) and Olson *et al*. (1997) showed that use of Alaskan salmon streams by grizzly bears was better determined by their ability to tolerate humans than by the more traditional categories of age, sex, and maternal status. Their work demonstrated that non-habituated adult grizzly bears reduced activity at an Alaskan salmon stream in response to an extended lodge season. In contrast, habituated adult bear activity remained substantially unchanged.

While these examples are not strictly analogous to the central Rockies, they do provide evidence that habituation and co-existence between humans and bears is possible even at close range without the need for large numbers of bears to be relocated or killed. With examples such as these, one can see that one of the most important factors in dealing with co-existence is education of *both* the bears and humans. Such education necessarily entails a level of habituation on the part of the bears.

This argument leads to the conclusion that humans need not be removed from the back country or from other natural areas. However, human access will require responsible conduct from those using the natural areas. In his report to the Department of Fisheries and Oceans [DFO], *Managing Human/Bear Conflict at the DFO Babine River Counting Fence and Living Compound*, Shelton (2001: 181 ff) noted that a certain level of habituation will, in fact, provide a degree of security and safety for both bears and humans. This report was intended to instruct DFO employees on ways to deal safely with the increasing number of bears that they were encountering at the Babine River salmon counting fence in northern British Columbia. His recommendations focus on teaching both the DFO employees and the local bears where they should expect each other to be, instructed employees in the use of various deterrent methods such as electric fencing, spray, and firearms, and set usage times for both humans and bears.

As with the Alaskan examples, the Babine River situation is not wholly analogous to the situation in the central Rockies. Therefore, Shelton's suggestions cannot simply be copied as a tool for managing human use in the back country of the mountain parks. Neither the British Columbian nor the Alaskan examples are meant to act as templates for changing mountain park management schemes. Shelton's report simply provides additional evidence that close-range coexistence between bears and humans is possible, and that there are professionals who are actively and creatively attempting to find ways to bring it about. Their work, however, goes on outside Canada's national parks and beyond the control of Parks Canada. Moreover, it seems to have been largely ignored by Parks Canada advisors.

Can the presence of humans help bears?

Using the more common-sensical understanding of the precautionary principle advanced by Goklany (pp. 34–35 above), we can revisit the opinion that the "combination of habituated bears using lower quality habitats and demonstrating higher movement rates suggests less energy available for growth and reproduction" (Gibeau 2000: 4). To begin with, it is possible that habituated bears may have been displaced into marginal habitats by dominant bears. After moving into this marginal habitat, their movement rates would have necessarily increased in order to locate sufficient forage. An increased rate of movement would likely have increased the rate at which they encounter humans, familiarizing them with human presence, causing them to become "habituated."

"Habituation" can also be seen as an adaptive survival trait. That is, some female grizzlies in the CRE may have become habituated as a side-effect of using human-influenced habitat to help increase the survival rates of their offspring. Research indicates that sows with cubs may use marginal or human-influenced habitat as a means of avoiding dominant males (Blood and Materi 1998). In the central Rockies, sow grizzlies frequent areas of high human use, such as the Lake Louise area and roaded areas. Furthermore, they do so without necessarily becoming food-conditioned. The relevant evidence has been noticed by the ESGBP researchers, though its significance was ignored. For example, Gibeau noted that

> social structure may also have a bearing on spatial distribution of a bear population. In Yellowstone National Park, Mattson *et al*. (1987) demonstrated that cohorts of subordinate bears were found in poor-quality habitats near developments, displaced by more dominant classes, particularly adult males. McLellan and Shackleton (1988) also determined that adult males used remote areas whereas adult females and some subadults used areas closer to roads. While my results pointed to differential use by sex and age, I was unable to determine whether this distribution is a natural phenomenon or the result of intense competition for space with humans. (2000: 34)

In common-sense language, the presence of humans in areas such as Lake Louise may be used by sows and their cubs in order to avoid dominant males. The biological evidence supports this interpretation (Mattson 1990; Blood and Materi 1998). Using the precautionary principle of "prudence in the face of uncertainty" and "erring on the side of preservation," when the evidence indicates that females use marginal habitats and the presence of humans as a form of cover from dangerous adult males, then it appears likely that restricting human use could harm survival rates within the adult female cohort.

The probability of harm necessarily increases when the removal of human influence encourages "wary" adult males to use habitats they had previously chosen to avoid because of human presence. This change in male grizzly behaviour would then force females out of known habitats into new, marginal ones, likely causing decreases in fecundity and survival and certainly causing a disruption in their habitat use. Moreover, a decrease in female survivability would almost be guaranteed because the most recent ESGBP numbers indicate an almost perfect, 99% rate of adult female survival (Herrero *et al*. 2000: 30). Even if one discounts the recent trend in female survivability as a statistical anomaly and relies on the longer-term survival rate of between 90% and 95% (Herrero *et al*. 2000: 29), these still relatively high rates would present an excellent argument for precaution. With little room for increase and a great deal of room for decrease in the adult female survival, tinkering with a management scheme that clearly works (as evidenced by adult female survival rates of 90% to 99%) must be prohibited by application of either the extreme preservationist version of the precautionary principle or the more moderate precautionary principle of Goklany. There is nothing paradoxical in the notion that the presence of humans has, in fact, helped maintain the current high levels of survival. As all the authorities attest, bears are highly adaptable and they have clearly adapted to humans.

For conservation biologists, however, all the arguments regarding the application of the precautionary principle or the need to avoid Type II errors, move in a single direction: removing humans from parks and other natural areas. Where human presence may mitigate some environmental harm, in this case maintaining or increasing the survival rates of adult female grizzlies, the precautionary principle is abandoned and ignored. It seems evident, therefore, that the objective is simply to restrict or remove humans; the discussion of Type II errors or the precautionary principle is rhetorical camouflage.

If one revisits ESGBP arguments in light of the above considerations, they seem to be at variance with standard scientific thinking. ESGBP researchers strongly advocate maintaining wariness, which in terms of the dichotomy between wary and habituated means keeping bears non-habituated. When transformed into public policy by Parks Canada, the direction of its effort is towards "managing for wary grizzly bears" (Jalkotzy *et al*. 1999: 9). There is a vital difference, however, between managing for wary bears and managing for wary *behaviour*.

As we have indicated above, managing for wary behaviour is possible because it can be observed in hunted bear populations or those bears habituated through aversive training. But, focusing management on wary bears would be difficult, because all bears exist on a continuum somewhere between wary and habituated and the same bear can vacillate widely between wary and habituated behaviour, depending on its environment—as ESGBP researchers themselves acknowledge (Herrero 1985: 15; Gibeau 2000: 10). Moreover, managing for wary behaviour would benefit the CRE grizzly population because it would encourage them to avoid direct contact with humans while allowing them to use human-influenced habitat.

It is probably true that, in specific and limited circumstances, grizzlies that have been sheltered from human influence may have a natural wariness of humans that helps to reduce conflict between humans and bears (Norkin 1997). However, it is far too late to apply such an experimental strategy to the CRE population. Such a strategy would require sheltering CRE grizzlies from human influence for several generations of bears. Absent the implementation of mass human relocation in accord with schemes such as those advocated by the Wildlands Project, that is not going to happen.

Fortunately, more than the logic of a Darwinian adaptive survival strategy is involved in disputing the ESGBP notion that "wary, healthy" bear populations require drastic reduction or curtailment of human use in the parks. In sharp contrast to ESGBP reports, British Columbian researcher Gary Shelton argues that bears are not by nature "shy nocturnal animals" that avoid humans whenever possible:

> Grizzlies with that type of [wary] behaviour have had significant mortality by humans, who first eliminated bears with higher levels of day activity and aggressive behaviours and modified the behaviour of surviving bears that had family members killed, or have been wounded or dosed with shotgun pellets . . . It takes 30 to 40 years of significant human influence before most females in a grizzly population are teaching their cubs to be nocturnal and to run when they see, hear, or smell a human. (2001: 85)

Rather than being naturally wary, wariness is actually a learned behaviour, a defence from human threats. Consequently, Shelton argues that hunting pressure and aversive conditioning teaches bears (even "habituated" bears) to avoid humans. This argument, which also accords with common sense, contradicts the hypothesis of a "natural" wariness that ESGBP research argues is best achieved through seclusion from human influence (Gibeau 1998, 2000).

As noted above, several groups have recommended that the status of Alberta's grizzly population be upgraded to "threatened." One of the implications of a changed designation would be an end to limited entry hunting. This could have unintended consequences for grizzly bear management in Alberta, as evidence indicates that the removal of hunting pressure on a grizzly population encourages both a loss of wariness and a corresponding increase in negative encounters between bears and humans. According to Shelton, the decrease in hunting pressure on grizzly populations during the moratorium in British Columbia on hunting grizzly bears encouraged a much bolder response by grizzlies toward humans:

> For a very long time, we had levels of mortality and types of mortality on grizzly bears that suppressed their numbers and made them fearful of humans. During the last 15 years, that influence has been reduced to the point that most bear populations are increasing, and many grizzlies no longer fear people. They are reasserting their position as a dominant species. (2001: 182)

Literature from Eurasia also supports the hypothesis that bears are more wary when they are hunted than when they are protected (Norkin 1997).

David Garshelis has observed an additional irony: while most legally protected bear populations appear to be declining, most hunted populations are on the rise. He explains:

> Historically . . . in both North America and Europe, managed hunting has been an effective system for protecting bear populations. It has worked because it has enlisted a clientele interested in ensuring continued abundance of the resource. It has also worked because, for species such as bears that can be a nuisance and a threat, it transfers the killing of animals from the general public to a smaller group of people (i.e., the hunters). (Garshelis 2002: 22)

In conclusion, while aversive training techniques and hunting pressure on grizzly populations would of course habituate bears to people, the type of wariness so induced by humans is protective and beneficial for both bears and people (Montana Chapter of the Wildlife Society 1999). So far as the CRE grizzly population is concerned, habituation is not the issue. This population is already habituated to some extent; the issue is to ensure the right kind of habituation.

Conclusion

The preservationist movement in North America has embraced a new mission-oriented version of biology. Supported by tax dollars and generous government grants and by vocal and effective international environmental interest groups and lobbyists, conservation biology has had a distinct impact on the management of Canada's national parks. The basis of conservation biology is the "fundamental shift in ethics" (Gibeau 2000: 49) toward a new understanding of what natural resources and parks are for. Even so, because conservation biologists employ the language and concepts possessing considerable phonemic overlap with other branches of wildlife science, conservation biology appears similar to standard or ordinary wildlife biology. Only when the end purposes are brought into focus do the differences between the two appear.

The issue that we take with conservation biology is not that its practitioners have preconceived opinions. We believe it is reasonable to expect that research claiming to be scientific, that is funded by tax dollars, and that has a direct impact on the management of publicly owned lands would be carried out in such a way that the biases of researchers have limited influence on their findings. As Friedman (1991, 1997) argued, researchers who advocate theories that lead to significant changes in management policy should act as the strongest critics of their own work.

The ESGBP researchers asked that "interested readers ... carefully examine the strengths and limitations of their data." This is a conventional scientific protocol for which the present *Critical Issues Bulletin* is a response. We have argued that ESGBP research has allowed an admitted and systemic preservationist bias to influence its research on grizzlies and, no doubt, on other large carnivores in the mountain national parks. This bias has encouraged policy recommendations, including restriction of human use and extension of the authority of government and interest groups beyond existing park boundaries to privately owned and leased land outside parks and other protected provincial lands. We have shown that the ESGBP researchers themselves have failed to meet basic scientific requirements. By invoking a talismanic "precautionary principle," they deliberately advance questionable findings based on incomplete methodologies, flawed models, and highly debatable assumptions as the foundation for promoting restrictions on human activities, particularly in Canada's national parks. These restrictions are advanced initially as being necessary to ensure the preservation of biodiversity. Subsequently, their supporters, who are active in environmental lobby and litigation groups, further bias these already questionable assertions by widely publicizing selected portions of the research. Couching their reviews of the abbreviated research findings in lurid headlines and quasi-scientific language, they offer a stark and alarming choice between forced restriction of human activity and environmental desolation. However one describes the entire complex strategy, from developing wildlife population estimates on the basis of dubious assumptions to a multi-pronged litigation strategy, it is not science.

Contrary to accepted conventions of scientific procedure, which require rigorous testing of hypotheses, ESGBP researchers have stated the opinion that "the ultimate test of any applied research program will be if scientific findings are used to inform either policy process or management practices" (Gibeau 2000: 50). In this light, they have easily passed their ultimate test. If the "applied research program" described in this paper is as scientifically questionable as we have argued, the cost of translating it into wildlife management practices are bound to be inordinately high and the benefits correspondingly low.

This *Critical Issues Bulletin* has brought into focus a number of criticisms of ESGBP research and modeling efforts. Before any further ESGBP research is used as an aid in developing land management policy, and before any further tax funding is devoted to this research, it would be prudent for ESGBP researchers to provide information and data relative to the concerns we have raised. If the ESGBP is going to continue to offer recommendations for policy, it is imperative that their science be credible. In order to enhance this credibility, we recommend the following:

- Given that the ESGBP has now collected the targeted 100+ years of reproductive data, we recommend that their entire *raw* data set, modeling software, and parameters be placed in the public domain, not least of all because their research has been substantially funded by federal and provincial tax dollars.
- The results of PHVA simulations of grizzly bear populations in the central Rockies should not be used to guide any actual management regimes until the data, the assumptions, and the methodology are reviewed by independent modeling specialists.
- Future use of habitat effectiveness models and security areas analysis should be constrained by the necessary inclusion of a cost/benefit analysis to determine if the implementation of the findings derived from the models will cause greater damage to provinces, regions, or communities than alternative management actions.
- These models should only be used as one of a group of tools in a broad suite of land and wildlife management approaches. No single tool should play as determinative a role in the management of Canadian National Parks as the habitat effectiveness model now does.
- Parks Canada should define and provide specific guidelines for the implementation of the precautionary principle. The current ambiguity surrounding its definition and the preservationist tenor to its past application requires that a coherent framework (such as provided by Goklany 2001 or Lomborg 2001) be applied and implemented. Economic and other social science information is needed in order to assess the costs and benefits of alternative management actions.
- Parks Canada should renew its commitment to both human use and environmental protection of the parks.
- While some communication with landowners and managers adjacent to the national parks may be appropriate, Parks Canada's "ecosystem management" approach should not be used to expand their management prerogatives beyond national park boundaries. Likewise, any "adaptive management" strategies must be tempered with the need for legal and administrative certainty for park visitors and service providers.

Credible, independent peer-reviewed science, along with a broad suite of management tools and developing technologies can provide the necessary apparatus to understand bear biology and models. When this understanding is rooted in a management approach that emphasizes individual responsibility, choice, and the education of bears and humans, both populations will be better served.

Appendix A: Funding the Eastern Slopes Grizzly Bear Project

Parks Canada's funding of the Eastern Slopes Grizzly Bear Project (ESGBP), 1994–2003 ($000s)

Expenditure	1994/ 1995	1995/ 1996	1996/ 1997	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003*	Total
Researchers	50	60	60	50	50	50	50	75		445
Monitoring	45	45	55	56	49	21	20	25	30	346
DNA Sampling/Analysis		16								16
Lake Louise Monitoring			30	28	17	28	21	72		196
Lake Louise Research								13		13
Helicopter	10	10								20
Expert Workshop							4			4
Miscellaneous	3	3	4	4	5	4	1	29		53
Regional Habitat Mapping			3							3
Veterinarian**	2	2	5	7	8	1	4	3		32
Vehicles**	11	11	1							23
Aerial Monitoring**	25	25	30	27	30	25	30	30		222
GIS/Data Analysis**	3	3	3							9
Operating Support**				3	3	1	1			8
Monitoring Technician**	2	2	4	4	4					16
TOTAL	151	177	195	179	166	130	131	247	30	1,406

* Funding provided by the Parks Canada Species at Risk Recovery Fund.
** Multispecies support. Costs were estimated as some records were not available and some records were shared.
Source: Parks Canada, Access to Information Request (July 2002).

Appendix B: Parks Canada Science Review

In June, 2002, when the research and writing of this Critical Issues Bulletin was complete, Stephen Woodley and Gilles Seutin published a report from the National Office of Parks Canada in Ottawa entitled *A Review of the Science Programs in the Banff and Lake-Louise-Kootenay-Yoho Field Units* (Woodley and Seutin 2002). The general purpose of the report is to argue in favour of enhancing and strengthening the scientific work done in the Banff and *Lake-Louise-Kootenay-Yoho* (LLYK) field units. The report also addresses a number of issues raised in this publication.

Woodley and Seutin begin from recommendations advanced by the Council of Science and Technology Advisors in their 1999 report, *Science Advice for Government Effectiveness* (CSTA 1999), usually referred to as the SAGE report. In this report, six principles for sound science were identified, including the following:

> **II. Inclusiveness**
> Advice should be drawn from a variety of scientific sources and from experts in many disciplines in order to capture the full diversity of scientific schools of thought and opinion. (CSTA 1999: 4)

When quoting this section, Woodley and Seutin write "relevant disciplines" (2002: 7) rather than "many disciplines," which is a broader designation. The SAGE report also notes that where there is "significant scientific uncertainty" or "a range of scientific opinion" or there are "potentially significant implications for sensitive areas of public policy and where independent scientific analyses can strengthen public confidence," then it is "especially important" to seek advice from external and independent sources. Moreover, the SAGE report concludes: "Decision makers need to be open to both solicited and unsolicited advice from external sources" (CSTA 1999: 4). Parks Canada has not followed the SAGE advice on inclusiveness.

> **III. Sound Science and Science Advice**
> The government should employ measures to ensure the quality, integrity, and objectivity of the science and science advice it uses, and ensure that science advice is considered in decision-making. (Woodley and Seutin 2002: 7)

This is section III as quoted by Woodley and Seutin. The SAGE report adds that "the public expects government" to behave this way and that such independent scientific advice is to be considered "seriously," even when unsolicited. Special emphasis is given to scientific and external peer review. Moreover, "science advisors need to contribute sound scientific information unfiltered by other policy considerations." The science advisors themselves must be chosen "to reflect the diversity of opinions and to counter potential biases" and their advice must distinguish "scientific fact and judgement from their personal views in formulating their advice" (CSTA 1999: 5). Parks Canada has not followed the SAGE advice for Sound Science and Science Advice.

> **V. Openness**
> The government is expected to employ decision-making processes that are open, as well as transparent to stakeholders and the public. (Woodley and Seutin 2002: 7)

Thus, Woodley and Seutin. The SAGE report says:

> Democratic governments are expected to employ decision making processes that are transparent and open to stakeholders. Openness implies a clear articulation of how decisions are reached, policies are presented in open fora, and the public has access to the findings and advice of scientists as early as possible. It is essential that the public be aware of what the responsibility of government is in relation to the use of science. (CSTA 1999: 7)

The SAGE report also notes that "advice providers," including presumably unsolicited ones,

> need to be confident that their advice is considered seriously in decision making. Finally, there

> needs to be consultation with stakeholder groups and public discourse to ensure that public values are considered in formulating policy. Early and on-going consultation both within government and with the public can mitigate greater negative debate and controversy when policies are announced. (CSTA 1999: 7)

In each of these areas, Parks Canada has systematically and egregiously failed to comply with guidelines and practices that it appears to endorse. With respect to "uncertainty and risk," also noted by Woodley and Seutin and listed in the SAGE framework, we have explained in the course of this report that risk analysis is consistently interpreted in such a way as to exclude human beings from protected areas even when human presence might benefit wildlife. The SAGE report explains that: "The goal of risk management is scientifically sound, cost-effective, integrated actions that reduce risks while taking into account social, cultural, ethical, political, and legal considerations," which includes the "need to communicate to the public and stakeholders the degree and nature of scientific uncertainty and the risk management approach utilized in reaching decisions" (CSTA 1999: 6–7). Parks Canada has not followed the SAGE advice on Uncertainty and Risk.

To assess the quality of the science conducted in the mountain parks, Woodley and Seutin: (1) interviewed 29 people using common questions, questions specific to the individual situation, and open-ended conversation; (2) assessed Parks Canada management documents to identify and prioritize science needs; and (3) assessed scientific publications by Parks Canada and contract researchers "over a 10-year period, including those in the grey literature." A further sample was selected "in particular to explore the issue of peer review" (Woodley and Seutin 2002: 9).

Peer review is the central issue in the publication of any scientific article or book in the natural sciences, the social sciences, or the medical sciences. It is the bedrock of scientific integrity and the foundation of scientific credibility. With respect to the statements reported in the previous paragraph, it would have been helpful to have the text of the questions available. This is done in social science in order to assess independently the validity and reliability of the instrument. It would have been helpful to have been provided with a definition of "the grey literature," which appears to be a term of art used by Parks Canada. It would also have been helpful to know the technique used to draw the sample with which they explored the issue of peer review.

Instead, the authors turn to a short disquisition on the meaning of science, which "is perhaps best thought of as a verb rather than a noun" (Woodley and Seutin 2002: 10), by which they mean the science is "a process for acquiring information and knowledge that enables learning" (p. 10). They then discuss the levels of investment in this "process" in the mountain parks and arrive at a total figure of about $8.8M for the period from 1994 to 2001 for project expenditures, excluding salaries and overhead. Approximately $6M was spent in Banff. For this expenditure, the Banff and LLYK field units have produced "in the order of 10 peer reviewed publications a year" (p. 11). The actual publications are not listed, nor is any breakdown between Banff and LLYK made. We will consider the issue of peer review below in more detail.

The authors conclude, however, that "relative to its investment" about 10 peer-reviewed papers a year constitutes "a high level of science activity" (Woodley and Seutin 2002: 12). Moreover, nearly everyone interviewed said it was "good quality" science. Of the 28 people listed as having been interviewed, well over 80% were either Parks Canada employees, recipients of Parks Canada contracts, or environmental activists.

There are, however, at least two critics, one, a "private citizen," the other, an officer of the Association of Mountain Parks Protection and Enjoyment. The details of their criticism were not provided. Instead, Woodley and Seutin assert that "ecosystem science" cannot provide "predictive precision" and so must rely on the precautionary principle as a way of translating uncertainty into management decisions. We have seen, however, that the precautionary principles as understood by Parks Canada is part of the problem and exists independently of predictive imprecision of "ecosystem science," which is also an undefined term of art (see, however, LeRoy and Cooper 2000: 19–20).

Woodley and Seutin discuss a number of housekeeping matters such as the need to rely heavily on graduate students and congratulate the authors of several unnamed "recent research projects" on the "solid project design" that has informed their work. And yet, "many specialists and biologists" with whom they spoke raised questions about the solidity of the research design and suggested that "consultations and peer reviewing might be warranted." On the whole, however, the authors assure us that Parks Canada has "done an excellent job at defining and reviewing the design of the projects" (Woodley and Seutin 2002: 23).

When the authors discuss the data on peer review, they use a 15-year time period, not the seven-year period (1994 to 2001) used earlier to assess Parks Canada's expenditures on research. They do not provide any information about the costs for this 15-year period. Included in the category of peer-reviewed publications were university theses, conference proceedings, and articles in both "minor" and "primary" journals. There are no examples given of either type of journal nor of conferences said to have been refereed. University theses are not usually considered peer-reviewed publications. In all categories, 41% of the publications from Banff and 16% of LLYK were "peer reviewed." Of those published in "primary journals," 19% were produced at Banff and 7% at LLYK (Woodley and Seutin 2002: 25).

By the broad definition of peer review, Banff's researchers produced seven publications a year and LLYK, fewer than three. Using the more strict understanding of peer review that confines it to "primary journals," Banff produced slightly more than three a year and LLYK produced just over one publication a year. Woodley and Seutin are of the opinion that "the level of peer review conducted in Banff is very high by any standards" (Woodley and Seutin 2002: 25). It is more accurate to say that seven (or three) publications a year is high only by Parks Canada's standards.

Since there are no costs given for the 15-year period and the data for the seven-year period from 1994 to 2000 indicate only that Banff and LLYK "have been producing in the order of 10 peer reviewed publications a year" some additional assumptions must be made to calculate the per-unit costs of a peer-reviewed publication. We will simplify by looking only at Banff, which is considered to have a "very high" production of peer-reviewed articles. Adding the lower rates for peer-review articles in LLYK would raise the costs per unit.

If we assume that funding levels over the 15-year period are about the same as those from 1994 to 2001—around $850,000 a year—under the broad definition of peer review, each publication cost about $120,000. Under the strict definition, each peer-reviewed publication from Banff cost about $258,000.

Woodley and Seutin single out the ESGBP's research and claim that 60% of their publications were peer reviewed. They do not provide costs so no estimate of the price of each publication can be made. Nor are the publications listed, so it is impossible to determine what kind of peer review was involved.

The authors next considered the question of translating scientific advice into management decisions. The authors state: "there is not a clear path for science advice to get to the management table, nor any clear record of what the science advice for a given issue was, and how it was used." As a result, the authors continue, "management decisions are seen by many as lacking in openness and transparency," which results in "a level of misunderstanding between managers and specialists, with the latter feeling that scientific information and advice they worked hard to produce was not appropriately considered by managers" (Woodley and Seutin 2002: 27).

If the "science" produced by the "specialists" were reliable and valid wildlife biology, this might be a problem. But, because so much of the conservation biology produced by these "specialists" is so questionable to begin with, the common sense and experience of management officials in Parks Canada actually on the ground in the parks (rather than at headquarters in Ottawa) has no doubt served the citizens of Canada and park visitors much better than the strict application of such "science" ever could do.

The concluding sections of the report by Woodley and Seutin contain some remarkable assertions. First, they note that there is no proper method of archiving data and no regulations by which data can be made available to external scrutiny—which is what genuine peer review would entail.

Second, they claim that, if only the scientific value of the projects had been properly communicated, criticism would vanish. The possibility that some projects are ill conceived and expensive seems not to have occurred to them.

Third, the authors complain that much of the criticism of Parks Canada has been "ideological, value-based and even personal," and not directed at the credibility of the science. When scientific credibility is questioned, however, they claim that the focus is on the following three issues (Woodley and Seutin 2002: 33):

(1) research is driven by researchers' personal values, not objective analysis;

(2) it is not peer reviewed;

(3) its fundamental concepts—including ecological integrity and population viability analysis—are invalid.

We have quoted and analyzed, in this Critical Issues Bulletin and in a previous publication (LeRoy and Cooper 2000), the statements of researchers who provided this "scientific" advice that indicated clearly that their "personal values" drove their research. Indeed, the whole notion of conservation biology is, as we have argued in great detail, an ideological movement, not science, which is in any case a noun, not a verb.

Further, the report by Woodley and Seutin indicates, in a vague and unscientific way, just how much of the "science" produced in the mountain parks is subject to peer review. It is our view that seven (or three) reports a year is not a record to be proud of. Moreover, it is not at all clear who the "peers" in this peer review process are. That is, no evidence is provided as to whether the "peers" are employees of Parks Canada, researchers in the ESGBP or scholars independent of the researchers who wrote the reports. There is no discussion of whether the "primary journals" are, in fact, scientific and reputable, nor what these journals are.

Third, we have discussed above the notions of ecological integrity and population viability analysis. Readers can judge for themselves how valid and reliable these notions are and the legitimacy with which they are employed by Parks Canada and their "specialists."

For Woodley and Seutin, however, matters are clear: "we examined each of these issues during our review and see no evidence of any systemic pattern of poor or biassed science being done" (Woodley and Seutin 2002: 33). They may take comfort in what they failed to see; we do not.

Notes

1 This conclusion is based on a basic ranking of environmental charities, as classified by the CCRA charities division as G1: “nature, habitat-conservation groups”, G2: “preservation of species, wildlife protection”, G3: “general environmental protection, recycling services”. In 1998, CPAWS spent $75,440 on political advocacy. The information was analyzed by the authors using a database compiled by the CCRA charities division. It should be noted that only a small fraction of Canadian environmental charities chose to declare the amount spent on advocacy (line 124 on the CCRA registered charity information return), limiting the utility of such a ranking.

2 At time of printing, the Act had yet to receive Royal Assent.

3 As Paterson noted, “this statement is a genetic non-sequitur, in that the second part [that the population is usually already in trouble] is not a certifiable consequence of the former [that the population may be highly inbred]. Technically, all domesticated animals are ‘highly inbred,’ and repetitive inbreeding, called ‘line-breeding,’ in animal husbandry is the main mechanism by which desired characteristics are set and reinforced in a population” (pers. comm. with Barry Cooper and Sylvia LeRoy, 2002).

4 The total grizzly bear population in British Columbia is estimated to be between 10,000 and 13,000 animals (BC Ministry of Environment, Lands and Parks 1995).

5 Unsurprisingly, ESGBP researchers qualify this finding with the judgments that the population is “delicately balanced” (Ellis 2001), and “balanced on a pencil head . . . balanced at best” (Zickefoose 2001).

6 This unquestioned and immediate classification of “rock and ice” as unsuitable ignores the fact that grizzlies throughout North America regularly make use of rock and talus slopes in their search for prey species such as marmots (see http://www3.gov.ab.ca/srd/fw/watch/rabb_hoary.html for a brief description). In Yellowstone, grizzlies use rock and talus slopes as an essential foraging area for army cutworm moths (*Euxoa auxiliaries*), which is recognized by Yellowstone park managers as one of “four major food sources” for Yellowstone grizzlies (National Parks Service 2000: 44, 157).

7 Stephen Herrero and his son, Jacob completed the initial cumulative effects assessment for the Cheviot project (Herrero and Herrero 1996).

8 The reintroduction of the fire regime, which shaped the Eastern Rockies ecosystem, would do far more to bolster habitat needs for this population than the reduction of contemporary human impacts will. See Kay 1994, 1995; Kay *et al*. 1999.

9 This criteria is based on a World Conservation Union (IUCN) requirement for a minimum viable population of 1,000 individuals (IUCN 2001: 21–23).

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