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.