

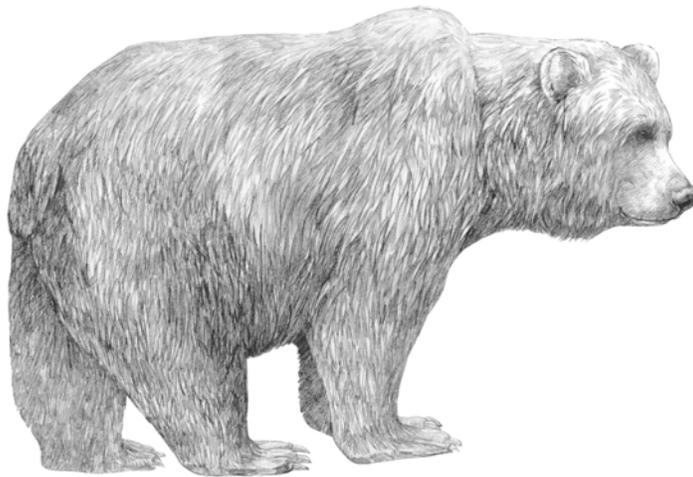
COSEWIC
Assessment and Update Status Report

on the

Grizzly Bear
Ursus arctos

in Canada

Prairie population
Northwestern population



PRAIRIE POPULATION – EXTIRPATED
NORTHWESTERN POPULATION – SPECIAL CONCERN
2002

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA



COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

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COSEWIC Assessment Summary

Assessment Summary – May 2002

Common Name

Grizzly bear (Prairie population)

Scientific name

Ursus arctos

Status

Extirpated

Reason for designation

Extirpated in the prairie region of Canada

Occurrence

Alberta, Saskatchewan, Manitoba

Status history

Canadian range considered as one population and designated Not at Risk in April 1979. Split into two populations in April 1991 (prairie population and northwestern population). Prairie population designated Extirpated in April 1991. The species disappeared from the prairies in the 1880s. Status confirmed in May 2000 and in May 2002. Last assessment based on an update status report.

Assessment Summary – May 2002

Common Name

Grizzly bear (Northwestern population)

Scientific name

Ursus arctos

Status

Special Concern

Reason for designation

The grizzly bear's habitat is at risk from expanding industrial, residential and recreational developments. Habitat and population fragmentation are underway in the southern part of the bear's distribution. The life history characteristics of this bear make it particularly sensitive to human-caused mortality (including hunting, poaching, accidents and nuisance kills). Its behavior frequently brings it into conflict with people, leading to increased mortality where human activities expand. It has disappeared from a substantial part of its historic range, but there are still over 26,000 grizzly bears in Canada. The grizzly bear's area of occupancy has not decreased substantially over the past 20 years. The future of several populations that are either completely or mostly isolated is highly uncertain and dependent on conservation.

Occurrence

Yukon Territory, Northwest Territories, Nunavut, British Columbia, Alberta

Status history

Canadian range considered as one population and designated Not at Risk in April 1979. Split into two populations in April 1991 (prairie population and northwestern population). Northwestern population designated Special Concern in April 1991. The status was re-examined and confirmed in May 2002. Last assessment based on an update status report.



COSEWIC Executive Summary

Grizzly Bear *Ursus arctos*

Description

Grizzly bears share the typical ursid body form, and are large, muscular, and robust. In contrast to American black bears, grizzlies have a prominent shoulder hump, concave facial profile, and long front claws. Fur colour ranges from blonde through shades of brown to nearly black. Males are, on average, 1.8 times as heavy as females. Typical body mass for adult females ranges from 100 kg for interior populations to 200 kg for coastal bears.

1.2 Distribution

Grizzly/brown bears are known or believed to occur in Canada, U.S.A., and at least 42 Eurasian countries. Many Eurasian populations are insular, small, and endangered. World-wide, the brown bear has lost an estimated 50% of its range and abundance since the mid-1800s. The grizzly bear in Canada currently occupies an estimated area of 2,574,000 km², or about 26% of the country's land mass. Massive range contraction in North America and Canada has occurred in the post-glacial and historical periods. Today, grizzlies are found in parts of Alberta, British Columbia, Yukon, Northwest Territories, and Nunavut.

Habitat

Grizzly bears are habitat generalists. They can be found from sea level to high-elevation alpine environments. In Canada they occupy habitats as diverse as temperate coastal rain forests and semi-desert Arctic tundra. Most grizzly bears eat primarily vegetation, and their habitat associations are therefore strongly seasonal and typically reflect local plant development. In mountainous regions this may result in seasonal elevational migrations.

General Biology

Although they have a carnivore's feeding and digestive anatomy, grizzly bears are omnivorous and many are primarily herbivorous. In some areas, however, grizzlies are effective predators of moose and caribou, and coastal populations feed heavily on spawning salmon. Female bears usually have their first litters at 6 years of age, litter sizes are 2 or 3, and intervals between litters are commonly 3-4 years. Longevity is around 20 years, although bears as old as 34 have been recorded. Grizzly bears are not territorial, but use home ranges of up to 8,000 km², although in richer environments they use much smaller areas. Grizzlies hibernate for up to 7 months each winter, and cubs are born in the den in January or February.

Population Size and Trends

The Canadian grizzly population is estimated at between 26,916+ and 29,150+. British Columbia has the largest population, with at least 14,000 bears. About 6,000 to 7,000 grizzlies live in the Yukon, 5,100 live in the Northwest Territories, and 1,000 live in Alberta. The population in Nunavut is unknown but is probably between 800 and 2,000. Historical numbers in Canada are unknown, but were certainly much higher. However, the population is believed to have been generally stable since 1990.

Limiting Factors and Threats

There is some natural mortality in bear populations, but most grizzlies die from human activities. Populations in most areas in Canada are hunted, and licenced hunters kill over 450 grizzly bears each year. Another 100 are known to be killed by other human causes, and substantial numbers are killed and not reported.

Incursions into grizzly bear habitat by human activities including mining, forestry, agriculture, residential development, and recreation degrade habitat quality for bears and increase mortality risk. Grizzly bears may be attracted to sites of human activities by potential food. Attraction to garbage and livestock, for example, is responsible for many grizzly bear deaths.

The development of roads and other linear features into grizzly bear habitat is a particular threat. Roads themselves pose little harm, but their use by humans reduces habitat effectiveness in a buffer zone around the roads. In addition, roads provide access for humans with firearms who, legally or illegally, kill bears that would otherwise be less vulnerable.

Human activities have resulted in geographic or genetic isolation of several Canadian grizzly bear populations, including 8 that have been identified in southern BC. Each is small, at fewer than 100 bears, and rescue potential from neighbouring populations is low to nil. The activities that cause isolation also contribute to mortality, so such isolates are at elevated risk of extirpation.

Existing Protection

About 8.3% of the range currently occupied by grizzly bears in Canada is classified as “protected”. However, hunting and activities that may degrade habitat quality for grizzly bears are permitted in some “protected” areas. All provinces and territories have restrictions on hunting that include closed seasons, limited-entry permits, harvest quotas, and protection for females and cubs. Bait is not allowed when hunting for grizzly bears, and trade in bear parts is prohibited.



COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) determines the national status of wild species, subspecies, varieties, and nationally significant populations that are considered to be at risk in Canada. Designations are made on all native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fish, lepidopterans, molluscs, vascular plants, lichens, and mosses.

COSEWIC MEMBERSHIP

COSEWIC comprises representatives from each provincial and territorial government wildlife agency, four federal agencies (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biosystematic Partnership), three nonjurisdictional members and the co-chairs of the species specialist groups. The committee meets to consider status reports on candidate species.

DEFINITIONS

Species	Any indigenous species, subspecies, variety, or geographically defined population of wild fauna and flora.
Extinct (X)	A species that no longer exists.
Extirpated (XT)	A species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A species facing imminent extirpation or extinction.
Threatened (T)	A species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk (NAR)**	A species that has been evaluated and found to be not at risk.
Data Deficient (DD)***	A species for which there is insufficient scientific information to support status designation.

* Formerly described as “Vulnerable” from 1990 to 1999, or “Rare” prior to 1990.

** Formerly described as “Not In Any Category”, or “No Designation Required.”

*** Formerly described as “Indeterminate” from 1994 to 1999 or “ISIBD” (insufficient scientific information on which to base a designation) prior to 1994.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list.



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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

Update COSEWIC Status Report

on the

Grizzly Bear *Ursus arctos*

Prairie population
Northwestern population

P. Ian Ross¹

Ian Ross, the writer of this COSEWIC report, died in the crash of a small airplane in Kenya on June 29, 2003, while working on lion conservation. His dedication to wildlife conservation was exemplary. This report bears witness to his skill and knowledge. His death is an irreparable loss to Canadian conservation.

2002

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2. SPECIES INFORMATION

2.1 Name, Classification

Ursus arctos is widely known as the grizzly bear or the brown bear. Typically, Eurasian and coastal North American populations are called brown bears, whereas interior North American bears are referred to as grizzlies. Common names such as “Kodiak bear”, “Alaskan brown bear”, “silvertip”, and “barren-ground grizzly” are vernacular only and are misleading as to the geographic distribution, morphology, or habitat association of the species. Taxonomy is as follows:

Class: Mammalia

Order: Carnivora

Family: Ursidae

Genus: *Ursus*

Species: *arctos*

Wide variation in phenotype across its broad distribution originally resulted in the description of more than 90 subspecies in North America (Merriam 1918). Refinement of taxonomic criteria later led to the widely accepted identification of 2 subspecies, *U. a. middendorffi*, from the Kodiak Island archipelago, and *U. a. horribilis*, from the remainder of North America (Rausch 1963). Subsequent reclassifications identified 3 (Kurtén 1973) or 7 (Hall 1984) North American subspecies.

Recent mitochondrial DNA sequence analysis of grizzly bears, however, disputes all of the historical North American classifications (Cronin *et al.* 1991; Waits *et al.* 1998). Four mtDNA lineage groups, or clades, have been distinguished in North America (Figure 1). Little congruity was noted between mtDNA phylogeny and the morphological variation used in previous subspecific categorization of grizzly bears, and the boundaries of each phylogeographic clade are not consistent with those of the currently accepted subspecies (Waits *et al.* 1998). However, Waits *et al.* (1998) argue against revision of the taxonomy of the grizzly bear based on the results from a single mtDNA region.

2.2 Description

Grizzly bears share the typical ursine body morph: large, muscular, and robust. Attributes that characterize members of the species include a prominent shoulder hump, concave facial profile, and long front claws (Figure 2). Considerable variation in physical appearance occurs among grizzly bears across their North American range. Pelage colour ranges from blonde through shades of brown to nearly black. Sexes are dimorphic, with males, on average, 1.8 times as heavy as females (Hilderbrand *et al.* 1999). Typical body mass for adult females ranges from 100 kg for interior populations to 200 kg for coastal bears (McLellan 1994). Adult males average 190 kg in interior populations, and 322 kg in coastal populations (McLellan 1994). Because body mass of bears increases greatly between spring and fall, then declines over winter, the season of capture strongly influences these data.

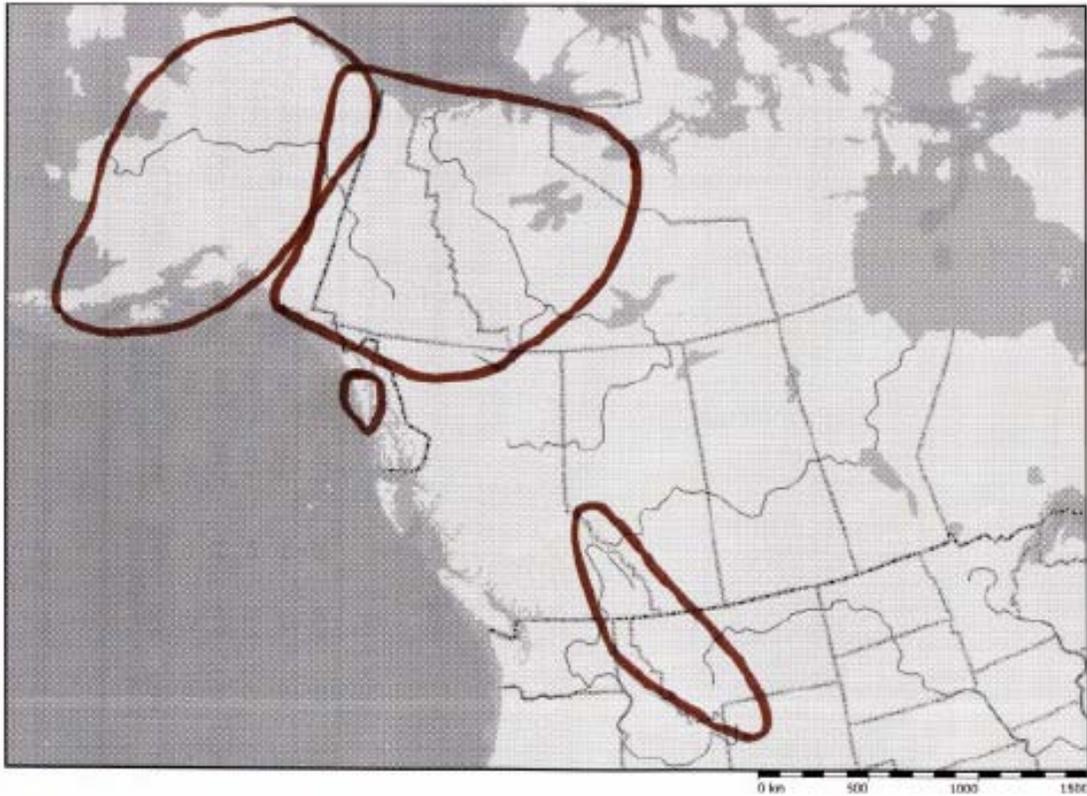


Figure 1. Four clades of grizzly/brown bears in North America defined by mtDNA sequence analysis. Note zone of overlap at Arctic National Wildlife Refuge in northeastern Alaska (see text). From Waits *et al.* (1998).



Figure 2. Immobilized adult female grizzly bear (*Ursus arctos*) in northeastern British Columbia. Note concave facial profile and long front claws. Photo by author.

2.3 Populations

Distinction of subpopulation units for grizzly bears in Canada is difficult. With the exception of a few isolated groups in southern BC, within their Canadian distribution (Figure 3), grizzly bears essentially occupy continuous habitat.

McLoughlin *et al.* (In Press) used multivariate cluster analysis of telemetry data to distinguish 3 population units of grizzly bears in the central Canadian Arctic. Population ranges for female bears were exclusive, but male population ranges overlapped. However, bears of both sexes emigrated out of their original population unit; up to 35% of males could be expected to emigrate from their source unit per year. Furthermore, genetic interchange among population units was likely. McLoughlin *et al.* (In Press) concluded that exchange rates among population units prevented distinction of any of the 3 as independent demographic units, and that the grizzly bear population in the central Arctic should be managed as one continuous population, and contiguous with adjacent populations outside his study area. At present, man-made barriers to grizzly bear movement do not occur in the Arctic and bear movements and dispersal are not compromised as they are in particular southern situations.

Genetic criteria have been used to distinguish Evolutionarily Significant Units (ESUs) and Management Units (MUs; Moritz 1994). An ESU is a group that has been isolated from conspecifics long enough to have undergone meaningful genetic divergence (Ryder 1986). An MU is a group within which population dynamics are driven primarily by birth and death rather than by immigration and emigration; MUs are populations with significant differences in allele distributions (Moritz 1994). However, both of these definitions are predicated upon geographic isolation of the units under consideration (Paetkau 1999).

Genetic analysis of grizzly bears from representative locations throughout the Canadian range does not support distinction of populations. Although 4 genetically defined groups, or clades, have been identified in North America (Figure 1), boundaries between clades are indistinct and have not been demarcated. Contact zones between clades cannot be ruled out; in fact, one has been identified in the Arctic National Wildlife Refuge (Waits *et al.* 1998). Intuitively, interchange of individuals among clades is to be expected because habitat between clade areas is essentially continuously occupied by grizzly bears, and the species is capable of and characterized by moderately high dispersal ability (LeFranc *et al.* 1987; Weaver *et al.* 1996; but see McLellan and Hovey 2001). At present, distinction of grizzly bear population units based on genetic criteria—with the exception of confirmation of genetic isolation—is not very useful to the evaluation of their status in Canada. Demographic data, including estimates of population size and trend, specific to individual clades are not complete enough to determine status of members of those clades. In addition, clade association has not yet been assigned for grizzly bears throughout much of their Canadian distribution, including most of British Columbia and the eastern Arctic (Waits *et al.* 1998), precluding definition of Canadian subpopulations on this basis.

2.3.1 Population Isolates in Southern British Columbia

Recent genetic investigations have determined that grizzly bears in the Southern Selkirk Mountains are isolated. This work is described in Section 2.3.2.

Grizzly bears in the North Cascade Mountains also occupy an insular habitat area. Connection to occupied bear habitat to the east and northeast is unlikely across a broad (70-160 km) unoccupied band, and has not been demonstrated except for a single translocated individual that returned (McLellan 1998; T. Hamilton, pers. commun.). Potential connectivity to occupied bear habitat to the northwest is impeded by a barrier consisting of the Fraser River, the Trans-Canada Highway, the Canadian Pacific and Canadian National railroads, and associated developments, and is also undocumented. Genetic confirmation of isolation in the North Cascades is not currently possible because of the paucity of samples from within the area.

The population within the North Cascades Grizzly Bear Population Unit (GBPU) was estimated to consist of <20 individuals (Province of British Columbia 1995) but may include up to 23 bears (NCGBRT 2001). However, recent, unsuccessful efforts to detect bears within the area (M. Austin, K. Romain, pers. commun.) suggest that even these estimates may be high. The Canadian portion of the North Cascades could support a population of 44-64 bears (Province of British Columbia 1995). A provincial recovery plan is being developed for the North Cascades (NCGBRT 2001). Recovery plan components under consideration include access management, prevention of internal fracture zones, restoration of linkages to external population units, and population augmentation. This population unit is contiguous to the south with the North Cascades Grizzly Bear Recovery Zone in the U.S., which is isolated from any other U.S. grizzly population (USFWS 1993). The population in the U.S. portion of the North Cascades is believed to be <20 bears (W. Kasworm, pers. commun.), and may be as low as 5 bears (Servheen 1999a), and population augmentation is being considered. Recent efforts to detect bears using DNA extracted from barbed-wire hair snags have been largely unsuccessful; in 5304 trap nights between 1998 and 2000 spanning both sides of the border, a single female grizzly bear was detected, on the Canadian side (K. Romain, pers. commun.).

At least 6 other population isolates have been identified in southern BC (T. Hamilton and B. McLellan, pers. commun.). Three of these occur within GBPUs which have been recognized by the province as Threatened. The status of these population isolates is described in Section 6.3.

Grizzly bears in other parts of Canada may exist in virtual isolation, but this has not been confirmed through documented geographic or genetic isolation. The southern fringe of grizzly bear distribution consists of several peninsular extensions (Figure 4; Section 2.3.2). Where these peninsulas are constricted, bear movement is compromised. Actual status of some of these "peninsulas" is unknown, and connectivity along them may in fact be inhibited or lost. Examples include the Kettle-Granby, Valhalla, Central Monashee, and Yahk GBPUs in south-central to southeastern BC

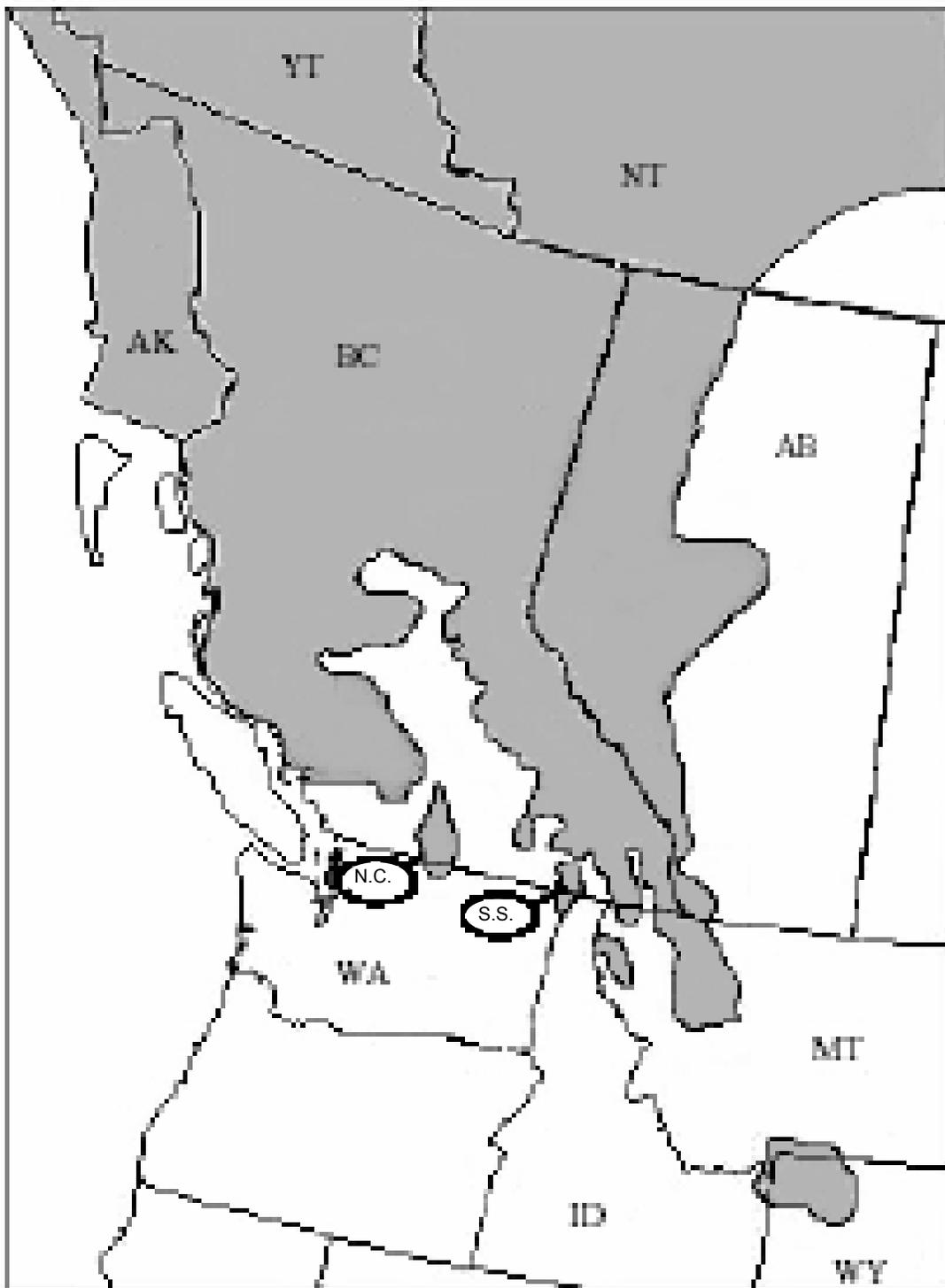


Figure 4. Approximate current distribution of grizzly bears in southwestern Canada (after McLellan 1998). Locations of North Cascades (N.C.) and South Selkirks (S.S.) population units are marked. Historic (ca. 1800) distribution included all mainland areas shown.

(Figure 11). Although complete population isolation has not yet been demonstrated, it is suspected by local authorities as a consequence of a combination of natural barriers and human development and activity zones (T. Hamilton, B. McLellan, pers. commun.; McLellan 1998), and each of these has been recognized by the Province of BC as a Threatened GBPU. In the southern Rocky Mountains of Alberta and BC, reduced genetic flow across the Trans-Canada Highway through Banff National Park, and across Highway 3 through the Crowsnest Pass, has been documented (M. Gibeau, M. Proctor, pers. commun.; Proctor *et al.* In Press).

2.3.2 Southern Selkirk Mountains Population

Prepared by Michael Proctor and Ian Ross.

2.3.2.1 Introduction

In this section we discuss the recent documentation of the genetic and demographic isolation of grizzly bears inhabiting a region in the Southern Selkirk Mountains of southern British Columbia. These data and their interpretation are significant as they demonstrate one possible mechanism for the slow process of anthropogenic isolation and local extinction which threatens the long term survival of grizzly bears, particularly at the southern edge of their North American distribution. There is particular relevance in that newly isolated units (population islands) of grizzly bears have an elevated risk of local extirpation. Furthermore, habitat peninsulas have a greater risk of turning into islands.

Geographic population isolation has both genetic and demographic consequences. The genetic isolation of small populations leads to loss of genetic diversity through genetic drift and increased inbreeding. Reduced genetic variability should decrease the population's ability to respond to future environmental changes because the breadth of genetic options has been reduced. In reality, a population's response to reduced genetic variability may not be so simple. For example, the brown bears on Kodiak Island, Alaska, have extremely reduced (one-third) genetic variability relative to mainland populations (Paetkau *et al.* 1998a), yet they have survived and apparently thrived for tens of thousands of years. A similar finding among Newfoundland black bears (Paetkau *et al.* 1998a) suggests that genetic variability may not be an immediate threat to bear populations in North America. Demographic isolation, however, may be more relevant in the modern landscape where an isolated small population may require immigrants from a nearby source population to offset population declines induced by anthropogenic habitat degradation and mortality.

Grizzly bears, at the southern edge of their North American distribution in southern Canada, inhabit relatively narrow "habitat peninsulas" corresponding to mountain ranges (Figure 4; McLellan 1998). There is an elevated risk of population isolation within these peninsulas with the associated risk of local extirpation, particularly for small populations.

Michael Proctor's PhD research has been investigating grizzly bear population fragmentation in southeastern British Columbia and southwestern Alberta. His very recent work has documented the existence of "habitat peninsulas" in the southern Selkirk and southern Purcell Mountains and the complete isolation of the grizzly bears in the southern Selkirk Mountains south of British Columbia Highway 3A. Proctor used 15 locus microsatellite genotypes and a log-likelihood population assignment test and related genetic distance measure (Paetkau *et al.* 1995; Paetkau *et al.* 1997; Paetkau *et al.* 1998b) to genetically characterize bears in specific geographic areas and to measure the migration patterns between these local populations.

2.3.2.2 Southern Selkirk grizzly bear population isolation

There are 3 types of genetic evidence, introduced here and discussed below, that suggest the grizzly bears in the southern Selkirk Mountains are genetically and demographically isolated from the adjacent grizzly populations in the region. One is the population assignment test that clusters individuals by their similar allele frequencies and compares that to their location (Paetkau *et al.* 1995; Waser and Strobeck 1999). Related to the assignment test is the genetic distance, D_{LR} , that quantifies the genetic distance between 2 populations (Paetkau *et al.* 1997). The third test is the standard population genetic measure of heterozygosity. In this context, we used relative expected heterozygosity as an index of relative genetic variability (Nei and Roychoudury 1974).

2.3.2.3 Genetic samples and southern Selkirk population boundaries

Genetic samples were obtained from several sources. The BC Ministry of Environment provided hair samples from the 1996 Central Selkirk Grizzly Bear Survey covering 9,866 km². The US Fish & Wildlife Service (W. Kasworm) provided samples from bears handled within the Yaak River area in northwestern Montana and southeastern BC, and Idaho Fish and Game (W. Wakkinen) provided samples from bears handled in the southern Selkirks within the US. M. Proctor collected hair samples from the southern Selkirks and the southern and central Purcells within Canada. All samples were collected in the 1990s, and most (90%) were collected since 1996. Samples from handled bears were extracted from blood or hair collected during capture events and all others were non-intrusively collected using scent lures and barb wire corrals as detailed in Woods *et al.* (1999).

The set of 45 samples representing the southern Selkirk Mountain population came from an area of approximately 8,000 km² south of the BC Highway 3A transportation corridor which parallels the west arm of Kootenay Lake between Balfour and Nelson. The eastern boundary was the Kootenay River and Kootenay Lake valley containing the towns of Creston BC and Bonners Ferry, Idaho. The western boundary for sampling was BC Highway 6 between Nelson and Salmo. This population extends south into Idaho to the southern limit of occupied habitat within the Selkirk Mountains (W. Wakkinen, Idaho Dept. of Fish and Game, pers. commun.); some samples were contributed from Idaho.

Immediately to the west of the southern Selkirks is a small area (1,440 km²) with very few grizzly bears (BC Wildlife Branch population estimate ~10 bears) that was not sampled. To the west of this area is an unoccupied zone south of Castlegar BC in the Trail BC area.

2.3.2.4 Evidence from the population assignment test

The assignment test uses allele frequencies from the populations to be compared. The likelihood of assignment to any population is the cumulative probability of occurrence of 30 alleles in this instance (15 loci/bear and 2 alleles/locus). Each bear is assigned to the population with the highest probability of assignment. Comparing 99 grizzly bears sampled from the Central Selkirk Mountains and 45 bears from the Southern Selkirk Mountains, Proctor found that all bears were assigned to the area of their capture (Figure 5). This result strongly suggests that of the sampled bears, there were no migrants between geographic areas and that all bears were captured in the area of their birth. The strong segregation of individuals corresponding to each geographic area (Figure 5) clearly separates the bears from the 2 populations based on their differing cumulative allele frequencies. The power of these results is enhanced by the relatively high percentage of bears that was sampled from each population. The 45 samples from the southern Selkirks represent approximately 40-55% of the entire (Canada plus US) estimated population of 97 (82-112) bears (extrapolated from Wielgus *et al.* 1994; BC Ministry of Environment estimate, G. Woods pers commun; W. Wakkinen, Idaho Dept. of Fish and Game, pers. commun.). The 99 samples from the central Selkirks represent approximately 40% of the estimated population in that area (256; Mowat and Strobeck 2000). Proctor also found a similar result when comparing the Southern Selkirk population to a sample of 22 bears from the Southern Purcell Mountains immediately to the east (Figure 6). The sample of 22 bears from the Purcells is small (but still >40% of estimated population: BC Wildlife Branch and W. Kasworm, pers commun.) but strongly suggests a separation of the 2 populations with no dispersal between the areas. The Southern Selkirk grizzly population appears to be completely isolated from the bears immediately to the north and east.

These assignment test results contrast sharply with comparisons of the Central Selkirk bears to the Northern Selkirk bears (Figure 7). Allele frequencies of these 2 areas are minimally separated with evidence of bears moving between areas. Bears in these 2 areas are clearly not genetically or demographically separate.

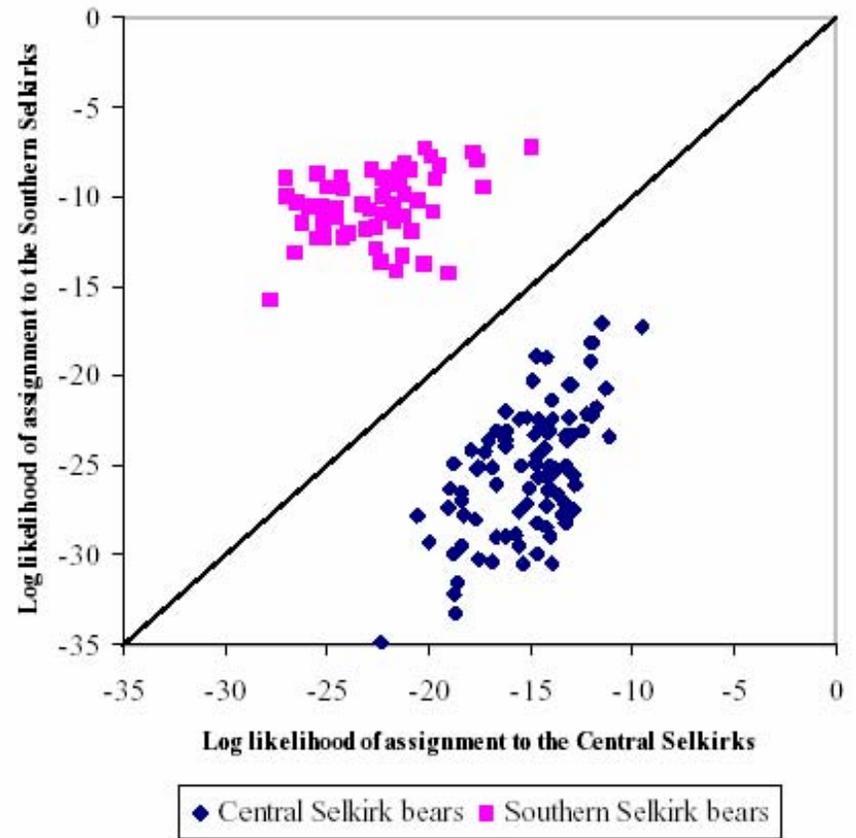
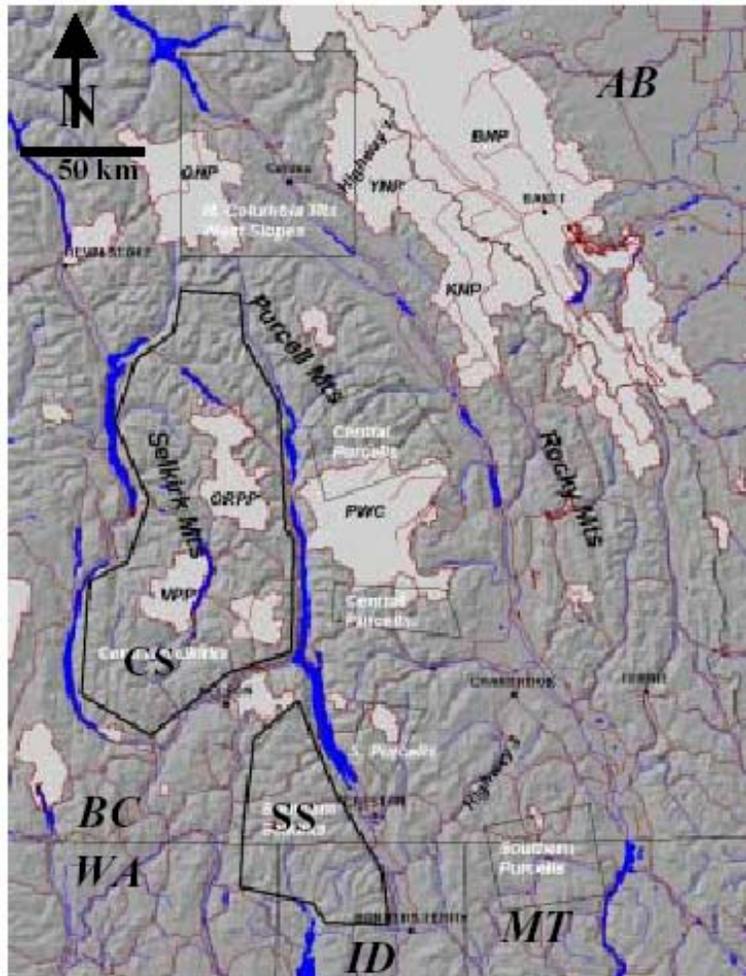


Figure 5. Map and population assignments of the Southern Selkirk (SS) and Central Selkirk (CS) Mountains grizzly bears.

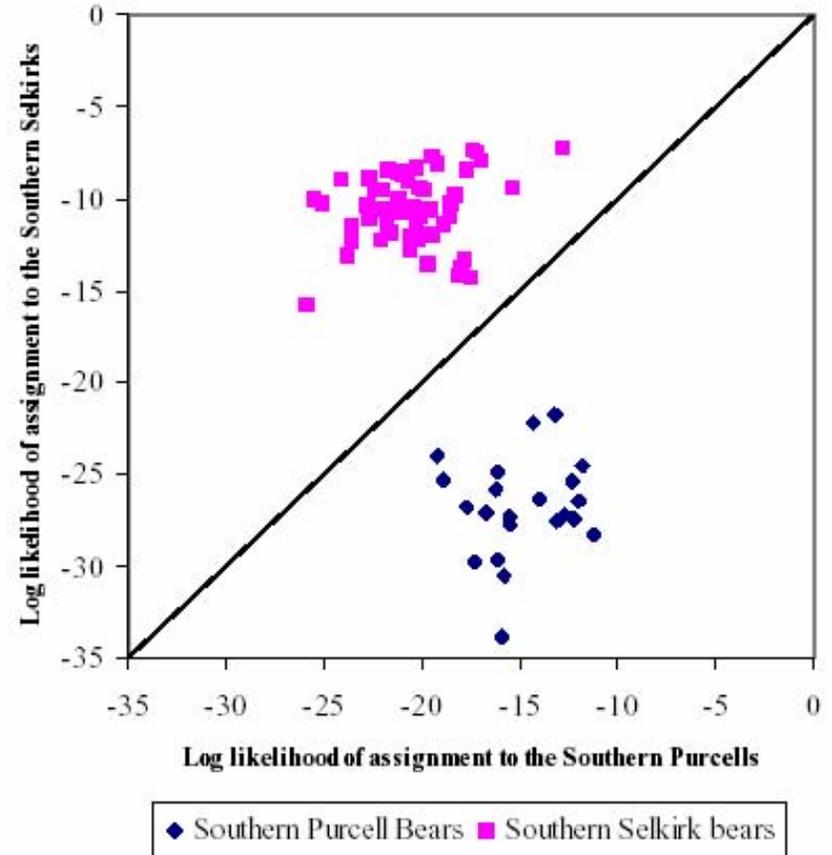
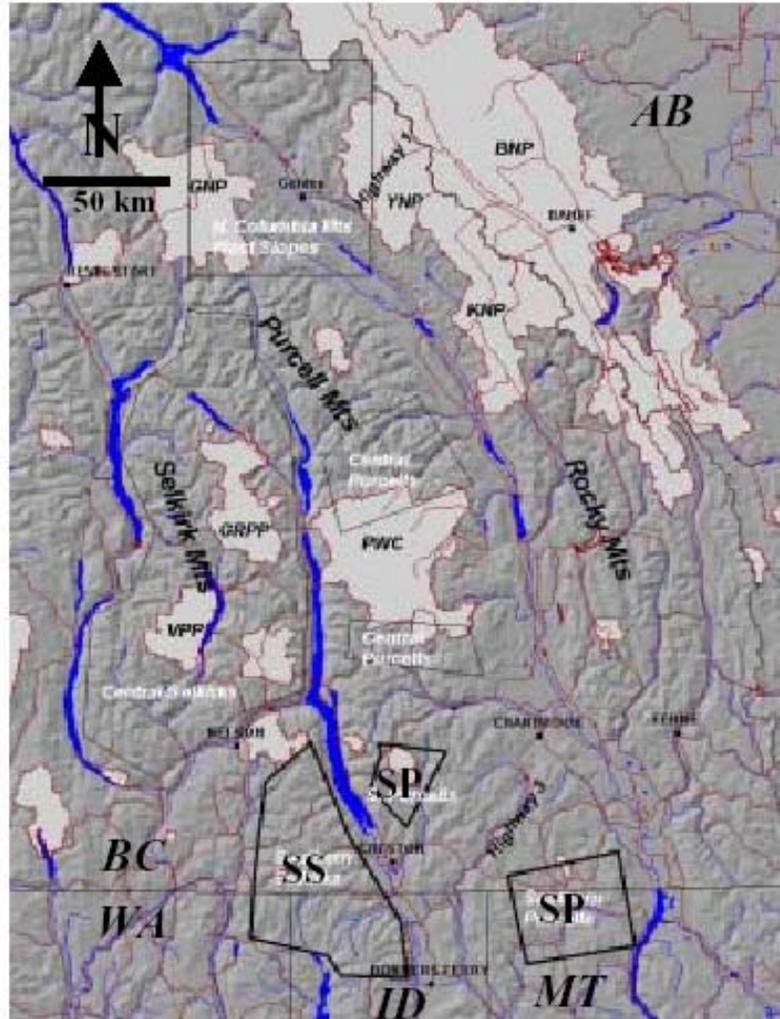


Figure 6. Map and population assignments of the Southern Selkirk (SS) and Southern Purcell (SP) Mountains grizzly bears.

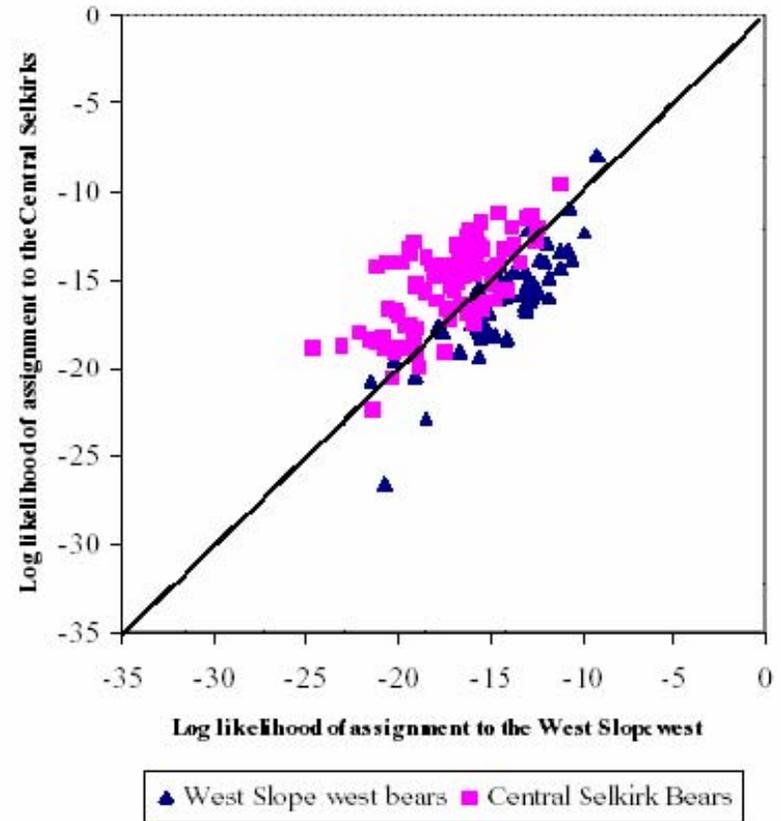
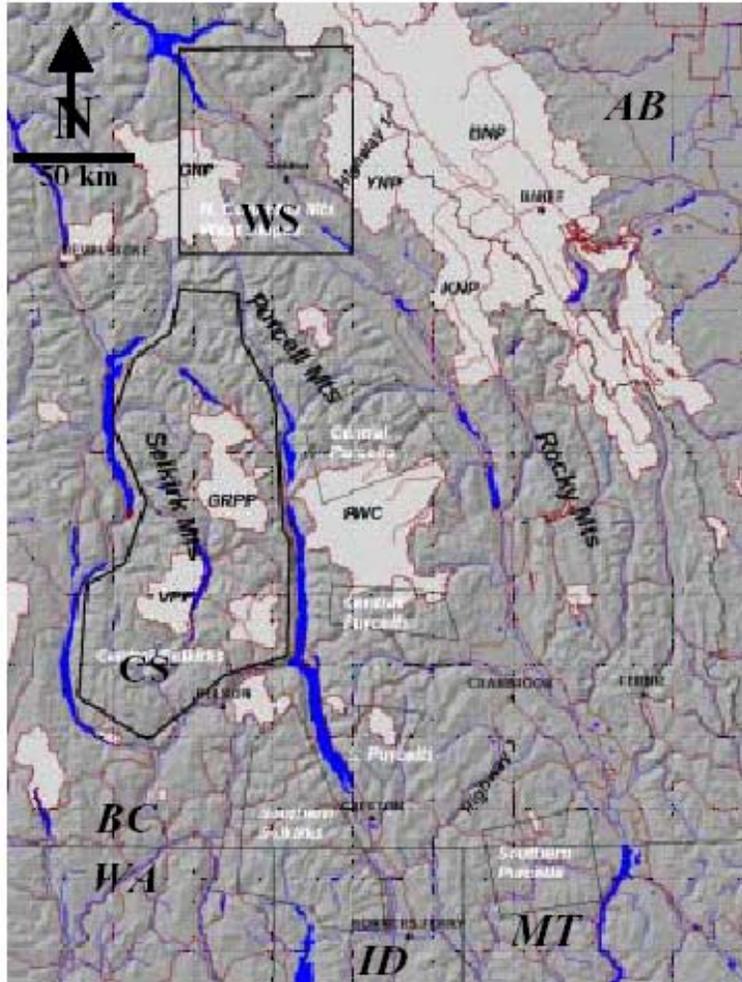


Figure 7. Map and population assignments of the Central Selkirk Mountains (CS) and the North Columbia Mountains west of the Columbia River (“West Slope”; WS) grizzly bears.

2.3.2.5 Evidence from genetic distance

Genetic distance is related to migration and mutation rates, population sizes, genetic drift, and time (Hartl and Clark 1997). While an exact relationship between genetic distance and movement rates has not been established, progress on this topic has been made. Using the same microsatellite loci used by Proctor, Paetkau *et al.* (1999) found that population pairs of polar bears (*U. maritimus*) with a genetic distance (D_{LR}) greater than 3.5 had no observed inter-population migrants. This result indicates that a threshold of genetic distance may exist above which migration is extremely limited or non-existent. The D_{LR} values found in Paetkau *et al.*'s (1999) polar bear population pairs ranged from 0 to 7.8 ($F_{st} = 0.002-0.108$). These polar bear populations are probably at equilibrium between mutation, migration, and genetic drift, and natural fractures are responsible for the observed population structure (Paetkau *et al.* 1999). Proctor measured the genetic distance (D_{LR}) between the southern and Central Selkirk grizzly populations at 11.4 ($F_{st} = 0.133$), far greater than the 3.5 threshold for “no migration” suggested by Paetkau *et al.* (1999). Furthermore, the southern Selkirk system is unlikely in equilibrium and the genetic distance of 8.5 is a conservative estimate. While D_{LR} is a relatively new genetic measure, Paetkau *et al.* (1997) found it correlated closely with more traditional genetic distance measures such as Nei's standard measure, D_s .

2.3.2.6 Evidence from loss of genetic diversity

Figure 8 shows the average heterozygosities of 8 grizzly bear assemblages in adjacent geographic areas (Figure 9) within southern BC and Alberta. When comparing the heterozygosity of all 15 loci between the Southern Selkirks and the immediately adjacent Central Selkirks, Proctor found that the average heterozygosity of grizzly bears in the Southern Selkirk Mountains (Figure 8) is lower than expected (paired sample t -test $p < 0.05$). These data suggest that this assemblage of bears has been genetically isolated for at least several generations. Loss of genetic diversity in small populations is dominantly mediated by genetic drift (Lacy 1987), a genetic random walk process driven by the small sub-sampling of alleles of breeding individuals between subsequent generations.

Using mean values for demographic parameters, Proctor estimated the time since isolation of the southern Selkirks grizzly bear population unit from the central Selkirk bears at 60 years. This calculation is a rough approximation based on several assumptions that are difficult to verify. Rather than being an exact documentation of time since isolation it provides a plausible framework for explaining the reduced heterozygosity displayed by the southern Selkirk grizzly bears. It assumes that the Central Selkirk and Southern Selkirk grizzly bears were connected in the past, had equal heterozygosities, and that the larger Central Selkirk population has not

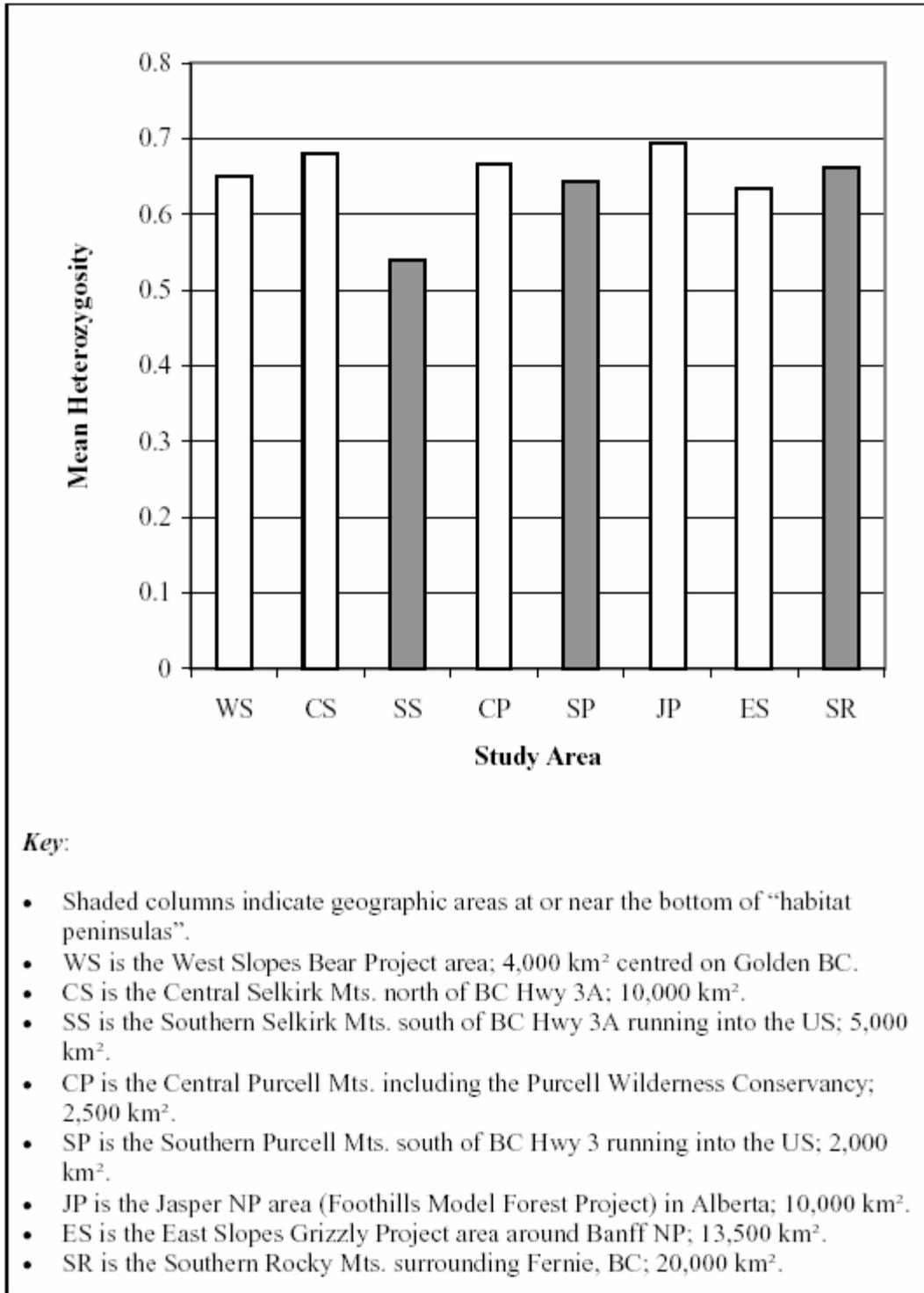


Figure 8. Average heterozygosity in grizzly bear populations in southeastern BC and southwestern Alberta. See Figure 9 for study area locations.

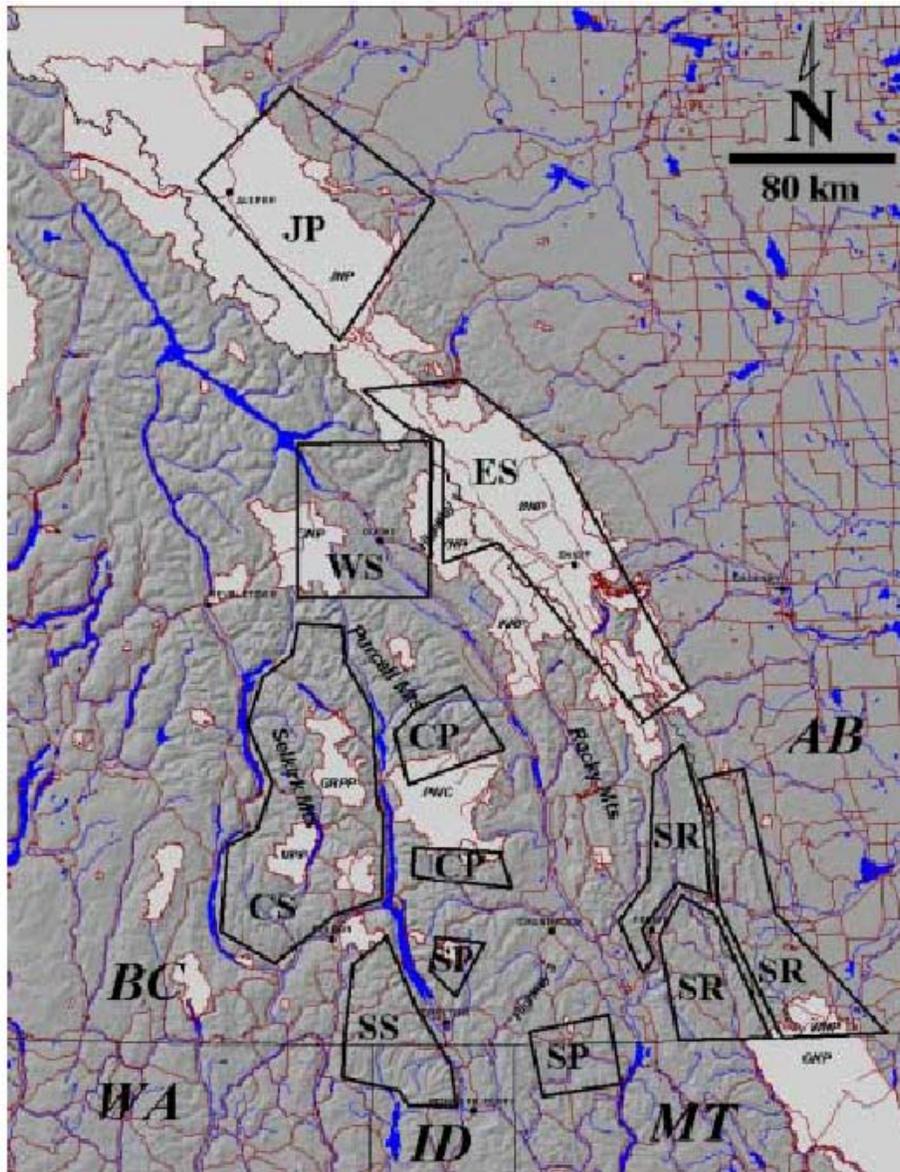


Figure 9. Location of study areas in southeastern BC and southwestern Alberta providing grizzly bear samples for evaluation of heterozygosity. Letter codes for areas are same as in Figure 8.

experienced a significant reduction in heterozygosity since isolation. It also assumes, probably incorrectly, that the isolation event was abrupt. Proctor also estimates grizzly generation time at 10 – 15 yrs (Allendorf and Servheen 1986; Craighead *et al.* 1995) and an effective population, N_e (number of breeders contributing to a subsequent generation), of 0.11 of the total population size (range = 0.04 - 0.19, Paetkau *et al.* 1998a).

A further indicator of reduced genetic diversity is the unbiased probability of identity (PI). The PI value represents the probability that 2 individuals selected at random from within a population will have identical genotypes at all 15 loci. For the Southern Selkirks

population unit, the PI was 1/822,000,000. By comparison, the PI for the Central Selkirks was 1/11,000,000,000,000, and for the Southern Purcells it was 1/2,000,000,000,000.

2.3.2.7 *Grizzly bear habitat peninsulas in southern British Columbia*

The isolation of the Southern Selkirk grizzly population from the Central Selkirks and the Southern Purcell grizzlies contrasts with the connectivity between the grizzlies in these same 2 mountain ranges just to the north. Results comparing the grizzlies in adjacent areas in the northern parts of the Selkirk and Purcell Mountain ranges suggest that bears are moving between the mountain ranges (Figure 10). These results suggest that the adjacent grizzly bear populations in the Southern Selkirk and Purcell Mountains are acting as two habitat peninsulas.

2.3.2.8 *Discussion*

Habitat fragmentation is considered to be a major threat to population, and ultimately species, persistence in modern conservation biology theory (Caughley and Gunn 1996). Habitat fragmentation, taken to an extreme, leads to population fragmentation. In the case of grizzly bears, particularly near the southern edge of their North American range, the peninsular nature of their currently occupied habitat makes them susceptible to anthropogenic population fragmentation resulting in habitat islands. These islands are at elevated risk of extirpation, particularly when there are fewer than 100 individuals in the island as is the case in the Southern Selkirks. This mechanism, coupled with human-induced habitat degradation and mortality, probably represents the major threat to long term grizzly bear persistence in southern Canada.

Proctor notes that there are two possible explanations for the lower heterozygosity and divergent allele frequencies of the southern Selkirk grizzlies. The Southern Selkirk population may be a remnant of a past separate population inhabiting land to the southwest of the west and south arms of Kootenay Lake, or the Southern Selkirks may be a recently pinched-off island that was previously connected to the northern populations through the central Selkirks. Proctor argues that the latter explanation is far more likely. He notes that the valley creating the fracture to the north is relatively narrow, holding the slow river-like west arm of Kootenay Lake. Until the recent past, Kootenay Lake had for centuries offered a landlocked salmon (*Oncorhynchus nerka*) run that spawned in many of its tributaries. At present this run is severely reduced, primarily kept alive in a controlled spawning channel. Other isolating mechanisms include a narrow strip of continuous human settlement lining the BC Highway 3A corridor. This highway is the modernization of an historic route that supported the development of the area's fruit-growing industry starting in the early 1900s. Twenty to forty years ago, calls to the Wildlife Branch of the BC Ministry of Environment to deal with nuisance grizzly bears were relatively common. Since 1990, these calls have all but ceased (G. Woods, pers. commun.). Besides the riparian habitat exclusion mediated by these settlements, decades of fire suppression in the valley have reduced early seral stage habitats yielding an even-aged conifer forest of low quality as grizzly bear habitat.

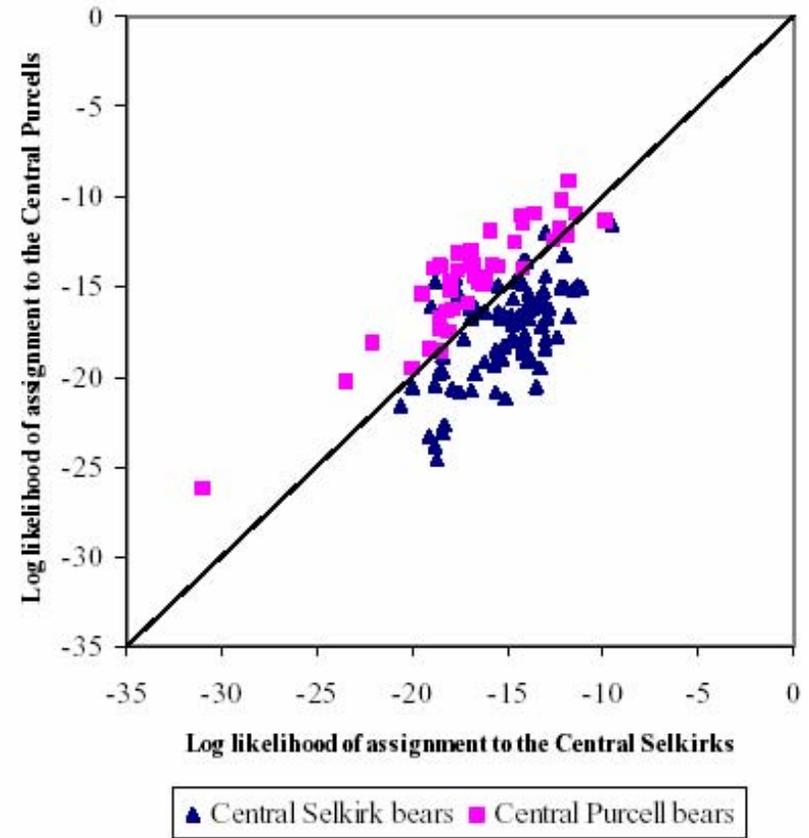
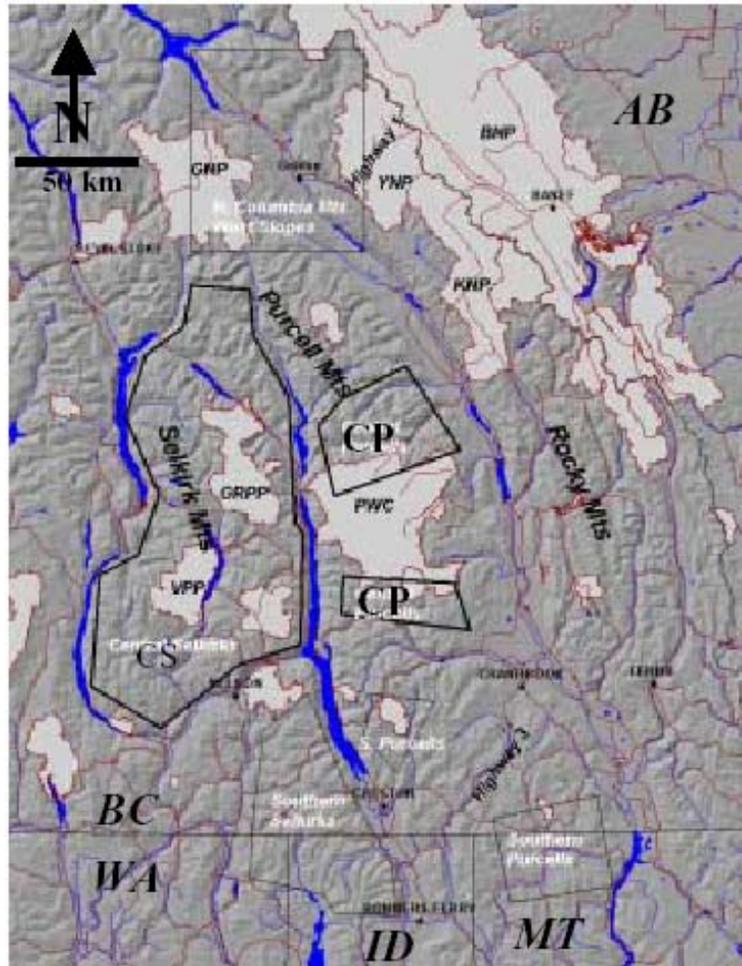


Figure 10. Map and population assignments of the Central Selkirk (CS) and Central Purcell (CP) Mountains grizzly bears.

To the immediate east of the Southern Selkirk population unit is the continuation of BC Highway 3A along the south arm of Kootenay Lake, as well as the town of Creston and associated agricultural developments. To the west is a relatively developed landscape of towns and agriculture in the vicinity of Arrow Lake and the Columbia River. The Southern Selkirk grizzly population is functionally an island.

While it is difficult to prove that the Southern Selkirk and Central Selkirk grizzly bears were connected in the past, a review of developments of the past century provides ample evidence to support the fragmentation hypothesis. Conversely, if the west arm of Kootenay Lake in its historic natural state had the potential to fracture grizzly bear populations, then innumerable other fractures would exist within grizzly bear distribution and the bulk of the Canadian grizzly population could not be considered a contiguous unit.

Proctor also argues that it is the context of the small population size (97 animals; see above) and 10% effective population size that provides an explanation of the divergent log likelihood population assignments that demonstrate the separation of these two populations. Furthermore, the southern Selkirk grizzly population possibly went through a population bottleneck from excessive human-induced mortality in the early part of the 20th century, hastening the genetic drift process.

In essence, the grizzlies in the Southern Selkirks and adjacent connecting lands likely experienced heavy human-related mortality in the early 1900s by activities of miners and farmers. This was further exacerbated in the last few decades by an increasingly dense and continuous human settlement separating the two populations.

There is nothing particularly unusual about this population fracture in that the conditions that most likely created it exist in many areas throughout western North America and southern BC, including other areas presently and recently occupied by grizzly bears. The problem has risen to the acute stage when combined with the narrow peninsular nature of occupied habitat in the region.

Proctor *et al.* (In press) report on the fragmentation of grizzly bear populations on both sides of BC Highway 3 as it crosses the Rocky Mountains in the Crowsnest Pass. They demonstrate that the highway corridor, with approximately 7,000 vehicles per day and non-continuous human development, has all but severed female grizzly movement and dispersal across the highway. They found evidence of male grizzly movement across the highway but argue that a greater-than-expected genetic distance across the highway corridor suggests limited and reduced male grizzly bear movement and gene flow.

2.3.2.9 Threats and population stability

Grizzly bear hunting was eliminated in the Southern Selkirks in 1995, but the last bear legally harvested was in 1991 (G. Woods, pers. commun.). Wielgus *et al.* (1994) reported that the Southern Selkirk population was tentatively stable, with threats to this condition being human-related mortalities. Recent research in the US (W. Wakkinen, Idaho Fish & Game, pers. commun.) reports that numbers may be on the rise as a

result of progress in reducing human-caused mortalities. No recent research within Canada has been conducted. Canadian wildlife managers for the area are aware of the threat of human-related mortalities but feel the situation is stable at present (G. Woods, pers. commun.). However, an island population with an estimated 97 animals with an effective population of 5 to 20 is clearly at risk of extirpation in the long term.

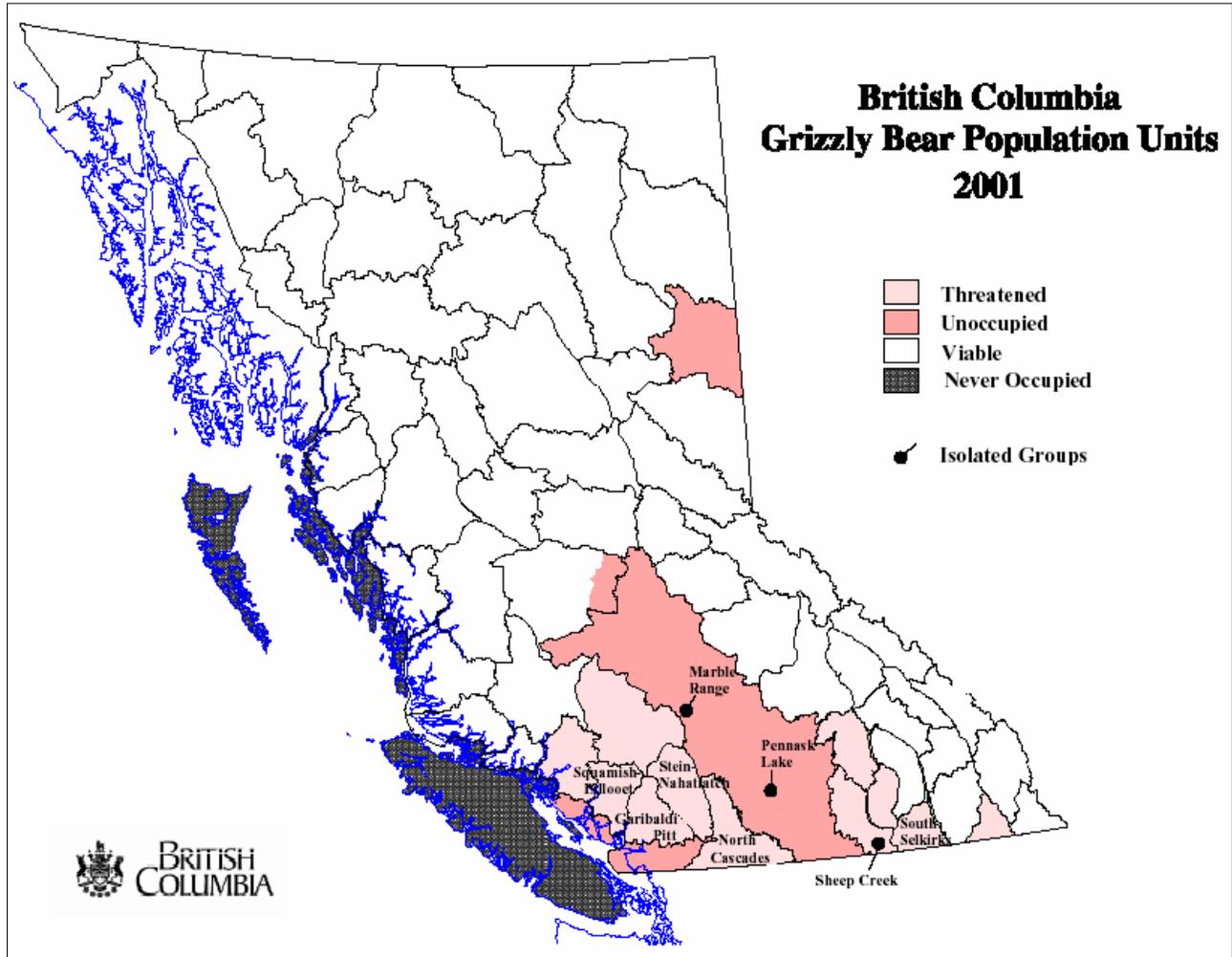


Figure 11. Grizzly Bear Population Units in British Columbia. Map courtesy of BC Ministry of Water, Land and Air Protection. Labeled GBPU are isolated (see text).

3. DISTRIBUTION

3.1 Global Range

Ursus arctos maintains a vast holarctic distribution (Figure 12). Populations are known or believed to occur in Canada, U.S.A., and at least 42 Eurasian countries (Servheen *et al.* 1999). Many Eurasian populations are insular, small, and endangered.

World-wide, the brown bear has lost an estimated 50% of its range and abundance since the mid-1800s (Servheen 1990). Within the contiguous lower 48 United States, grizzly bears have been eliminated from 98% of the range occupied in 1800 (Servheen 1999a).



Figure 12. Global distribution of grizzly/brown bears.

3.2 Canadian Range

The post-glacial distribution of *Ursus arctos* included nearly all of western Canada and extended well to the east. Fossil and other evidence indicates the bear's apparent prehistoric occurrence in Ontario (Peterson 1965) and Labrador (Elton 1954; Speiss 1976; Speiss and Cox 1977; Veitch and Harrington 1996).

The occurrence of grizzly bears in Labrador during historic times is a matter of contention. Labrador is specifically excluded from range descriptions for the species in most references (e.g., Banfield 1974, Servheen 1990, Pasitschniak-Arts 1993, McLellan and Banci 1999). However, Elton (1954) and Veitch and Harrington (1996) cite anecdotal reports of trade in bear skins, believed but not confirmed to be of grizzlies, in Labrador as recently as 1926. Veitch and Harrington (1996) attributed the extirpation of

grizzlies from Labrador to a dramatic decline in caribou abundance, coupled with human exploitation, and believed that the grizzly's extirpation facilitated colonization of Labrador tundra by black bears. Jonkel (1987) disputed the existence of the "Ungava grizzly", but acknowledged that individual bears may have wandered east of Hudson Bay. Based on available evidence, if a breeding population of grizzlies ever occurred in Labrador during historic times, densities and abundance must have been exceedingly low.

The grizzly bear in Canada currently occupies an estimated area of 2,574,000 km², or about 26% of the country's land mass (Figure 3). Massive range contraction in North America and Canada has occurred in the historical past, particularly in the Prairies (Figure 13). Primary reductions in the North American and Canadian range were concurrent with European settlement and the advent of firearms. However, no reduction in distribution in Canada has been documented since COSEWIC assigned a status of "Vulnerable" (later changed to Special Concern) to the grizzly bear in 1991.

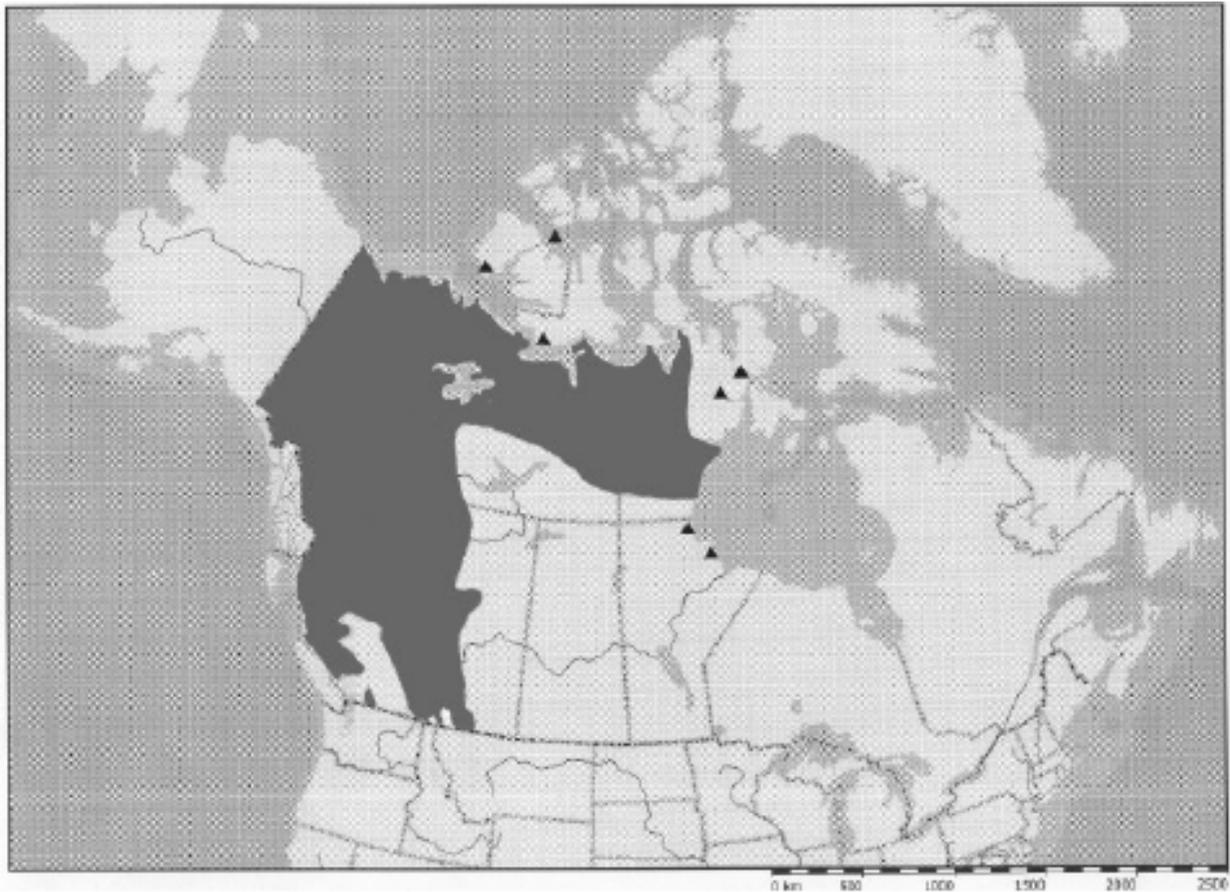


Figure 3. Current distribution of grizzly bears in Canada. Confirmed observations outside normally occupied range are identified by triangles.

4. HABITAT

4.1 Definition

Grizzly bears are habitat generalists. They can be found from sea level to high-elevation alpine environments. In Canada they occupy habitats as diverse as temperate coastal rain forests and xeric Arctic tundra. Although they have a carnivore's feeding and digestive anatomy, grizzly bears are functionally omnivorous and many are primarily herbivorous. Habitat associations are strongly seasonal and typically reflect local phenology. In mountainous regions this may result in seasonal migrations along an elevational gradient.

Grizzly bear habitat use has been widely described for most ecoregions (e.g., Schwartz *et al.* In press). This report focuses on contributions to the literature over the past 10 years, and especially those specific to Canada.

Habitat-use patterns of grizzly bears in the central Arctic have been recently described. Gau (1998) defined 5 bear seasons according to observed changes in bear diets, and used direct observations to assess habitat selection. During spring, bears selected bedrock habitats and other relatively snow-free sites. Wetland types, especially those with cover, were selected during early and mid-summer. In late summer, bears concentrated on eskers (ridges of gravel and sand established by melting glaciers), coincident with the ripening of berries. Habitats selected during fall were wetlands and mesic or mat tundra.

McLoughlin *et al.* (2002a) used resource selection functions, satellite telemetry data, and classified Landsat imagery to evaluate habitat use by grizzly bears in the same area of the central Arctic. Bears generally selected home ranges with disproportionate prevalence of esker, tussock/hummock successional tundra, lichen veneer, birch seep, and tall shrub riparian habitats. Within individual home ranges, bears selected eskers and riparian tall shrub habitats.

The high-density of an interior grizzly bear population in southeastern British Columbia was attributed mostly to productive berry fields resulting from extensive wildfires 50-70 years earlier (McLellan and Hovey 2001a). Avalanche chutes and riparian patches were important habitats in this area before and after berry season. Regenerating cutblocks were avoided during all seasons.

Physiographic and vegetative descriptions of grizzly bear habitats exist for many parts of Canada. However, anthropogenic attributes are increasingly taking precedence over biophysical features as determinants of grizzly bear habitat quality. Human activities can influence how bears are able to use potential habitat. In areas where bears are not habituated, they avoid zones of human activity (McLellan and Shackleton 1988; McLellan 1990). The resulting reduction in habitat effectiveness can extend over a land area much larger than that occupied by the development itself. Consequently, assessments of grizzly bear habitat commonly apply indicators of residual habitat

effectiveness in consideration of the secondary effects of human activities (USDA For. Serv. 1990; Gibeau 1998, 2000). Recently, efforts to model security areas for grizzly bears (areas where bears can meet their energetic needs while choosing to avoid humans) have been used to help direct land-use planning for grizzly bear conservation (Gibeau *et al.* 2001). Security areas are those which consist of suitable habitat, are large enough to meet minimum daily area requirements for foraging, and which are outside of zones of influence of human activities. In southern Alberta and BC, Gibeau *et al.* (2001) estimated that minimum size of grizzly bear security areas was 9 km². Minimum areas required to meet energetic needs can be expected to vary among environments. For example, in richer coastal areas, minimum areas may be smaller. On the Arctic tundra, minimum areas may be much larger.

4.2 Trends

Trends in habitat availability for grizzly bears in Canada since 1990 are not pronounced. Relative to the vast area of occupancy, little habitat has been directly lost. However, declines in habitat effectiveness have been documented in some areas and are likely in many others (e.g., Gibeau 1998). Increases in human developments, and particularly access, have degraded habitat quality throughout most of grizzly bear range.

4.3 Protection/Ownership

4.3.1 Protected Areas

Protected areas occur throughout grizzly bear distribution in Canada. In total, approximately 214,616 km² of land within the current distribution is classified as protected (Tables 1, 2). This represents about 6.2% of the estimated total extent of occurrence in Canada, and about 8.3% of the estimated area of occupancy. This total, and the following discussion, excludes numerous small (generally <50 km²) protected areas. It is clear that most Canadian grizzly bears live on multiple-use lands.

Table 1. Federally designated protected areas within grizzly bear distribution in Canada.

Name and Location	Land area (km ²)	First Nations subsistence hunting?
Waterton Lakes National Park, AB	525	no
Banff National Park, AB	6,641	no
Jasper National Park, AB	10,878	no
Kootenay National Park, BC	1,406	no
Yoho National Park, BC	1,310	no
Glacier National Park, BC	1,350	no
Mt. Revelstoke National Park, BC	260	no
Kluane National Park, YT	22,015	yes
Ivvavik National Park, YT	10,170	yes
Vuntut National Park, YT	4,345	yes
Nahanni National Park, NT	4,766	yes
Tuktut Nogait National Park, NT	16,340	yes
Thelon Wildlife Sanctuary, NT/NU	52,000	no
Total	132,006	

Table 2. Summary of provincial and territorial protected areas within grizzly bear distribution in Canada.

Location and Type	Land area (km ²)	Comments
Alberta		
Provincial Parks	874	Excludes Wildland Parks and other protected areas with various land-use restrictions
Wilderness Areas	1,010	
British Columbia		
Yukon		
Territorial Parks	7,632	Grizzly bear hunting permitted
Kluane Wildlife Sanctuary	6,450	
Northwest Territories and Nunavut		Several Territorial Parks, but with very small land areas
Total	82,610	

“Protected Areas” can mean different things. For example, hunting in provincial parks is prohibited in Alberta, but permitted in much of BC. National parks preclude consumptive use of natural resources, except that in the north subsistence hunting by First Nations is generally allowed. Particularly in southern Canada, activities including intensive recreational, residential, and infrastructure developments, and which may be clearly detrimental to grizzly bears, are commonly permitted in areas classified as protected. For this report, “Protected Areas” refers to areas which prohibit resource extraction industries, such as mining and timber harvest, and which have a mandate to generally protect grizzly bear habitat. However, since grizzly bear hunting is permitted in some of these areas, accidental, illegal, or management mortalities may continue, and habitat alteration may occur, not all can be considered grizzly bear sanctuaries.

Bear populations within each protected area are contiguous with areas outside park boundaries, and in some cases (e.g., Waterton Lakes and Revelstoke National Parks), protected areas may be too small to completely protect the entire home range of even a single bear. Other, larger, parks protect some resident bears, but those populations may be too small to be viable on their own. Most likely, protected areas may serve as core refugia, but are dependent on adjacent, unprotected areas to sustain viable bear populations.

In most cases, protected areas were established with primary goals other than grizzly bear conservation. As such, and because in most areas grizzly bears have very specific seasonal habitat requirements, many protected areas do not include substantial areas of high-quality bear habitat, and the best habitats may lie outside protected areas. This may be particularly true in mountainous areas where scenic values inspired creation of parks which are comprised largely of rock and ice.

4.3.1.1 Alberta

Three National Parks, 5 Provincial Parks, and 3 Wilderness Areas protect grizzly bears and 19,928 km² of bear habitat in Alberta. This is 10% of the estimated 200,000 km² (Alta. Env. Prot. 1997) of occupied grizzly bear range in Alberta. Additional areas such as Wildland Parks, Natural Areas, and Ecological Reserves, provide some restrictions on land-use activities, but their status varies and many are small relative to grizzly bear life history needs.

4.3.1.2 British Columbia

Four National Parks within grizzly bear range in BC exclude resource extraction and hunting on a total of 4,326 km². Province-wide, there are 717 Provincial Parks, Recreation Areas, and Ecological Reserves, totalling 97,552 km². Some of these are outside grizzly bear distribution, many are very small, and land-use restrictions are variable. Resource extraction is prohibited in 61 larger (>50 km²) Provincial protected areas totalling 67,142 km² within grizzly bear range, but hunting is permitted in nearly all of them. One protected area, Khutzeymateen Provincial Park (443 km²), was established specifically as a grizzly bear sanctuary, and hunting there is prohibited below 1,000 m elevation above sea level. Grizzly bears occupy about 750,000 km² in BC, and “protected” areas cover about 9.5% of that.

4.3.1.3 Yukon

Three relatively large National Parks in the Yukon protect a total of 36,530 km² of potential grizzly bear habitat. Aboriginal subsistence hunting is permitted in all. Resource extraction and other habitat perturbations are also restricted in Tombstone Territorial Park, Fishing Branch Wilderness Reserve, and the Kluane Wildlife Sanctuary. Protected areas in the Yukon total 50,612 km², about 10.5% of the Territorial area.

4.3.1.4 Northwest Territories and Nunavut

Grizzly bears occur within 2 National Parks in Northwest Territories, but none in Nunavut. First Nations hunting is permitted in both. The Thelon Wildlife Sanctuary straddles the NWT/Nunavut boundary and excludes all hunting or resource extraction. The total protected area is 73,106 km².

4.3.2 Land Ownership

The majority of grizzly bear habitat in Canada is publicly owned. Public land comprises 92% of British Columbia and 60% of Alberta. Private lands in both provinces are concentrated in the south and in urban areas, and disproportionately include areas outside grizzly bear distribution. Therefore, public land ownership within grizzly bear distribution is likely higher than the provincial averages, especially in Alberta. Almost all land in the Yukon, Northwest Territories, and Nunavut is publicly owned.

5. GENERAL BIOLOGY

5.1 General

The essential biology of the grizzly bear has been thoroughly described, and excellent reviews can be found in LeFranc *et al.* (1987), Pasitschniak-Arts (1993), Craighead *et al.* (1995), Pasitschniak-Arts and Messier (2000), and Schwartz *et al.* (*in press*). The following sections address recent advances in the knowledge of life-history characteristics that are pertinent to the species' status.

5.2 Reproduction

Age at primiparity, litter size, and interbirth interval for grizzly bears are variable, and appear to be influenced by habitat quality (Hilderbrand *et al.* 1999; Ferguson and McLoughlin 2000). Typically, females produce their first litters at 5-7 years of age, and have litters of 1-3 cubs about every 3 years (Schwartz *et al.* *in press*). Successful first breeding has been documented for females as young as 3.5 years (Aune *et al.* 1994; Wielgus and Bunnell 1994) and as old as 9.5 years (Case and Buckland 1998). Some reproductive parameters for grizzly bears in and near Canada are presented in Table 3.

5.3 Survival

Survival rates in grizzly bear populations have been estimated in several Canadian locations (Table 4). Direct comparisons among studies is confounded by the variety of means used to estimate rates (Schwartz *et al.* *in press*), but general trends are apparent. Adult female survival is typically high (>0.90). Adult male survival tends to be lower, particularly in hunted populations, due to legal protection of females with young, in concert with hunter preferences for larger bears. Subadult survival is variable, but is typically relatively low for males. In most populations, survival of cubs is lowest of all age classes, but increases for yearlings.

5.4 Physiology

The most notable element of grizzly bear physiology are those features related to denning. Although some grizzly bears in some areas do not den every year (Van Daele *et al.* 1990; Murphy *et al.* 1998), lack of food and harsh weather compels most bears to hibernate during winter. Duration of denning depends on the class of bear; pregnant females generally enter dens first and emerge last, and adult males usually spend the shortest time denned. The duration of den occupancy is also related to latitude, with bears at higher latitudes generally entering dens earlier and remaining denned longer (Schwartz *et al.* *In Press*). Grizzly bears in Banff National Park spent, on average, about 4.5 months each year in dens (Vroom *et al.* 1980). In the central Canadian Arctic, average duration of den occupancy was 185 days (6.2 months) for males and 199 days (6.6 months) for females (McLoughlin *et al.* 2002*b*). On the Tuktoyaktuk Peninsula, bears were estimated to occupy dens for 6-7 months per year (Nagy *et al.* 1983*a*).

Table 3. Estimated reproductive parameters of grizzly bears in and adjacent to Canada. Rates were estimated using various methods and comparisons must be made cautiously.

Location	Age (yrs) ¹ at first litter		Litter size ²		Interbirth interval (yrs)		Reference
	Mean (n)	Range	Mean (n)	Range	Mean (n)	Range ³	
Flathead River, BC	6.0 (5)	5 - 8	2.3 (31)	1 - 3	2.7 (9)	1 - 4	McLellan 1989c
N. Continental Divide, MT	5.7 (10)	4 - 7	2.1 (56)	1 - 4	2.7 (16)	2 - 4	Aune <i>et al.</i> 1994
Tuktoyaktuk Peninsula, NT	5.9 (10)	5 - 8	2.3 (18)	1 - 3	3.3 (8)	3 - 4	Nagy <i>et al.</i> 1983a
Kananaskis, AB	5.5 (3)	3 - 6	1.4 (5)	—	3.0 (3)	—	Wielgus and Bunnell 1994
Selkirk Mountains, US / BC	7.3 (5)	6 - 7	2.2 (10)	2 - 3	3.0 (6)	2 - 4	Wielgus <i>et al.</i> 1994
Khutzeymateen Valley, BC	—	—	2.4 (8)	1 - 3	—	—	MacHutchon <i>et al.</i> 1993
Swan Mountains, MT	5.7 (3)	4 - 8	1.6 (17)	1 - 2	3.0 (6)	2 - 4	Mace and Waller 1998
Mackenzie Mountains, NT	—	8 - ?	1.8 (6)	—	3.8 (5)	—	Miller <i>et al.</i> 1982
Kluane National Park, YT	6.7 (7)	6 - 8	1.7 (11)	—	—	3 - 4	Pearson 1975
Richardson Mountains, NT	—	5 - 6	2 (?)	—	—	—	Nagy and Branigan 1998
Kugluktuk, NU	8.7 (6)	7 - 10	2.3 (19)	1 - 4	2.6 (8)	1 - 4	Case and Buckland 1998
Anderson-Horton Rivers, NT	10.8 (12)	6 - ?	2.3 (37)	1 - 3	4.3 (15)	3 - 5	Clarkson and Liepins 1993
Brock-Hornady Rivers, NT	—	5 - 6	1.5 (?)	—	—	—	Nagy and Branigan 1999
Berland River, AB	—	6 - ?	1.8 (5)	1 - 3	—	—	Nagy <i>et al.</i> 1988
Northern Yukon, YT	—	6 - 8	2.0 (6)	1 - 3	—	3 - 5	Nagy <i>et al.</i> 1983b
Eastern Slopes, AB	6.7 (8)	6 - 12	1.9 (24)	1 - 3	3.8 (24) ⁴	2 - 7+	Garshelis <i>et al.</i> 2001

¹ Ignores "half-years"; e.g., ages reported as 6.5 were considered to be 6 years old.

² Cubs of the year.

³ Includes some litters that died.

⁴ Includes 8 complete intervals (mean = 3.4 yrs). Adding 16 incomplete intervals and assuming next litters were born at the minimum interval yields a mean of 3.8 years. Modelling to account for litters born later than the minimum interval lengths yields a mean of 5.0 yrs.

Table 4. Estimated annual survival rates of grizzly bears in and adjacent to Canada. Rates were estimated using various methods and comparisons must be made cautiously.

Study	Location	Hunted?	Adult		Subadult		Yearling	Cub	Reference
			Male	Female	Male	Female			
1	Flathead River, BC *	Y	0.92	0.94	0.92	0.94	0.88	0.82	McLellan 1989b
2	Flathead River, BC *	Y	—	0.95	—	0.93	0.94	0.87	Hovey and McLellan 1996
3	North Fork Flathead, BC / MT *	Y	0.89	0.96	0.78	0.94	—	—	McLellan <i>et al.</i> 1999
4	Kananaskis, AB	Y	0.70	0.93	0.89	0.89-0.93	— ¹	0.78	Wielgus and Bunnell 1994
5	Blackfeet-Waterton, MT / AB	Y	0.63	0.92	0.80	0.86	—	—	McLellan <i>et al.</i> 1999
6	Mountain Parks, AB / BC	N	0.89	0.91	0.74	0.95	—	—	McLellan <i>et al.</i> 1999
7	South Fork Flathead, MT	N	0.89	0.89	0.78	0.87	—	—	McLellan <i>et al.</i> 1999
8	Selkirk-Yaak, US / BC **	N	0.84	0.95	0.81	0.93	—	—	McLellan <i>et al.</i> 1999
9	Selkirk Mountains, US / BC **	N	0.81	0.96	0.90	0.78	— ¹	0.84	Wielgus <i>et al.</i> 1994
10	Swan Mountains, MT	N	—	0.90	—	0.83	0.91	0.79	Mace and Waller 1998
11	Interior Mountains, US / CAN ²	Y/N	0.88	0.93	0.80	0.92	—	—	McLellan <i>et al.</i> 1999
12	Eastern Slopes, AB	N	—	0.95-0.96	—	0.89-0.95	0.88	0.78	Garshelis <i>et al.</i> 2001

*, **Rates calculated within same study, sharing some data, over a different period or with different methods.

¹Included with cubs.

²Combined data from studies 3, 5, 6, 7, 8.

The physiology of hibernating bears is complex and interesting, and is reviewed in Hellgren (1998). Essential elements of bear hibernation include the maintenance of survival metabolic costs through catabolism of stored fat and protein, and the lack of urination or defecation for very long periods. For pregnant females, which give birth during the denning period, costs of latter-stage gestation and lactation must also be met in the absence of foraging. Weight loss in hibernating wild bears over the denning period has ranged from 16 to 37% (Hellgren 1998). In Alaska, adult females lost an average of 73 kg (32%) of body mass over winter (Hilderbrand *et al.* 2000). Most (56%) of this mass loss was fat. Females emerging from dens with cubs or yearlings were lighter than solitary females, and had less fat and lower lean body mass, indicating the relative costs of hibernation, gestation, and lactation. Total body fat during early summer dropped to as low as 6.3% of body mass in grizzly bears in the central Canadian Arctic, and climbed as high as 33.6% in autumn (Gau 1998).

Preparation for a long fast includes hyperphagia, particularly of high-caloric foods such as berries and carcasses. This compulsion to generate fat stores adequate to minimize muscle catabolism during the denning period drives foraging and directs much grizzly bear behaviour during late summer and autumn. For example, grizzly bears in central coastal British Columbia roamed widely during berry season, using 10 berry species in divergent habitats (Hamilton and Bunnell 1987), and fall migrations to salmon streams have been widely reported for coastal bear populations (LeFranc *et al.* 1987).

5.5 Movements/Dispersal

5.5.1 Home Range

As with most species, home range size in grizzly bears is negatively correlated with general habitat quality. Bears with access to predictably abundant, high-quality foods and long growing seasons, such as in temperate coastal areas, tend to have small home ranges. For example, home ranges on Admiralty Island, Alaska, averaged 115 km² for males and 24 km² for females (Schoen *et al.* 1986). Bears living in dryer and colder interior or northern environments typically require much larger home ranges. The largest reported grizzly bear home ranges are from the central Canadian Arctic; they are up to 2 orders of magnitude larger than coastal Alaskan home ranges (Table 5). Home ranges are typically several times larger for male bears than for females, presumably due to male breeding activity and perhaps influenced by the increased energetic demands of larger body size (Gau 1998; McLoughlin *et al.* 1999).

Local climate affects grizzly bear home range size by influencing primary productivity, and thereby food availability and accessibility (McLoughlin and Ferguson 2000). Most grizzly bear home range sizes in Canada lie between the extremes cited above, as do the applicable climatic conditions. Typical grizzly bear home ranges, however, are large irrespective of location (Table 5).

Table 5. Estimated density and adult home range sizes (100% minimum convex polygon) for grizzly bear populations in Canada. Densities are based on radio telemetry studies, except where noted. Grizzly bear zone refers to descriptions by Banci (1991); see Table 12.

Study area	Grizzly bear zone	Density ¹ (bears/1,000 km ²)	Home range size (km ²)		Source
			Males	Females	
Northern Yukon, YT	1	26 - 30	645	210	Nagy <i>et al.</i> 1983b
Richardson Mountains, NT	1	19			Nagy and Branigan 1998
Anderson-Horton Rivers, NT	1	8.2 - 9.1	3,433	1,182	Clarkson and Liepins 1994
Brock-Hornady Rivers, NT	1	6			Nagy and Branigan 1998
Tuktoyaktuk Peninsula, NT	1	4	1,154	670	Nagy <i>et al.</i> 1983a
Ivvavik National Park, YT	1		435	144	MacHutchon 1996
Central Arctic, NT / NU	1,2	3.5	8,171	2,434	Penner 1998; McLoughlin <i>et al.</i> 1999
Mackenzie Mountains, NT	4	12		265	Miller <i>et al.</i> 1982
Kluane National Park, YT	5	37	287	86	Pearson 1975
Prophet River, BC ⁵	5,6	14.5 - 16.9			Boulanger and McLellan 2001 ²
Prophet River, BC ⁵	5	29			Poole <i>et al.</i> 2001 ²
Prophet River, BC ⁵	6	10			Poole <i>et al.</i> 2001 ²
Swan Hills, AB	6	7.4 - 9.6	244	113	Nagy and Russell 1978
South Wapiti, AB	6	7.4			<i>cited in</i> Nagy and Gunson 1990
Berland River, AB	6	4.6	1,918	252	Nagy <i>et al.</i> 1988; Nagy and Gunson 1990
Yellowhead, AB	6,10	14.9	1,733	668	Boulanger 2001 ² ; Stenhouse and Munro 2001
Hart Ranges, BC	7	49	77	47	Mowat <i>et al.</i> 2001 ² ; Ciarniello <i>et al.</i> 2001
Khutzeymateen Valley, BC	8	43 - 90	125	52	MacHutchon <i>et al.</i> 1993
Upper Fraser Basin, BC	9	12	1,697	326	Mowat <i>et al.</i> 2001 ² ; Ciarniello <i>et al.</i> 2001
Central Selkirk Mountains, BC	10	26.6			Mowat and Strobeck 2000 ²
Selkirk Mountains, BC	10	14.1			Wielgus <i>et al.</i> 1994
West Slopes, BC	10		318	89	Woods <i>et al.</i> 1997
Jasper National Park, AB	10	9.8 - 11.7	948 ³	331 ³	Russell <i>et al.</i> 1979
Flathead River, BC	12	57 - 80	668	253 ⁴	McLellan 1989a; B.N. McLellan, pers. commun.
Kananaskis, AB ⁵	12	16.2			Wielgus and Bunnell 1994
Kananaskis, AB ⁵	12	12.2 - 14.5	1,183	179	Carr 1989
Crowsnest, AB	12	15			Mowat and Strobeck 2000 ²
Central Rockies, AB & BC	12	9.8 - 16	1,560	305	Gibeau <i>et al.</i> 1996; Gibeau and Herrero 1997

¹Techniques for calculation of densities vary across studies, so comparisons must be made cautiously.

²DNA-based study.

³Weighted means as reported by McLoughlin *et al.* 2000.

⁴Includes only females with cubs.

⁵Different analyses and/or interpretations of the same data set.

Although habitat quality determines minimum home range size required to meet energetic needs, actual home range size used by grizzly bears may be influenced by population density. Nagy and Haroldson (1990) concluded that reduced bear density resulting from man-caused mortalities suppressed competition for resources, including space, and permitted use of larger areas.

5.5.2 Movements

Male grizzly bears generally have higher rates of movement than do females (LeFranc *et al.* 1987). In the central Canadian Arctic, male grizzly bears move faster than females in all seasons (McLoughlin *et al.* 1999). Movement rates of males were highest in spring, when energetic demands are high and males seek mates, and generally declined through autumn. Female movement rates peaked during summer when, in this area, food availability was considered low.

In some mountainous areas, an annual pattern of altitudinal migrations is typical in response to seasonal changes in vegetation phenology and the availability of other foods (LeFranc *et al.* 1987). For example, bears may emerge from relatively high-elevation dens and descend to valley bottoms to seek ungulate carcasses and early-emergent plants. As snow melt proceeds upslope, bears ascend to follow the emergence of fresh vegetation.

5.5.3 Dispersal

Subadult male grizzly bears usually disperse upon independence, whereas subadult females are commonly philopatric (LeFranc *et al.* 1987; Blanchard and Knight 1991). Dispersal distances for young grizzly bears are short compared with some other large carnivores. Mean dispersal distance for 4 subadult males in Yellowstone National Park was 70 km (Blanchard and Knight 1991). In southeastern British Columbia, male and female dispersals averaged 29.9 km and 9.8 km, respectively (McLellan and Hovey 2001b). The longest dispersals from maternal home ranges in this study were 67 km for a male and 20 km for a female. However, the species is large and mobile, and capable of long movements. One radio-marked subadult male grizzly bear in northeastern BC was shot 340 km from his maternal home range (P.I. Ross, unpubl. data). In the central Arctic, 1 subadult male moved 471 km in less than 1 month (R. Gau, pers. commun.).

Dispersal in grizzly bears is a gradual process, taking 1-4 years (McLellan and Hovey 2001b). Because of this, grizzly bears must be able to live in dispersal corridors, rather than simply disperse through them.

5.6 Nutrition and Interspecific Interactions

Like most bear species, grizzlies share the basic digestive anatomy and physiology of other members of Carnivora, but consume relatively large volumes of vegetation. The degree of herbivory varies among and within grizzly bear populations,

but in most, a variety of plants are highly important foods, and consequently there is a strong influence of season on diet. Conversely, bears in some areas are highly carnivorous, and in some cases, predatory. Based on stable isotope signatures, the contribution of vegetation to diets of adult female grizzly bears ranged from 19% in coastal Alaska to 98% in Kluane National Park (Hilderbrand *et al.* 1999a). Grizzly bears are probably best described as opportunistically omnivorous (Schwartz *et al.* In press).

Grizzly bear food habits are widely variable among regions. Many food-habits studies have been reported, and thorough reviews are provided in LeFranc *et al.* (1987), Pasitschniak-Arts (1993), Pasitschniak-Arts and Messier (2000), and Schwartz *et al.* (In press). Following are highlights of several recent Canadian studies.

In central coastal British Columbia, 65 distinct food items, including 49 plants, were identified (MacHutchon *et al.* 1993). In spring, sedges were the most commonly eaten food. Several forb species dominated the summer diet and persisted into the fall. From early August to mid-October, salmon (*Oncorhynchus* spp.) were the major food item. Bears were also observed feeding on mammals and a variety of intertidal invertebrates.

Grizzly bears in the Flathead drainage of southeastern British Columbia occur at a density at least twice as high as any other reported interior population (Table 5). McLellan and Hovey (1995) suggested that this high density was a result of the high quantity and diversity of bear foods in the Flathead area. Typical of many mountainous interior study areas (Hamer and Herrero 1987; LeFranc *et al.* 1987; Hamer *et al.* 1991), grizzlies in the Flathead fed largely on roots (especially *Hedysarum* spp.) and ungulates in early spring and again in late fall (McLellan and Hovey 1995). Feeding on whitebark pine (*Pinus albicaulus*) seeds was rarely observed, although this is an important food item in adjacent Glacier National Park, USA, and other regions where the 2 species overlap (Mattson *et al.* 2001). A variety of forb species, along with grasses and horsetails (*Equisetum* sp.), dominated the summer diet, and during late summer berries comprised up to 96% of scat volume. The presence of all known major interior grizzly bear foods, and the abundance of both huckleberry (*Vaccinium* spp.) and buffaloberry (*Shepherdia canadensis*) fruit, were considered particularly important in defining the high quality of habitat in the Flathead area.

In Ivvavik National Park, Yukon, grizzly bear seasonal food habits generally paralleled those of southern interior bears (MacHutchon 1996). *Hedysarum* roots, overwintered berries, and horsetails were important spring foods. Horsetails remained important during summer, but forbs were also heavily used. During fall, berries became important as they ripened, and roots returned to the diet. Grizzlies in Ivvavik Park hunted for ground squirrels (*Spermophilus parryii*) during summer and fall, and for caribou (*Rangifer tarandus*) during the brief mid-summer period they were available, but most (96-98%) foraging time was spent on vegetation.

Gau (1998) and Gau *et al.* (2002) studied food habits of barren-ground grizzly bears in the central Arctic. Caribou was the most prevalent food item, especially in spring, mid-summer, and autumn. In early summer, when caribou were essentially

absent, horsetails, sedges (*Carex* spp.) and Arctic cotton grass (*Eriophorum* spp.) dominated the diet. During late summer berries became most important, and were judged to be critical for deposition of fat reserves sufficient for denning.

The occurrence of meat in the diet of grizzly bears influences several physical and life history characteristics. Population density, female body mass, and mean litter size were positively correlated with dietary meat content (Hilderbrand *et al.* 1999a). In most areas, pre-hibernatory mass gain is largely dependent upon the consumption of massive volumes of berries during late summer. However, energetic maintenance costs were lowest, and rate of mass gain was highest, when dietary protein content was about 20-35%, indicating that even when berries were abundant, a mixed diet was most efficient for bears (Rode and Robbins 2000).

The availability of meat to grizzly bears is widely variable across study areas, and is generally seasonal. However, where and when meat is available, grizzly bears indicate a strong preference for it. In coastal Alaska, adult females ate an average of 8.5 kg/day of meat in spring, primarily moose carrion and calves (Hilderbrand *et al.* 1999b). During summer and fall, they consumed 10.8 kg/day of salmon, and meat contributed 80.4% (59.6% salmon and 20.7% terrestrial) of the fall diet.

Scavenged ungulate carcasses have long been recognized as an important food item, particularly in spring, of virtually all grizzly populations. However, the role of predation in grizzly bear nutrition, and in ungulate population dynamics, has more recently become clear. In southcentral Alaska, grizzly bears killed 44% of moose calves and accounted for 73% of calf mortality (Ballard *et al.* 1991); they also killed older moose including adult cows. Grizzlies were the primary cause of adult moose mortality in southwestern Yukon (Larsen *et al.* 1989), and have been identified as important moose predators in other areas as well (e.g., Gasaway *et al.* 1988; Mattson 1997; Bertram and Vivion 2002). Some classes of bear may be more successful predators than others. In east central Alaska, each adult male grizzly bear killed 3.3-3.9 adult moose annually, whereas each lone adult female killed 0.6-0.8 adult moose per year (Boertje *et al.* 1988). In that area, grizzlies killed 4 times more animal biomass than they scavenged.

Other important grizzly prey include caribou (Adams *et al.* 1995; Gau 1998), elk (*Cervus elaphus*: Hamer and Herrero 1991; Mattson 1997), and a variety of small mammals (especially ground squirrels [*Spermophilus* sp.] and marmots [*Marmota* sp.]). Muskoxen (*Ovibos moschatus*: Gunn and Miller 1982; Case and Stevenson 1991), mule deer (*Odocoileus hemionus*: Mattson 1997), mountain goats (*Oreamnos americanus*: Festa-Bianchet *et al.* 1994), bison (*Bison bison*: Mattson 1997), and black bears (*Ursus americanus*: Boertje *et al.* 1988; Ross *et al.* 1988) can also be occasional prey for grizzly bears. In the Canadian Arctic, grizzly predation on ringed seals (*Phoca hispida*) has been documented or inferred from sign (Clarkson and Liepins 1989; M.K. Taylor, pers. commun.; P.I. Ross, unpubl. data). Where available, army cutworm moths (*Euxoa auxiliaris*), ants, and earthworms may be important seasonal grizzly bear prey (Mattson *et al.* 1991; Mattson 2001; Mattson *et al.* in press).

Grizzly bears influence other species in ways aside from just eating them. Wolves (*Canis lupus*) and grizzly bears compete for live prey and for carcasses, and usurp kills from each other. However, Servheen and Knight (1993) reviewed grizzly bear/wolf interactions and found no evidence of effects on survival or reproduction of either species. The grizzly's relationship with obligate predators is more one-sided; bears (grizzly and black) visited 24% of cougar (*Puma concolor*) kills in Yellowstone and Glacier National Parks, and displaced cougars from 10% of carcasses (Murphy *et al.* 1998). Bears gained up to 113%, and cougars lost up to 26%, of their respective daily energy requirements from these encounters. Bear predation and incomplete consumption of carcasses (especially salmon) provides food for a variety of scavengers.

Grizzly bear digging for bulbs of glacier lily (*Erythronium grandiflorum*) enhances soil nutrients on those sites, encouraging regrowth and productivity of glacier lilies and other plants and structuring plant communities (Tardiff and Stanford 1998). Consumption of berries and other fruits leads to seed dispersal for those plants (Willson 1993). Grizzly bears also distribute nutrients from salmon carcasses into terrestrial systems. Of the total nitrogen in spruce foliage within 500 m of streams, 15.5-17.8% was derived from salmon, and 83-84% of that was contributed by bears through their urine or feces (Hilderbrand *et al.* 1999c).

Grizzly bears also interact directly with humans. There are millions of bear-human interactions in North America each year, nearly all with a peaceful, positive outcome. However, during 1990-1999, grizzly bears killed 18 people in North America (S. Herrero, pers. commun.). Over a 30-year period in Alberta and BC, there were about 4 times as many serious injuries as fatalities, suggesting an annual average 9.0 serious and fatal grizzly attacks on humans in North America during the 1990s. The rate of increase in bear-inflicted injuries is higher than the population growth rate in BC but not in Alberta (S. Herrero, pers. commun.).

5.7 Behaviour/Adaptability

Individual grizzly bears are clearly capable of learning behaviours and in that sense they are highly adaptable. Examples include innumerable anecdotes about individual bear responses to particular stimuli or situations. Many of these examples are related to conflict situations with humans. Bears which receive anthropogenic food rewards in response to particular behaviours will quickly become food conditioned (McCullough 1982). Habituation, by contrast, is the loss of fear of humans as a result of a lack of negative reinforcement. Both processes contribute to negative bear-human interactions.

Aversive conditioning programs have been tried and implemented in many places to take advantage of bears' ability to modify their behaviours (*e.g.*, review in LeFranc *et al.*; Schirokauer and Boyd 1998). One particularly promising approach involves the use of trained Karelian bear dogs to change behaviour of habituated bears (Hunt 2000). However, because most bear behaviour is strongly influenced by their overwhelming nutritional requirements, aversive conditioning is challenging.

Grizzly bear young remain with their mothers typically for 2-4 years (Schwartz *et al.* In press). This long period of dependence is presumably related to the complexity of behaviours that young bears must learn from their mothers in order to survive on their own.

Adaptability on the species level, however, is much lower, primarily because of their low reproductive rate. Population-wide changes in general behavioural patterns take many generations, and are always mitigated by the tenuousness of bears' nutritional status. Grizzly bears will engage in risky behaviours for food, and this means that individuals and populations will always be vulnerable to potential conflicts with humans.

6. POPULATION SIZE AND TRENDS

6.1 Introduction

Censusing grizzly bears is costly, difficult, and generally imprecise. Low sightability in most bear habitats precludes the use of direct-observation techniques such as aerial surveys. Sightability is better in tundra environments, but low bear densities in those areas render aerial surveys impractical. The most reliable and broadly used techniques employ invasive means including capture-mark-resight with or without radiotelemetry (Miller *et al.* 1987; 1997).

Recent developments in population estimation techniques include camera traps, wherein bears trip cameras and photograph themselves (Mace *et al.* 1994). Most recently, DNA fingerprinting of hair follicles from bears attracted to baited barbed wire snags has been used to identify and count individuals and estimate densities (Woods *et al.* 1999; Mowat and Strobeck 2000). Each technique requires rigorous adherence to statistical protocols to avoid or minimize biases and errors associated with problems such as unequal probability of capture or resight, assumptions of population closure, and identification of the precision of estimates.

In most reported Canadian studies, population estimates have been derived from a combination of capture data, telemetry data, and observation data. Most Canadian studies have required radiocollaring of bears to fulfil several additional project objectives, so derivation of population estimates using radiotracking data has been common. This approach is broadly applicable and broadly applied, but it frequently violates assumptions and usually provides no measure of precision (Mace *et al.* 1994). Furthermore, the high cost of estimating bear populations and the vastness of occupied grizzly bear range in Canada requires extrapolation of calculated densities across large areas of presumably similar habitat quality and bear density.

These difficulties lead to generally low precision in most estimates of grizzly bear population size. Consequently, most census data can only detect fairly drastic changes

in abundance over time. No Canadian jurisdiction claims a high degree of confidence in either the precision or accuracy of their grizzly bear estimate.

This preamble is essential to qualify the data presented in this section. Data were provided to the author by senior bear management personnel from each jurisdiction, and represent the current state of knowledge within that jurisdiction, upon which bear management decisions are based. Estimates of bear density and population size were based primarily on field studies within portions of each jurisdiction (Table 5), and extrapolated to account for data gaps elsewhere. Because bear populations are estimated provincially or territorially, those estimates are provided based on jurisdictional boundaries. However, it is noted that these estimates do not refer to distinct bear subpopulations.

The Canada-wide grizzly bear population is estimated at 29,921, with an estimated range of 26,916 to 34,150 (Table 6). The point estimate represents an increase of 4,781 (19%) from the 1990 estimate (Banci 1991). However, as noted in Table 6, higher estimates for most jurisdictions are related to changes in estimation methodology, reporting precision, and new data. Only Alberta reported an increased population, and that increase contributed only 290 bears. Over all of Canada, there is no evidence that the grizzly bear population size has changed since 1990.

The lack of precision in grizzly bear population estimates strongly influences the Canada-wide status of the species. Current census techniques for grizzly bears are only now beginning to permit inventory of bear populations, and to provide reliable estimates of population size complete with confidence intervals. These techniques were not available even 10 years ago, making earlier estimates of bear populations little more than guesses, and certainly not directly comparable to current estimates. Therefore, it is not possible to evaluate trends in grizzly bear population size over any period beyond the past 10 years, aside from extrapolations based on changes in habitat availability.

Age structure in bear populations is influenced by population fecundity and by management regime to which the population is subjected (for example, cases where adult cohorts are selectively removed; Schwartz *et al.* in press). Bears of breeding age have been estimated to comprise from 25.6% to 59.0% of a grizzly bear population (Schwartz *et al.* in press). According to these values, and taking the point estimate, the breeding-age population in Canada is 6,891 - 15,881 bears. Using the high and low population range estimates, the number of breeding-age bears could range from 5,893 to 16,682.

Table 6. Estimated grizzly bear populations in Canada, 1991 and 2001/2002. Data from sources cited in text, except where noted.

Jurisdiction	1991 ¹	2001/2002		Comments
		Point ²	Range	
Alberta	575	841	841 to 865	Estimated 46% increase since 1988 (3.9% annual increase).
BC	13,000	at least 14,000	14,000+	Iterative estimation methodology. Change not believed to represent absolute change in population. Province-wide, trend considered to be stable.
Yukon	6,300	6,300	6,000 to 7,000	Territory-wide trend considered stable. Official estimate is 6,000 - 7,000.
NWT	5,050	5,100	5,100	Does not imply population change. Land area and bear population of Nunavut excised in 1999, and estimation methodology revised to incorporate new data.
Nunavut	n/a ³	1,000	800 to 2,000	No official estimate available. Provided is a crude, unofficial estimate, determined from an estimated density of 4 bears/1,000 km ² for a 200,000 km ² portion of western and northern mainland Nunavut, plus an estimated density of 1 bear/1,000 km ² for a 20,000 km ² portion of eastern mainland Nunavut.
AB Natl. Parks ⁴	215	180	175 to 185	Revised estimation methodology. No perceived change since 1991.
TOTAL	25,140	at least 27,421	26,916+ to 29,150+	Changes in estimates between 1991 and 2001/2002 are largely due to revised methodology and new data. Overall, the Canada-wide trend between 1991 and 2001/2002 is perceived to have been stable.

¹Values reported in previous COSEWIC status report (Banci 1991). Actual date of original estimate varies.

²If a point estimate was not provided by the jurisdiction, the mean of the range was used.

³Nunavut was created in 1999. Previously, values were included with NWT.

⁴Banff, Jasper, and Waterton Lakes National Parks; not included in Alberta values.

6.2 Alberta

The total grizzly bear population on provincial lands in Alberta was estimated to be 841 in 2000 (Kansas 2002). In addition, about 175-185 bears are estimated to occur in Waterton Lakes, Banff, and Jasper National Parks for a province-wide total estimate of 1,016-1026 bears.

Alberta is the only jurisdiction to report an increase in grizzly bear population over the period covered by this status report update. The estimated absolute increase on provincial lands of 46.3% equates to an average annual increase of 3.9%. National Park totals remained essentially stable during this period. The 1990 estimate for Banff National Park of 75 bears (Nagy and Gunson 1990) is within the current estimated range of 60-80 bears (Gibeau *et al.* 1996; Herrero *et al.* 2001).

About 154,000 – 200,000 km² of provincial lands in Alberta are considered to be potential grizzly bear habitat (Nagy and Gunson 1990; Alberta Environmental Protection 1997). Although this is substantially reduced from historical levels (grizzlies formerly

occupied virtually the entire province: 661,000 km²), this range reduction occurred primarily in the 1800s and early 1900s. Range contraction since 1990 has not been documented, although it may have occurred at local levels. Recolonization of historic ranges is suspected in some areas, especially the agricultural fringe along the eastern and northeastern boundaries of current distribution (H.D. Carr, pers. comm.).

Between 1981 and 1999, the numbers of males, females, and total bears in the Alberta grizzly harvest have declined (Table 7), most likely due to changes in management practices. Hunting regulations became increasingly restrictive over that period, including the implementation of limited-entry permits, closure of fall seasons, and prohibition of non-resident hunting. Annual numbers of bears killed by other man-caused means did not change, but the total of all recorded man-caused mortalities declined.

Table 7. Known man-caused grizzly bear mortalities in Alberta, 1981 to 1999.

Year	Hunter kills ¹				Non-hunting man-caused			Grand total
	Males	Females	U/k sex	Total	Illegal	DLP	Other	
1981	17	9	5	31	5	1	1	38
1982	15	14	0	29	7	6	1	43
1983	27	16	1	44	5	6	0	55
1984	26	20	0	46	1	4	1	52
1985	25	19	0	44	2	3	2	51
1986	31	14	0	45	2	0	1	48
1987	27	16	1	44	7	14	0	65
1988	7	1	0	8	1	5	1	15
1989	5	3	0	8	9	2	0	19
1990	13	8	0	21	9	1	0	31
1991	7	3	0	10	2	3	2	17
1992	19	3	0	22	3	4	1	30
1993	12	8	0	20	1	8	1	30
1994	4	3	0	7	5	3	1	16
1995	11	3	0	14	1	3	0	18
1996	13	7	1	21	3	5	0	29
1997	8	3	0	11	4	4	0	19
1998	6	8	0	14	3	6	1	24
1999	12	9	0	21	6	5	4	36
Total	285	167	8	460	76	83	17	636
Overall Mean	15.0	8.8		24.2	4.0	4.4	0.9	33.5
S.E.	2.0	1.4		3.2	0.6	0.7	0.2	3.5
1981-1989 Mean	20.0*	12.4*		33.2*	4.3	4.6		42.9*
S.E.	3.1	2.2		5.2	1.0	1.4		5.5
1990-1999 Mean	10.5*	5.5*		16.1*	3.7	4.2		25.0*
S.E.	1.4	0.8		1.8	0.8	0.6		2.2
<i>P</i> -value	0.0055	0.0038		0.0018				0.0026

¹Includes all reported First Nations kills.

*Indicates values within columns are significantly different (2-tailed z-test).

Grizzly bear distribution in southern Alberta consists of a strip along the Continental Divide, in places narrowing to 30 km. This is contiguous with grizzly habitat on the BC side of the Divide, but even so remains constricted. The risk of population fracture along this strip, combined with relatively high mortality and control-removals of grizzlies from the southwestern corner of the province as a result of livestock depredation (Gunson 1995; H.D. Carr, pers. commun.), dictate a particular need for cautious management in this area.

A Population Viability Analysis (PVA) was conducted for the Central Rockies Ecosystem in Alberta and BC (Herrero *et al.* 2000). The model was based on assumptions for many input parameters, which were derived from science and which represented the best professional judgement of many of North America's grizzly bear experts, but the reliability of the model's predictions remains highly sensitive to even minor changes or errors in those assumptions. The model predicted that the grizzly bear population in that region is not presently secure. Increasing human population in the region was assumed (based on region-specific empirical data) to result in increased adult female grizzly mortality and/or decreased population fecundity. When projected increases in the human population were incorporated, the model predicted a rapid decline of the grizzly population. The model further predicted that goals of maintaining or increasing the population are unlikely to be met without strong mitigation efforts leading to a decrease in annual mortality. Consequently, even as the human population increases in the region, it will be essential to reduce human impacts on bears (Herrero *et al.* 2000).

6.3 British Columbia

The total grizzly bear population within British Columbia, including National Parks, was estimated at a minimum of 14,000 in 2002. This value is generally consistent with the provincial total estimated in 1991 (13,000 bears; Banci 1991). The current value arose from improved methodology and new data, as well as acknowledged uncertainty in the accuracy and precision of the estimate. The province-wide trend is considered to be generally stable, although declines in some areas and increases in others are suspected (T. Hamilton, pers. commun.). Grizzly bears along much of the southern fringe of their distribution in BC occur at low or very low densities, including in the Coast, Yahk, and South Selkirk Mountains (McLellan 1998).

Grizzly bears currently occupy an estimated 750,000 km² of British Columbia. Historically, about 917,000 km² of mainland BC provided bear habitat. Most of this 18% range contraction occurred prior to 1960. However, current stresses on grizzly bear habitat and distribution in the province remain focused on the southern fringe.

As reported in Section 2.3.1, at least 8 isolated grizzly bear populations have been identified in southern BC (Figure 11; McLellan 1998; T. Hamilton and B. McLellan, pers. commun.). Five of these occur within Grizzly Bear Population Units (GBPU) which have been designated by the province as Threatened. Status of these population isolates is summarized in Table 8. Each has been isolated primarily as a result of human developments and activities, which continue to threaten the persistence of the bear

**Table 8. Summary of isolated grizzly bear population units in southern British Columbia.
Data from T. Hamilton and B. McLellan (pers. commun.).**

Unit name	Estimated population	Boundaries	Specific Threats
Garibaldi-Pitt GBPU ¹	19	South: Lower Mainland; West: Pacific Ocean and BC Hwy 99; North: Duffy Lake Road and the parallel BC Hwy 99. Some connection may be possible across the Lillooet River and Harrison Lake to the Stein-Nahatalatch population (see below) but unlikely given low densities and degree of habitat alteration due to logging and agriculture and resulting high road densities and traffic volumes.	Extensive logging, resulting in reduction of habitat suitability under closed canopy second growth stands; very high recreational and commercial tourism use. Few salmon spawning areas outside urban/rural areas, and low ungulate densities.
Squamish-Lillooet GBPU	27	East: BC Hwy 99; West and South: Pacific Ocean; North: the highly developed (settlement, logging, agriculture) Upper Lillooet Valley.	Expanding settlement; very high open-road densities with high traffic volumes; very high recreational and commercial tourism use. Extensive logging resulting in an overall lowering of habitat suitability under closed canopy second growth stands. Fire suppression has exacerbated this situation.
Stein-Nahatalatch GBPU	60	East: Fraser River, 2 national railways and the Trans-Canada Highway; South by the highly settled Fraser Valley; North by the Duffy Lake Road, and the parallel BC Hwy 99. There may be limited connection west to the Garibaldi-Pitt GBPU (see above) across Harrison Lake and the Lillooet River.	Roads; logging; recreation; illegal mortality; potential conflict with cattle grazing; fire suppression.
Marble/Pavillion Ranges Group	<20	These bears are confined to an area south of Clinton, and east of Lillooet and the Fraser River.	There may be two groups of animals, one south and one north of Highway 12 through Pavillion. The area is extensively used for grazing, and is highly roaded with several settlements. These grizzly bears may represent the last group in Canada adapted to the extremely dry Southern Interior.
Sheep Ck/Rosland Group	<20	Isolated to the South by the US (no bears), to the West by the densely-settled Okanagan valley and to the North by Hwy 3. The bear population North of Hwy 3 is also at a very low density, although it is more likely linked to populations to the north and east.	Continued expansion of motorized access and settlement. Fire suppression has limited the amount of early seral (berry-producing) habitat and there is continued potential for conflict between livestock and bears.
Pennask Lake Group	<10	Completely isolated by unsuitable habitat.	Area is highly roaded and heavily used for public and commercial recreation. The area is "cottage country" with extensive logging roads throughout.
North Cascades GBPU	<25	See text Section 2.3.1.	See text Section 2.3.1.
South Selkirks GBPU	67	See text Section 2.3.2.	See text Section 2.3.2.

¹Grizzly Bear Population Unit.

population within each area. Survival of these population units will depend on recognition of their isolation, and active measures to reduce mortality, conserve habitat, and restore connectivity.

From 1976-1989 to 1990-1999, the numbers of grizzly bears killed legally and illegally did not change significantly (Table 9). However, the number of bears reported to be killed in defence of life or property (DLP) nearly tripled over that interval.

Table 9. Known man-caused grizzly bear mortalities in BC, 1976 to 1999.

Year	Hunter kills ¹			Non-hunting man-caused			Total
	Males	Females	Total	Illegal	DLP	Other ²	
1976	148	86	234	n/a	n/a		234
1977	176	93	269	n/a	4		273
1978	226	78	304	n/a	6		310
1979	200	117	317	4	13		334
1980	249	116	365	7	19		391
1981	250	129	379	2	7		388
1982	215	112	327	7	16		350
1983	238	119	357	9	16		382
1984	240	125	365	9	16		390
1985	211	133	344	8	20		372
1986	223	120	343	8	14		365
1987	230	137	367	6	17		390
1988	190	121	311	7	17		335
1989	210	130	340	22	21		383
1990	200	111	311	10	15		336
1991	222	134	356	8	14		378
1992	240	116	356	9	28		393
1993	160	77	237	3	35		275
1994	181	99	280	4	38		322
1995	183	105	288	5	83		376
1996	224	139	363	8	32		403
1997	154	70	224	1	41		266
1998	140	70	210	4	35		249
1999	169	95	264	7	81		352
Total	4,879	2,632	7,511	148	588	0	8,247
Overall Mean	203.3	109.7	313.0	7.0	25.6		343.6
S.E.	6.8	4.4	10.5	0.9	4.3		10.4
1976-1989 Mean	214.7	115.4	330.1	8.1	14.3*		349.8
S.E.	7.7	4.8	10.9	1.5	1.5		13.0
1990-1999 Mean	187.3	101.6	288.9	5.9	40.2*		335.0
S.E.	10.5	7.8	17.9	0.9	7.5		17.6

¹Does not include First Nations kills.

²Other man-caused mortalities (e.g., roadkill, research) are not subject to compulsory reporting in BC.

*Values significantly different (two-tail z-test; P=0.0007)

The southern fringe of grizzly distribution in BC consists of at least 4 peninsular extensions (McLellan 1994). Dedicated effort will be required to prevent further constriction of those peninsulas, with subsequent fragmentation. The PVA model for the Central Rockies Ecosystem described above (Section 6.2) pertains to a portion of southeastern BC as well. Its dire predictions can only be mitigated by reversal of current trends in human population and activity in grizzly country.

6.4 Yukon

The Yukon Territory-wide estimate in 2000 is 6,000 – 7,000 grizzly bears. The estimate of 6,300 reported by Banci (1991) is consistent with the current estimate and reflects changes in reporting precision rather than population size (J. Hechtel, pers. commun.). With local exceptions, the grizzly population in Yukon is considered to have remained stable since 1991.

Nearly all of the Yukon's land mass (483,000 km²) is occupied by grizzly bears. No reduction in bear distribution has been documented in the Territory.

From the 1980s to the 1990s, the Yukon harvest of males, females, and all grizzly bears declined slightly (Table 10). Other man-caused mortalities remained constant, but the total man-caused mortalities declined.

6.5 Northwest Territories

Direct comparisons of grizzly bear population estimates and evaluation of trends in the Northwest Territories are complicated by changes in jurisdictional boundaries. Nunavut was declared as a distinct territory on 1 April 1999, including a substantial land mass and a grizzly bear population. The bear population in Nunavut is considered later.

Additional land-claim agreements include the establishment of the Inuvialuit Settlement Region, the Gwich'in Settlement Area, and the Sahtu Settlement Area. The Government of the Northwest Territories continues to manage wildlife within these settlement areas, but does so co-operatively with a variety of agencies and land-claim organizations.

The total grizzly bear population for the Northwest Territories is estimated at about 5,100 (Gau and Veitch 1999; Table 6), within an area of about 641,000 km². After accounting for the removal of the bear population to what is now Nunavut, an increase is suggested since 1991. However, no data exist in support of either an increase or a decrease during that period. Official estimates of the grizzly bear population size had not been made previously. It is the opinion of regional wildlife managers that grizzly populations within the Northwest Territories have been essentially stable since 1991 (D. Cluff, J. Nagy, and A. Veitch, pers. commun.). There is no evidence of a change in distribution of the grizzly bear in the Northwest Territories since historic times (Schwartz *et al.* in press).

Table 10. Man-caused grizzly bear mortalities in Yukon, 1980 to 1999. Records exclude the Inuvialuit Settlement Region and the Gwich'in Settlement Area (see Table 10).

Year	Hunter kills ¹				DLP	Other	Grand total
	Males	Females	U/k sex	Total			
1980	54	29	0	83	9	3	95
1981	58	26	1	85	6	3	94
1982	58	21	1	80	16	4	100
1983	46	28	1	75	8	2	85
1984	76	36	0	112	15	6	133
1985	59	37	1	97	17	3	117
1986	53	41	0	94	11	1	106
1987	85	41	0	126	20	1	147
1988	68	43	0	111	5	2	118
1989	57	34	0	91	14	1	106
1990	64	25	0	89	15	4	108
1991	44	33	0	77	6	4	87
1992	55	36	0	91	14	1	106
1993	44	27	0	71	13	0	84
1994	47	30	0	77	9	2	88
1995	37	26	0	63	18	0	81
1996	72	30	0	102	13	0	115
1997	58	29	0	87	22	1	110
1998	43	19	0	62	10	1	73
1999	46	20	0	66	12	2	80
Total	1124	611	4	1739	253	41	2033
Overall Mean	56.2	30.6	0.2	87.0	12.7	2.1	101.7
S.E.	2.7	1.6		3.8	1.1	0.4	4.2
1980-1989 Mean	61.4*	33.6*		95.4*	12.1	2.6	110.1*
S.E.	3.7	2.3		5.2	1.6	0.5	6.0
1990-1999 Mean	51.0*	27.5*		78.5*	13.2	1.5	93.2*
S.E.	3.5	1.7		4.2	1.4	0.5	4.7
<i>P</i> -value	0.0396	0.0387		0.0114			0.0272

¹Includes First Nations kills.

*Indicates values within columns are significantly different (2-tailed z-test).

Because of changes in jurisdictional boundaries, mortalities in Northwest Territories and Nunavut are considered jointly (Table 11). Hunter kills, DLP kills, and total mortalities fluctuated over the reporting period.

Table 11. Known man-caused grizzly bear mortalities in Northwest Territories¹ and Nunavut, 1989 to 1999.

Year	Hunter kills ²				Non-hunting man-caused			Grand total
	Males	Females	U/k sex	Total	Illegal	DLP	Other	
1990	5	3	0	8		8		16
1991	7	1	1	9		6		15
1992	10	1	0	11		5		16
1993	8	4	1	13		12		25
1994	14	1	1	16		13		29
1995	5	0	4	9		9		18
1996	12	3	1	16		4		20
1997	10	1	0	11		15		26
1998	5	1	2	8		15		23
1999	5	2	0	7		7		14
Total	81	17	10	108	0	94	0	202
Mean	8.1	1.7	1.0	10.8		9.4		20.2
S.E.	1.0	0.4	0.4	1.0		1.3		1.7
ISR ¹ Total								
1990-1999	151	33	15	199		52		251
GSA ¹ Total								
1990-1999	19	4	4	27		26		53
Grand Total	251	54	29	334	0	172	0	506
Grand Mean	25.1	5.4	2.9	33.4	0	17.2	0	50.6

¹Includes kills from the Yukon portion of the Inuvialuit Settlement Region (ISR) and Gwich'in Settlement Area (GSA).

²Includes First Nations kills.

6.6 Nunavut

Prior to 1 April 1999, the grizzly bear population in Nunavut existed in the Northwest Territories. Currently, no official population estimate for Nunavut exists. Grizzly bears occur within 2 regions: Kitikmeot and Kivalliq (formerly Keewatin). Densities within either region have not been estimated. However, in an attempt to develop a reasonable guess as to the number of bears within Nunavut, I extrapolated from empirical data collected in the closest proximity, in consultation with regional wildlife managers. It must be stressed that this exercise was completed in order to provide a working guess of population size, in recognition of the fact that grizzly bears do exist in Nunavut. It does not indicate a familiarity with the grizzly bear population or its habitat within Nunavut.

Grizzly bear density in the Brock-Hornaday Rivers area, immediately west of the NWT/Kitikmeot boundary, was estimated at 6/1,000 km² (Nagy and Branigan 1998). In the Lac de Gras area (Central Arctic), spanning the North Slave/Kitikmeot boundary, the bear density was estimated at 3.5/1,000 km² (Penner and Associates 1998;

P. McLoughlin, pers. commun.). I assumed a typical density of 4/1,000 km² and applied it to an arbitrarily-defined area of 200,000 km² in the northwestern corner of mainland Nunavut. This value is considered a reasonable guess for grizzly bear density across much of the Kitikmeot Region (B. Patterson, pers. commun.). The result was an estimate of 800 bears.

Grizzly bear densities in eastern mainland Nunavut are believed to be much lower, although no estimates exist (M. Campbell, pers. commun.; R. Mulders, pers. commun.). Consequently, I estimated a density of 1 bear/1,000 km² for an area of 200,000 km² extending west from the Hudson Bay coast, south from the Arctic Ocean coast, and north from the Manitoba border. This yielded an estimate of 200 bears, for a Nunavut total of 1,000 bears. Accounting for uncertainty in density and extent of distribution, an estimated population range of 800-2,000 bears is reasonable. Given the crude nature of these estimates, no assessment of population trend is possible. Local managers are aware of no major changes in grizzly populations in the Kitikmeot and Kivalliq regions over the past decade (B. Patterson, M. Campbell, pers. commun.).

Grizzly bears probably occupy most of mainland Nunavut (Figure 3). This distribution has likely not changed in historic times (Schwartz *et al.* in press).

Because of changes in jurisdictional boundaries, mortalities in Northwest Territories and Nunavut are considered jointly (Table 11). Hunter kills, DLP kills, and total mortalities fluctuated over the reporting period.

6.7 Canada

Overall population size and distribution of grizzly bears in Canada are not known to have changed since 1991. The total extent of occurrence may approximate 3,469,000 km² as reported by Banci (1991) and McLellan and Banci (1999), although the current area of occupancy is probably closer to 2,574,000 km².

Humans kill a reported mean of 504 grizzly bears in Canada each year (Table 12). About 84% of these mortalities are by legal hunters (including First Nations). Defence of Life or Property (DLP) kills account for another 13%. Based on the estimates of total Canadian population size (Table 6), known man-caused mortality accounts for an average of about 2.0 to 2.4% of the grizzly bear population each year. This mortality rate is not distributed evenly across the jurisdictions.

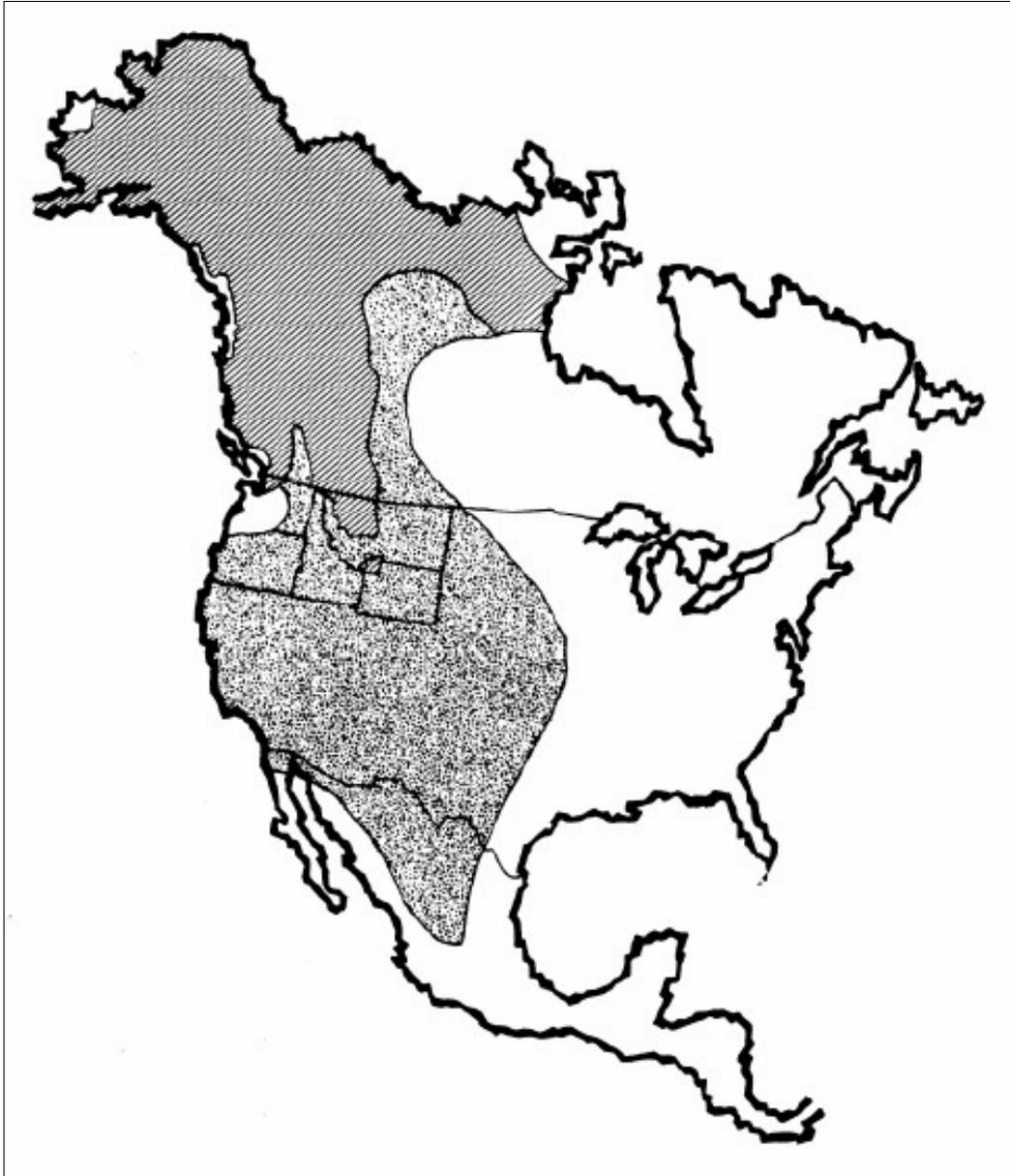


Figure 13. Current (diagonally hatched) and historic (ca. 1800) distribution of grizzly bears in North America. Adapted from Servheen (1990).

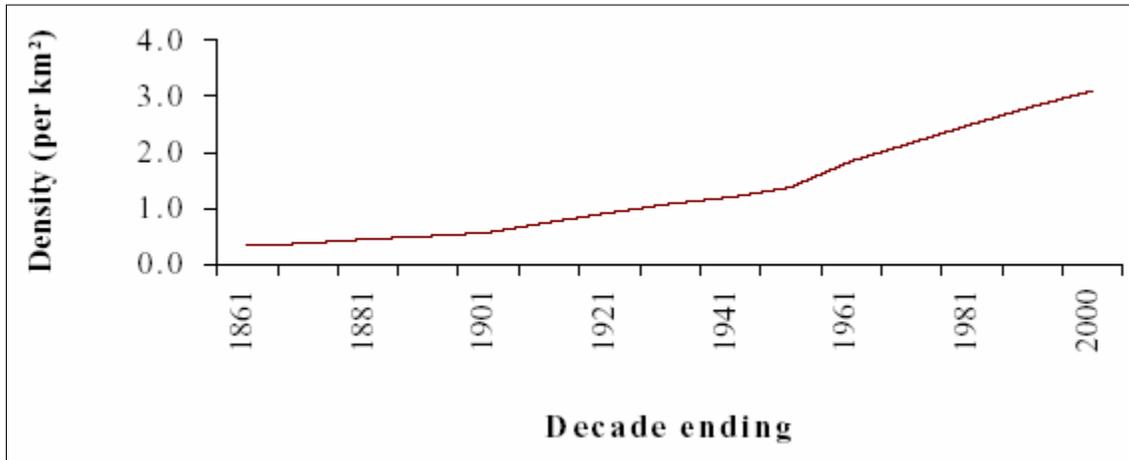


Figure 14. Human population density in Canada by decade, 1861 to 2000.

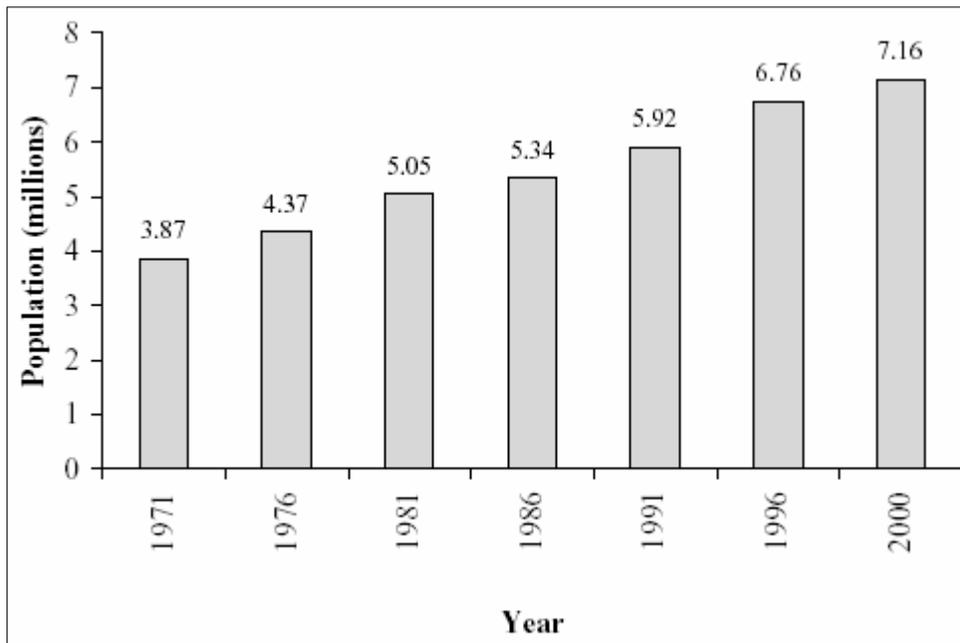


Figure 15. Total human population of Alberta, British Columbia, Yukon, and Northwest Territories (including Nunavut), 1971 to 2000. Data from Statistics Canada.

6.8 Population Size and Trend—Summary

The total grizzly bear population in Canada is estimated to be a minimum of 27,421, with a range of 26,916+ to 29,150+. Of these, 6,890+ to 17,199+ are of reproductive age. Grizzly bears currently occupy several discontinuous areas and therefore comprise several subpopulations. Eight population isolates have been

identified along the southern fringe of grizzly bear distribution in BC, with a total population of <250 bears (T. Hamilton and B. McLellan, pers. commun.). For 6 of these units, population estimates are <30 bears each. For each of the remaining 2 units, estimates are 60-70 bears. The remainder of the Canadian grizzly population occupies some 2,574,000 km² that is essentially continuous. Grizzly bears have been extirpated from the prairie ecozone.

Canadian grizzly populations have been greatly reduced from historic levels, but have remained essentially consistent since 1990. Even the small and isolated populations in southern BC are believed to be stable.

7. LIMITING FACTORS AND THREATS

7.1 Abundance

Grizzly bear populations can be affected through direct mortality, or through factors that influence vital rates such as natality. In most Canadian populations, direct human-caused mortality figures largely in the potential persistence of grizzly bears. Natural mortality occurs in all bear populations, and can be substantial, but in nearly all regions including some protected areas, most grizzlies die from human-related causes (Schwartz *et al.* in press).

Humans kill grizzly bears in a number of ways. All provinces and territories where grizzly bears persist manage the species as a game animal. Hunting seasons are provided for First Nations, resident and, in some cases, non-resident hunters. Bears are commonly attracted to sites of human activity, and may be destroyed as perceived or real threats to life or property. Grizzly bears are shot illegally, perhaps in cases where they were mistaken for black bears, or for malicious reasons. Finally, like all wildlife, grizzly bears are susceptible to accidental human-caused mortality such as collision with vehicles and trains.

In the interior mountains of southern Alberta and BC, and northern Montana, Idaho, and Washington, humans caused 77% of known mortalities of radiocollared grizzly bears, or 85% if suspicious deaths were included (McLellan *et al.* 1999). Of 83 mortalities, 14 were natural, 16 were legally harvested, 21 were killed in defence of life or property (DLP), 19 were poached, 8 were other human-caused kills, and 5 died of unknown causes.

Benn (1998) reviewed records of grizzly bear mortalities in the Central Rockies Ecosystem (CRE) of Alberta and BC (there is some overlap between the datasets of Benn [1998] and McLellan *et al.* [1999]). For his whole study area, humans caused 627 (98%) of all documented mortalities. On Alberta provincial lands, 190 human-caused deaths were recorded during 1972-1996. Legal hunters (including First Nations) killed 107 (56%), poachers killed 31 (16%), 48 (25%) were DLP kills, and 4 bears (2%) died of other human causes. Overall mortality rate was estimated at 6.1-8.3%, with a

substantial regional disparity. For the Bow River Valley and south, mortality rates were estimated at 1.5-3.1%, whereas north of the Bow River, mortality rates of 7.3-15.9% were estimated.

In the East Kootenays (BC) portion of the CRE, 319 man-caused mortalities were recorded between 1976 and 1996 (Benn 1998). Licenced hunters (excluding First Nations) killed 257 (81%), poachers killed 11 (3%), 48 (15%) were killed in DLP, and 3 (1%) deaths were of unspecified human causes. Man-caused mortality rates were estimated at 1.4% (1976-1981), 2.9% (1982-1996), and 2.5% for the entire period.

In Kootenay, Yoho, and Banff National Parks, humans caused 118 (91%) of 129 known grizzly bear mortalities from 1971 to 1996 (Benn 1998). Of these, 85 (72%) were DLP kills, 22 (19%) were killed on highways or railroads, and 11 bears died of other human causes. The man-caused mortality rates were estimated at 8-10% during 1971-1983, 2% during 1984-1996, and 4.5-5.7% overall. Clearly, even in National Parks which prohibit hunting, grizzly bears are not secure from human-caused mortality.

The data reviewed by Benn (1998) were based on records of *reported* mortalities, which are strongly biased toward legal anthropogenic sources. Natural mortalities are more difficult to document, especially without radiotelemetry. Therefore, the observations summarized above are best viewed as an evaluation of *human-caused* mortalities.

A second major problem for grizzly bear managers is the prevalence of undocumented human-caused mortality. In all jurisdictions, grizzly bear kills are subject to compulsory reporting. Most agencies attempt to account for unreported mortalities in their grizzly bear management plans, but documentation, especially for illegal kills, is difficult. McLellan *et al.* (1999) determined that without radio monitoring, 46-51% of all mortalities of radiocollared grizzly bears would have been unrecorded. For only human-caused deaths (including suspicious, unknown-cause deaths), 34-46% of mortalities would have been undocumented without radiotelemetry. Unreported mortalities have also been documented in an ongoing research program in west-central Alberta (G. Stenhouse, pers. commun.). In addition to illegal kills, it can be difficult to document accidental deaths (*e.g.*, roadkills) and First Nations kills, which are not subject to compulsory reporting in all jurisdictions.

Management responses to grizzly bear/human conflicts often include capture and translocation rather than destruction of the offending bear (Schwartz *et al.* In press). Although translocated bears have at least a chance at survival not realized if they were destroyed, translocation should not be considered a solution to conflicts. Homing ability is well-developed in grizzly bears, and many bears return quickly (Miller and Ballard 1982). In the Yellowstone area, survival rates of transported bears were lower than for bears that were not moved (0.83 *versus* 0.89), especially for males and adult females (Blanchard and Knight 1995). In northwestern Montana, 38% of translocated bears died within 2 years (Riley *et al.* 1994). Irrespective of survival of the transported individual,

any successful translocation must be considered functionally equivalent to a mortality to the source population.

Because grizzly bears are long-lived, have low reproductive potential, and their populations are difficult to monitor, they are extremely difficult to manage. Current demography in a grizzly bear population is the consequence of a series of events that occurred over the previous 10-20 years (Doak 1995). Managers need to ensure that population age distributions are “healthy”, and that reproduction and recruitment are maintained. Excessive mortality and disruption of breeding potential can lead to mistaken impressions of viability, wherein a few old bears persist at very low densities over several years. Such “living dead” populations exist in France (Camarra 1999), northern Italy (Osti 1999), and Spain (Clevenger *et al.* 1999).

Population Viability Analysis (PVA) is a technique used to predict population persistence. Increasingly, it is used to model extinction risk for grizzly bear populations (Mills *et al.* 1996; Herrero *et al.* 2000). Input variables for PVA are region-specific, so reasonable estimates of bear population characteristics and habitat conditions must be known and foreseeable. Because of the range of those variables among grizzly populations, it is not usually feasible to apply these models to predict the extinction risk in arbitrary areas, or to determine minimum sizes of protected areas (Mattson *et al.* 1996). Use of PVA to influence management actions requires at least 2 difficult decisions: what probability of extinction is acceptable, and for what length of time does an acceptable risk of extinction need to apply? Reducing the probability of extinction of a grizzly bear population to zero is impossible given existing conditions and stochastic events. Managers who need to maximize the likelihood of population persistence must be prepared to aggressively minimize, and perhaps reverse, human influences on grizzly bear habitat and populations. As willingness to accept risk of extinction increases, regulated limits on human activities can relax. Similarly, ensuring persistence over a 1,000-year period requires far more restrictive planning than if the acceptable time frame were 100 years (Mattson *et al.* 1996). Such decisions have profound bearing on human society, and cannot be made by wildlife managers alone.

7.1.1 The Effects of Hunting on Grizzly Bear Populations

All provinces and territories with grizzly bears provide hunting seasons for them. Licenced hunting accounts for about 84% of documented man-caused mortality (Table 11). Using mean annual harvests during 1990-1999 (Table 11) and the current population estimates (Table 6), annual harvests have been 0.6 – 3.4%. Undoubtedly, harvests have exceeded these averages in some years and in some areas.

Grizzly bear populations “under optimal conditions for reproduction, natural mortality, and with males twice as vulnerable as females” are estimated to be able to sustain a maximum annual harvest rate of 5.7% (Miller 1990b:357). Grizzly bear management strategies in Canadian jurisdictions include goals of total man-caused mortality of 6% or less of estimated populations. Generally, other man-caused mortalities are subtracted from total quotas before harvest allocations are made.

Assuming that population estimates are accurate and all man-caused mortalities are documented, hunting mortality in Canadian jurisdictions is likely to be sustainable. Unfortunately, the fact that neither assumption is reasonable dictates that a conservative approach to all parameters is required.

As with all polygynous species, more male grizzly bears can be harvested than females without detriment to the population (Caughley and Sinclair 1994). Most management agencies actively direct harvest toward male bears, by protecting family groups and by scheduling hunting seasons when males are relatively active. In addition, male bears are larger and are preferred by most hunters. During 1990-1999, 65% of annual harvest in Canada has been male (Table 11). Consequently, the reproductive core of a bear population, the adult females, is granted greater protection. However, this harvest strategy, or any strategy that concentrates relatively high harvest on males, may exert pressure on the population against the natural density of males and adult sex ratio toward which the population gravitates under unharvested conditions. The social and behavioural implications of this are wholly unknown, but are likely important and warrant further study.

Heavy hunting pressure can alter grizzly bear population characteristics. An estimated annual average harvest rate of 11% over 12 years reduced an Alaskan bear population by 36%, and the female population by 32% (Reynolds 1999). Following 10 years of deliberate effort to reduce the bear population in another Alaska study, the sex ratio declined from 82 males/100 females to 28 males/100 females, although no change in density was measured (Miller 1995).

Information on sex and age composition of the harvest should not be considered a proxy for those parameters in the population, because different classes of bears may be more vulnerable to hunters (Bunnell and Tait 1980) and because hunters are selective (Miller 1990*b*). Interpretations of harvest data also often assume a stable age structure in the population (Miller 1990*b*). Misinterpretation of data on harvest characteristics may lead to unsubstantiated conclusions of population status. For example, commonly used indicators of overharvest include a declining harvest age structure or an increase in proportion of females in the harvest (Miller 1990*b*), so failure to detect these trends might be interpreted as an indicator of population stability. However, there was no change in population age distribution in a heavily hunted area in Alaska (Miller 1995). Similarly, the relative vulnerability of male bears to harvest (Bunnell and Tait 1980) may conceal their actual decline in an overharvested population. In addition, low harvest rates mean small sample sizes, with correspondingly low statistical power to detect population decline from harvest data (Harris and Metzgar 1987).

Protection of female bears is not assured by establishing minimum proportions of males in the harvest (Miller 1990*b*). If those proportions are not met, restructuring of regulations to increase the male harvest (*e.g.*, earlier season opening) may be less appropriate than decreasing the female harvest. It is more important to protect an absolute number of female bears than to maintain a particular proportion of females in the harvest.

Trophy hunting of male bears is considered by some to be neutral or beneficial for populations because reduced male density is believed to increase cub production and survival, and to thereby stimulate population growth (review in Miller 1990a). The purported mechanism is that adult males are infanticidal and suppress population growth, and their removal is compensated by reduced intraspecific stress and increased recruitment. However, a review of research studies was inconclusive as to evidence of such density-dependent compensation in grizzly bear populations (McLellan 1994), and it was recommended that until such evidence was clear, managers should presume that rate of recruitment will not increase as a result of reduced population size (Taylor 1994).

Recent research suggests the opposite effect. In Sweden, brown bear cub survival was lower in an area with higher adult male mortality, and immigrating males were implicated as the cause of cub deaths (Swenson *et al.* 1997; In Press). Cub survival was reduced for 1.5 years after adult males were removed, indicating social disruption persisted for that long. When no adult males were removed for at least 1.5 years, cub survival was 0.98 to 1.00, suggesting that established resident males killed few cubs. Swenson *et al.* (1997) concluded that killing 1 adult male bear had a population effect equivalent to removing 0.5 to 1 adult female. In comparing hunted and unhunted grizzly populations in Canada, and controlling for differences in habitat quality and density, Wielgus and Bunnell (1995; 2000) found lower reproduction rates, mean litter size, and age at first parturition in the hunted population. Males immigrating to replace hunter-killed males were considered potentially infanticidal, and resident females avoided those bears and the high-quality habitats they used. The polarization of opinion on this topic among researchers, compounded by a dearth of conclusive data, supports the recommendations that this issue be treated conservatively and become the focus of directed research.

Because of the difficulty in obtaining accurate demographic data, a lack of understanding of the full suite of consequences of bear mortality, and the species' inherent low ecological resiliency (Weaver *et al.* 1996), management plans and harvest goals must in all cases be cautious and conservative.

7.1.2 The Trade in Bear Parts

Asian medicine has relied on bear parts for thousands of years. Today, demand for bear parts persists with practitioners of traditional medicine, has expanded from China to Korea and Japan, and has followed Asian immigrants to other continents. Bile from bear gall bladders has been the substance most widely sought, but markets exist for other body parts, especially paws. Bear bile and galls comprise putative remedies for a number of internal ailments including diseases of the liver, heart, and stomach.

Bear bile and galls are valuable. Documented retail prices can reach US\$500/gram for bile, and US\$2,000 for whole gall bladders (Servheen 1999b). Reliance on bears and bear parts has contributed substantially to the decline in distribution and populations of several bear species in Asia. Exploitation of bears for medicinal supplies has expanded to include North American bear populations to

address demand of traditional users in both North America and Asia. All bear species are used to provide medicinal ingredients. Because of the difficulty in successfully prosecuting offenders, and the relatively mild penalties imposed by many jurisdictions, poaching for wild bears is perceived to be highly profitable.

With the exception of a limited market for pelts, no Canadian jurisdiction permits trade in grizzly bear parts. Therefore, all such trade is illegal and impossible to document or monitor, and it is difficult to evaluate the magnitude of exploitation of North American bear populations. However, reports of successful prosecutions (*e.g.*, BCMOE 2001a) indicate that it occurs. Efforts to curtail trafficking in bear parts have improved in some areas. For example, BC passed legislation in 1997 that prohibits possession of bear gall bladders or any part or derivative of a bear gall bladder. Further, it is illegal in BC to possess any product that contains—or is alleged to contain—bear bile. Although aggressive legislation is essential to inhibit trade in bear parts and undoubtedly is a partial deterrent, offences and prosecutions continue.

As populations of wild Asian bears continue to drop from habitat degradation and excess killing, the Asian supply of bear parts will decline further and pressure to compensate for this shortfall by exploiting other bear populations will increase. There are more wild bears in North America than in the rest of the world combined (Servheen 1999b). In light of the high profits available from trafficking in bear galls, bile, and other parts, it is probable that North American bear populations, including grizzlies, will come under increasing pressure to supply this market.

Medicinal use does not account for all trade in bear parts. The trophy value of grizzly bears, in particular, also inspires some degree of poaching and commercial traffic in grizzly trophies (*e.g.*, BCMOE 2001b). If legal hunting opportunities for grizzly bears in Canada and elsewhere become more restricted, this threat can be expected to increase.

7.2 Habitat

Habitat perturbations influence an area's capacity to support grizzly bears. Although natural and anthropogenic habitat alterations can be beneficial to bear populations (*e.g.*, enhancement of early forest successional stages through fire or timber harvest), of greater concern to grizzly bear status and conservation are those activities which degrade habitat effectiveness. Foremost in importance among habitat alterations are those which convert grizzly bear habitat to areas which will not be suitable for bears either permanently or over a long-enough term to affect population characteristics. Included in this category are certain resource-extraction industries, agriculture, and residential development. For many years, such developments proceeded throughout much of grizzly bear range effectively or completely unmitigated. Recently, however, in response to acknowledged declines in the global, North American, Canadian, and local distributions of grizzly bears, proposed developments are increasingly subject to critical scrutiny. Examples of recent attempts to assess the

effects of proposed industrial developments on grizzly bear habitat and populations include Herrero and Herrero (1996), Diavik (1998), and BHP (2000).

Mining and hydrocarbon extraction are of concern because the nature of valuable geologic deposits dictates that mines are dug and wells are drilled where the deposits happen to be found; locating and extracting those resources in other, more environmentally appropriate locations is often not possible. Society's demand for those resources, therefore, directs that within certain constraints, we *will* have those mines and wells and some degree of habitat loss will occur. Particularly precious resources such as oil and gas can drive economies on the provincial or federal scale, exerting considerable pressure against the need to preserve grizzly bear habitat.

For example, gross revenues from hydrocarbon production in Alberta exceeded \$26 billion in each of 1996 and 1997, and 76% of production is exported from the province (Alberta EUB 1999). In support of this, over 200,000 wells have been drilled in Alberta since 1902, with annual increments of 8,000 to 13,000 during recent years. In addition, by the end of 1998, the total length of pipelines within Alberta was 264,000 km; the oilfield road network is thousands of kilometres long. A substantial, but unknown, fraction of these wells, pipelines, and roads occurs within current grizzly bear distribution. Each well site, access road, and servicing pipeline constitutes a long term or permanent habitat alteration, and most should be considered negative. Pipelines and roadside verges may provide foraging opportunities for bears (Nagy and Russell 1978), but increased vulnerability to hunters may offset any potential advantage. Hydrocarbon exploration and development are also progressing rapidly in southwestern Northwest Territories, and interest in development of a pipeline along the length of the Mackenzie Valley has been recently renewed.

Until the late 1980s, the grizzly bears of the Canadian Arctic were relatively remote from industrial developments. However, the announcement of the discovery of diamonds in 1991 triggered unprecedented interest and exploration activity. Between 1991 and 1993, more than 23,000 diamond-related mineral claims, encompassing over 160,000 km², were staked in the Slave Geologic Province of NWT and Nunavut (Mining Recorder's Office, Department of Indian Affairs and Northern Development, Yellowknife, unpublished records). By the end of 2001, one diamond mine was in production, a second was nearing start-up, and several more were in advanced stages of exploration, or development applications were in review. In 1999, the sole producing diamond mine contributed 19% of the Gross Domestic Product of the Northwest Territories (BHP 2000). Development of mines on the Arctic tundra brings a new threat to grizzly habitat. Although mine footprints are relatively small, habitat effects are exacerbated by the open tundra landscape, the local intensity of disturbance, the relative scarcity and importance of high quality habitat patches, and exceptionally low bear density. Each development also serves as a potential site of conflict between bears and humans, with associated risk of bear mortality. Because of the enormous home range sizes typical of Arctic grizzlies (Table 5), bears have an elevated risk of encountering even widely dispersed and low-density developments, especially if those sites are attractive to bears because of the presence of anthropogenic food material or bears' natural curiosity and

inclination to investigate potential food sources. The birth and rapid development of the diamond-mining industry in Canada point to the capriciousness and unpredictability of resource extraction activities and the markets that drive them. Barely one decade ago, few would have anticipated intensive interest in mining within the barrenlands of the central Canadian Arctic. It is conceivable, and even predictable, that within the next decades, pressure will mount to exploit resources which have not yet been discovered, or for which current demand is non-existent.

Commercial timber harvest in Canada alters a substantial amount of grizzly bear habitat each year. During 1997, clearcut logging totalled 175,808 hectares in British Columbia, 50,697 hectares in Alberta, and 429 hectares in NWT (BC MOF 1998a; NRC 1998). In the Yukon, 1,921 hectares were clearcut in 1996. Habitat effects of timber harvest are dynamic, and depending on post-harvest treatments, bears may respond positively to early seral stages during revegetation of cutblocks. However, McLellan and Hovey (2001a) found very little bear use of large regenerating cutblocks in southeastern British Columbia, because few bear foods occurred there. With all cutblocks, for at least a short term after logging, habitat effectiveness is profoundly reduced. Associated with timber harvesting is the development of roads. As of 1998, the BC provincial forest was accessed by a network of roads including 43,000 km of Forest Service Roads, 120,000 km of permitted (operational) roads, and 150,000 km of abandoned roads and trails, for a total of 313,000 km (BC MOF 1998b). "Abandoned" roads and trails are no longer maintained, but in most cases are likely accessible to all-terrain vehicles. Each year, 5,000-10,000 km of roads are added to this total.

Agricultural development was probably responsible for a substantial component of grizzly bear range contraction in Canada, and continues to date. Conversion to crop land permanently deletes that land as grizzly bear habitat. Livestock grazing leads inevitably to grizzly bear mortality when bears are removed because of real or perceived threats of depredation (LeFranc *et al.* 1987).

Of all anthropogenic habitat alterations within grizzly bear range, the most disruptive is probably residential development. With increasing affluence, more people build homes on the fringes of grizzly bear distribution. With most industrial developments, human activities are confined temporally on a diurnal, seasonal, or rotational scale. When the people leave, so does the habitat disruption, with the possible exception of a disturbed footprint. Residential developments are more disruptive because the human presence is virtually continuous and permanent. Although the area of habitat displacement related to a single home may be small, each contributes to the cumulative influence of whole subdivisions, and works in concert with other developments and activities in the region. Additionally, the attractants usually associated with human homes (*e.g.*, garbage, pet food, livestock) dictate that bears with home ranges overlapping with permanent human habitation are at extremely elevated risk of mortality (McLellan 1994).

In most cases, effects of individual human activities do not operate in isolation to influence grizzly bear habitat or populations. For example, in west-central Alberta, human activities including timber harvest and coal mining apparently reduced grizzly

bears over the period 1971-1995 (Herrero and Herrero 1996). This apparent population decline could not easily be attributed to specific causes, but a combination of excessive human-induced mortality, and habitat loss and alienation due to development were probable causal factors. Overall, existing human developments and activities in the area appeared to have been the primary factors leading to apparent carnivore population declines. Technological advances and enhanced modelling power (e.g., Geographical Information Systems) have improved the ability of managers to predict, evaluate, and mitigate cumulative environmental effects, but the rate at which cumulative effect scenarios are developing in grizzly country is increasing rapidly.

Because it is not feasible to quantify all contributions to grizzly bear habitat alteration, and recognizing that they are a direct consequence of human population, the trend in numbers of people is a useful analogue of these activities. Strong associations between human density and loss of carnivore populations have been documented (Woodroffe 2000). In addition, the distance to, and size of, human population centres were strongly correlated with grizzly bear habitat effectiveness (Merrill *et al.* 1999). Human density in Canada increased almost 9-fold between 1861 and 2000, the period of most decline in the abundance and distribution of grizzly bears. Although the bulk of Canadians continue to live in the east, the rate of population growth in recent years is higher in the provinces and territories that have grizzly bears. Between 1971 and 2000, the Canadian population increased by 43%, less than the increase in Alberta (84%), BC (86%), Yukon (61%), or Northwest Territories including Nunavut (101%). The total population for the region increased by 85% over the same period. Population growth *rates* may decline over the short-term future, but *absolute* population within grizzly bear distribution will certainly increase (McLellan 1994; Herrero *et al.* 2000).

There is a clear link between habitat degradation and population effects in grizzly bears. Doak (1995) modelled the reduction of habitat quality in the Yellowstone area and predicted that even small amounts of habitat degradation could result in rapid declines in grizzly population growth rates. Even more insidious was his finding that when the rate of degradation was slow (1% per year), it could take more than 10 years to detect critical amounts of degradation beyond which bear populations could begin long-term declines.

7.2.1 Potential Consequences of Climate Change on Grizzly Bear Habitat

Global warming could lengthen the growing season particularly for bears at high latitudes, increasing the period during which green forage is available. These effects could be direct, in providing more vegetation for bears to consume, and indirect, in increasing habitat quality for bear prey—if those enhanced resources would be present at times when they are accessible to bears or migratory bear prey. This could shorten the duration that bears are confined to their dens and in a negative energetic state. If bears are able to exploit enhanced food resources, conceivably this could result in larger bears, lower mortality rates, and higher litter sizes and other reproductive parameters. Some landscapes may increase in overall productivity, and bear carrying capacity could increase. These changes may be most noticeable in marginal current

bear habitats such as Arctic or alpine tundra, and if productivity of high-Arctic environments increases, grizzly bear distribution may expand to include those areas.

Conversely, increasing temperatures will raise sea level and result in the inundation and loss of some of today's most productive coastal bear habitats. If warming is accompanied by generally drier conditions, plant-community structure may be altered such that productive, moist environments decline and are replaced with poorer-quality assemblages, with less palatable or less nutritious vegetation, and lower biomass of potential bear prey. Increasing temperatures may also facilitate human habitation of areas presently considered inhospitable, with the attendant problems related to conservation of grizzly bears within human-occupied landscapes.

However, such predictions are simplistic and wildly speculative because of the complexities of interactions among components of grizzly bear habitat. It is impossible to model the effects on each trophic element below grizzly bears, and many of those elements have keystone roles in defining bear habitat quality. For example, accurately predicting the positive or negative consequences of climate change on salmon or caribou life history and populations is unrealistic.

Throughout Section 7 of this report, evidence is presented that the greatest threats to the conservation of grizzly bear populations and habitats are those posed by human activities. Among all prophecies related to climate change, none is more unpredictable than human responses to a changing climate. How these may influence grizzly bears is beyond speculation.

7.3 The Effects of Roads on Grizzly Bears

The U.S. Fish and Wildlife Service (1993) believes that "roads probably pose the most imminent threat to grizzly habitat today" (pg. 21), and that "the management of roads is the most powerful tool available to balance the needs of bears and all other wildlife with the activities of humans" (pg. 145). Although direct mortality of grizzly bears from roads (*i.e.*, roadkills) has been documented, the most important effects of roads on grizzly bears are (1) loss of habitat effectiveness because of bears avoiding the disturbance associated with roads, and (2) shooting mortality facilitated by the development of new access routes for hunters and others with firearms.

7.3.1 Habitat Effects

Grizzly bears may be vulnerable to individual disruption arising from construction, maintenance, and use of linear developments. Efficient foraging strategies of bears were disrupted near human facilities including roads in Yellowstone National Park (Mattson *et al.* 1987). Archibald *et al.* (1987) documented, between prehauling and posthauling, a 33% and 39% reduction, respectively, in the number of times that 2 bears crossed a logging road in the Kimsquit Valley in British Columbia. These bears did not appear to habituate to logging traffic after 2 years of hauling. Grizzlies in southern Alberta did not appear to habituate to high-speed, high-volume traffic on the Trans-

Canada Highway (Gibeau *et al.* 2002). However, some authors believe that grizzly bears may become accustomed, or desensitized, to predictable occurrences, including traffic (Tracy 1977; Bader 1989; McLellan and Shackleton 1989). Presumably, bears are unlikely to habituate to infrequent traffic, and individuals may react more vigorously to once-per-week vehicle passages than to vehicles passing every few minutes. Similarly, regular spacing of vehicles is likely to contribute more toward habituation than the same volume of traffic concentrated in a brief period. Habituation may permit some bears to exploit high-quality habitats adjacent to roads; however, it may also greatly increase the likelihood of collision mortality or negative bear-human interactions, with the attendant risk of management action to remove problem bears. Another factor likely to influence bears' responses to human activity is whether or not bears are hunted. Habituated bears do not survive in hunted populations.

Disturbance along roads may result in habitat avoidance for grizzly bears. Logging-truck traffic in the Kimsquit Valley in British Columbia resulted in a 78% reduction in use of the "Zone of Hauling Activity" by radiocollared bears compared to non-hauling periods (Archibald *et al.* 1987). For 14 hours/day, 3%-23% of each bear's home range was unavailable to them because of disturbance. Because bears used these areas when hauling was not going on, it was clear that these areas were of value to the bears. In rich habitats such as coastal BC, where bear home ranges are small, these losses can limit access to important food sources.

In southeastern British Columbia, McLellan and Shackleton (1988) calculated that 8.7% of their total study area was effectively lost to bears as a result of road avoidance. Mattson *et al.* (1987) estimated that habitat effectiveness lost to developments was sufficient to support 4-5 adult female grizzly bears in their study in Yellowstone National Park.

On the Rocky Mountain Front in Montana, Aune *et al.* (1986) reported that for all monitored bears, "In spring and fall the 0-500 m distance to road category was used significantly less than expected. All other categories were used as much as expected when compared to random chance. In summer this distance category was used as much as expected. Results imply that in summer for all grizzlies sampled, road influence zone could be less than 500 m but during spring and fall may be at least 500 m." (pg. 59). Road-habituated bears "showed no significant road avoidance in spring or summer in the 0-500 m category. However (they) did significantly avoid this zone in fall. It appears that any road influence on these bears would be less than 500 meters from the roadside for spring and summer." (pg. 62). Bears which were classed as non-habituated to roads within their home ranges "showed significant avoidance of the 0-500 meter road category for all three season(s) and for fall the avoidance was significant to 1,000 meters of the roads." (pg. 62). In northwestern Montana, grizzlies used habitats within 914 m of roads at just 20% of the predicted rate, and used areas >1,860 m from roads more than predicted (Kasworm and Manley 1990). Female grizzlies avoided the Trans-Canada Highway in Banff National Park irrespective of habitat quality; male bears also avoided the highway, except when it traversed high-quality habitats (Gibeau *et al.* 2002). In southcentral BC during spring, 85% of bears avoided habitats—including highly-preferred habitats—adjacent to transportation corridors including the Trans-Canada Highway and a trans-continental railroad (Munro

1999). Avoidance was most pronounced in female bears, which avoided transportation corridors in all seasons.

Ruediger (1996) hypothesized that net impact on carnivores increases with construction standard of roads. High-speed, high volume interstate highways probably have a greater impact on carnivore populations than do small rural roads. Intuitively, heavily used roads probably have a larger negative effect on grizzly bears than quieter roads. Gibeau (2000) reported that adult female grizzly bears that would not cross the Trans-Canada Highway in Banff National Park (21,000 vehicles per day with an average speed of 110-115 km/hr), would cross other 2-lane highways (2,230 – 3,530 vehicles per day with an average speed of 80-115 km/hr). In northwestern Montana, the number of grizzlies showing selection for 500-m buffers surrounding roads decreased as traffic volume increased (Mace *et al.* 1996). All bears in this study avoided buffers around roads with >60 vehicle passes per day, and most avoided buffers around roads with >10 vehicle passes per day, but there was some selection, or neutrality, for buffers surrounding roads with <10 vehicle passes per day.

“Trails” include foot, bicycle, and equestrian trails, and may include roads that are closed to public use. Trails used by motorized off-highway vehicles are presumed to have the same effects on grizzly bears as roads. In northwest Montana, grizzlies avoided habitats within 274 m of trails (Kasworm and Manley 1990). Overall, trails displaced grizzly bears less than roads did in that study. In the Swan Mountains, Montana, grizzlies were found significantly further than expected from trails during spring, summer, and autumn (Mace and Waller 1996). These authors concluded that grizzly bears using the hiking area have become negatively conditioned to human activity occurring within and outside the area, and that they minimized their interaction with recreationalists by spatially avoiding high-use areas.

Roads and other linear developments may serve either as filters or barriers to the movements of grizzly bears. A highway appeared to exert short-term deflections on movements by 3 bears, all adult females, in Alaska (Miller and Ballard 1982). Gibeau *et al.* (2002) reported that in 7 years, a single radio-collared adult female grizzly and 2 radio-collared adult males crossed the Trans-Canada Highway in Banff National Park, and concluded that the highway was a barrier to adult female bears. Based on genetic sampling, Highway 3 through the Crowsnest Pass in southern Alberta and British Columbia is nearly a barrier to female grizzlies, and has apparently reduced male movement as well (Proctor *et al.* In Press). In Slovenia, a highway served as a home range boundary for 3 radio-monitored adult brown (grizzly) bears (Kaczensky *et al.* 1994). These bears approached the highway, closely at times, but the 2 females did not cross it and the male crossed it only twice.

No absolute threshold has been determined to define a road density which is acceptable to grizzly bears. In the Swan Mountains of northwestern Montana, grizzly bears used only areas with total road density (including closed and rarely used roads) <6.0 km/km² (Mace *et al.* 1996). Merrill *et al.* (1999) provide evidence for 1 km/km² of roads and trails as being a broader-scale threshold for relatively productive habitats

such as those found in the US Selkirks and Cabinet-Yaak ecosystems. At some density, roads will become complete barriers or mortality sinks to grizzlies (Ruediger 1996), even if adjacent habitats would support their populations. However, it is difficult to predict the consequences of any particular road density on a bear population since many factors such as habitat, road type, and traffic volumes also affect the degree to which bears avoid roads.

Effort has been made to standardize allowable road densities in grizzly bear recovery zones. At present, these range from 0.75 mi. open road/mi² (0.47 km/km²) to 1.0 mi. open road per mi² (0.62 km/km²) (US Fish and Wildlife Service 1993). The Gallatin National Forest in Montana has adopted an open road density standard of 0.5 mi./mi² (0.31 km/km²) (Paquet and Hackman 1995). It should be noted that the definition of “open roads” includes roads which are closed to public users but which are subject to administrative use exceeding “...one or two periods that together ... exceed 14 days during the time bears are out of the den (usually between April 1 and November 15)” (US Fish and Wildlife Service 1993:148).

Not all authors agree with these standards. Craighead *et al.* (1995) argue that these densities are much too liberal. They advocate, for grizzly bear recovery and conservation, an open road density no higher than 1.0 km per 6.4 km² (0.16 km/km²; 0.25 mi/mi²). They further recommend that roads on federal or state land that exceed this density be closed and obliterated.

Social disruption of grizzly bear populations resulting from linear developments has also been reported. Most records of habitat avoidance (see above) probably also represent cases of social disruption because displaced bears are forced into concentrations higher than those they might naturally seek. If different cohorts of bears demonstrate different tolerance for disturbance, then the resulting spatial arrangement of bears may also be suboptimal. Subordinate cohorts of bears were displaced into poorer-quality habitats near developments by more dominant classes, particularly adult males, in Yellowstone National Park (Mattson *et al.* 1987). McLellan and Shackleton (1988) also determined that adult males used remote areas whereas adult females and some subadults used areas closer to relatively low-use roads in southeastern BC. Conversely, female grizzlies remained further than males from high-volume highways in southwestern Alberta, regardless of relative habitat quality (Gibeau 2000).

7.3.2 Population Effects

Many authors have reported mortality in grizzly bear populations as a direct or indirect consequence of linear developments. Grizzly bears may be killed in collisions with vehicles (LeFranc *et al.* 1987; Gibeau and Heuer 1996). Gunson (1995) analyzed records of 798 grizzly bear mortalities on provincial lands in Alberta from 1972 to 1994; 5 bears were killed by trains, and 4 by other vehicles. Although such mortalities can be important to small or low-density populations, most authors concur that greater mortality effects arise out of indirect consequences of the construction of roads and other linear developments.

During winter (roughly November 15 to April 1), nearly all grizzly bears are in dens (Linnell *et al.* 2000). Bears may be displaced from their dens by industrial activity or other disturbance (Harding and Nagy 1980; Swenson *et al.* 1997). Bears that flee their dens during winter will likely experience severe physiological stress and may die. Pregnant females may lose their cubs (Swenson *et al.* 1997), and abandoned cubs will not survive. The danger of winter industrial operations within grizzly bear denning areas is that precise locations of dens will not be known, and new construction or other activities may inadvertently approach them very closely.

Linear developments like roads generally lead to increased mortality for grizzlies. Benn (1998) investigated the location of recorded grizzly bear kills in the Central Rockies Ecosystem. In Banff and Yoho National Parks, all 95 human-caused bear deaths with known locations occurred within 500 m of roads or frontcountry (*i.e.*, road-accessible) facilities, or within 200 m of trails or backcountry facilities. In the Alberta portion of the Central Rockies Ecosystem (CRE), 153 (89%) of 172 known-location kills were within 500 m of a road or within 200 m of a trail. In the East Kootenay (BC) portion of the CRE, 122 (71%) of 172 kills with known locations occurred within 1,000 m of a road or trail. Spatial analyses indicated that grizzly kill sites were not random with respect to the occurrence of roads and trails. Again, it must be noted that Benn's (1998) data pertain to reported mortalities of non-radiocollared bears, and are therefore biased against natural mortalities. The distribution of natural grizzly bear mortalities may be independent of human developments including roads and trails.

In the Flathead Valley of southeastern BC, 7 of 13 successful grizzly bear hunters had been on a road when they shot their bear (McLellan 1989b). Many other authors have identified shooting mortality in grizzly bear populations that was related to roads or other industrial access (*e.g.*, Aune and Kasworm 1989; Horejsi 1989; Knick and Kasworm 1989; Nagy *et al.* 1989; Titus and Beier 1992). Conversely, in a protected grizzly bear population in northwestern Montana annual mortality rates were 15 times higher in wilderness areas than in multiple-use areas, primarily from self-defence and mistaken-identity shootings (Mace and Waller 1998).

Even in un hunted populations, the geographic location of most human-caused grizzly bear mortalities is strongly correlated to human developments. All 8 human-caused mortalities in a study in northwestern Montana resulted from road access and illegal killing or management-related removals (Mace *et al.* 1996). Mattson *et al.* (1996) reviewed grizzly bear mortality in the Greater Yellowstone Ecosystem (GYE). A disproportionate 68% of all mortality occurred in habitat substantially impacted by humans yet this habitat represented 33% of the total habitat available to grizzly bears. Mortality in these impacted habitats was 5.8 and 11 times greater than the lowest rates in United States Forest Service roadless areas and United States Parks Service backcountry, respectively. Doak (1995) estimated that mortality risk for grizzly bears in the GYE was 5 times higher near roads.

Indirect mortality as a result of linear developments may occur in other forms. Mattson *et al.* (1987:271) stated "...that avoidance of roads and developments by

grizzly bears in Yellowstone Park probably resulted in poorer condition adult females and, consequently, higher mortality rates and lower fecundity for the cohort.” Gibeau (2000) reported that bears living in areas of unrestricted human access used lower quality habitat and travelled more than bears in restricted areas, thereby retaining less energy for growth and reproduction.

Indirect population-level effects may occur at a broader scale as well. That adult female grizzlies never crossed the Trans-Canada Highway in Banff National Park (Gibeau 2000) indicates potential interruption of population connectivity, and raises concerns about resultant effects on genetic diversity within this population. Adult bears rarely crossed a highway in Slovenia, and inbreeding is a concern in this small population of bears (Kaczensky *et al.* 1994). Reduced litter sizes and other indicators of inbreeding depression have been reported for inbred, captive brown bears (Laikre *et al.* 1996). Genetic diversity is important in maintaining evolutionary potential and individual fitness. Maintenance of genetic diversity in grizzly bear populations, however, is dependent upon connectivity to populations on the scale of the entire North American distribution (Paetkau *et al.* 1998). For isolated bear populations such as in Yellowstone and the North Cascades, a near-complete loss of genetic diversity is likely unless connectivity is restored or the population is augmented (Paetkau *et al.* 1998).

Table 12. Mean annual recorded man-caused mortalities in Canada during 1990-1999.

Jurisdiction	Hunter kills ¹				Non-hunting man-caused			total
	Males	Females	U/k sex	Total	Illegal	DLP	Other	
Alberta	9.1	4.7	0.0	13.8	3.7	4.2	3.1	24.8
British Columbia	187.3	101.6	0.0	288.9	5.9	40.2	n/a	335.0
Yukon ²	51.0	27.5	0.0	78.5	n/a	13.2	1.5	93.2
NWT and Nunavut ²	8.1	1.7	1.0	10.8	n/a	9.4	n/a	20.2
ISR and GSA ³	21.1	5.2	4.1	30.4	included in hunter kills			30.4
Total	276.6	140.7	5.1	422.4	9.6	67.0	4.6	503.6

¹Includes recorded First Nations kills in Alberta, Yukon, and NWT/Nunavut, but not BC (data not available).

²Excluding Inuvialuit Settlement Region and the Gwich'in Settlement Area.

³Inuvialuit Settlement Region and Gwich'in Settlement Area.

8. EXISTING LEGAL PROTECTION OR OTHER STATUS

8.1 International

Globally, the grizzly (brown) bear is listed by IUCN (The World Conservation Union) as LR(lc): Lower Risk, least concern. The species is listed in Appendix II of CITES (Convention on International Trade in Endangered Species), although populations in Bhutan, China, Mongolia, and Mexico are listed in Appendix I.

Grizzly bears in the conterminous 48 United States were listed in 1975 under the Endangered Species Act as Threatened (USFWS 1993). The US distribution is less

than 2% of its former range, and the total of 5 or 6 population units is 800-1,000 bears. Some US population units are contiguous with Canadian grizzly bear range.

8.2 Management in Canada

8.2.1 Alberta

In Alberta, the grizzly bear is Blue-listed (species *may be* at risk). The first goal of the Alberta grizzly bear management plan (Nagy and Gunson 1990) is to increase the provincial bear population to 1,000. The plan identifies 13 Bear Management Areas (BMA). Bear densities were estimated from research data in 5 representative habitat regions, and were extrapolated across occupied bear range and adjusted as necessary. Calculated bear densities ranged from 4.0 –14.7 bears /1000 km². The number of resident bears in each BMA and Wildlife Management Unit (WMU) was originally (1988) calculated as a function of the area of suitable habitat and the estimated bear density.

In this formula, the effect of land surface disturbance on grizzly bear habitat capability was estimated using current land-use maps. The actual surface area disturbed was doubled in the formula to buffer disturbance effects on bears. Results were considered to represent the maximum spring grizzly population in each BMA or WMU.

In subsequent years, the population estimate has been revised annually, based on the original anchor point calculated in 1988. The formula for revision of population estimates is based on the assumption that if total known man-caused mortalities are below the level judged to be sustainable, then the population will increase. In 2 areas where DNA-based inventories have been recently conducted (Mowat and Strobeck 2000; Boulanger 2001), population estimates were re-anchored at revised (higher) levels.

The maximum allowable man-caused mortality is 6.0% of the estimated grizzly bear population in each BMA. To account for non-hunting man-caused mortalities, the allowable annual licenced harvest is reduced by the ratio of legal kills to total kills. Unrecorded man-caused mortalities are estimated as 25% of the recorded kills. This results in a typical harvest quota of 2 - 4% of the estimated population in each BMA open to hunting. A further goal is to restrict the proportion of females in the total man-caused mortality to no more than 35%.

Legal grizzly bear hunting in Alberta is by residents only, during the spring, with licences available on a draw system. Bears in any group of >1 bear are protected. Baiting is prohibited, and kills must be registered.

Critique

The 46% population increase in Alberta over the period 1988-2000 (Table 6) is attributed largely to recovery following reduction of harvest mortality beginning in 1988 (Section 6.1). Although it is likely that some population recovery has occurred, the reported rate may be optimistic. Calculation of this rate of growth presumes that

populations occurring below habitat carrying capacity will recover quickly when harvest mortality is relaxed. It also presumes that undocumented man-caused mortality has remained stable and has not compensated for the decline in hunter kills. Further, it presumes that populations are presently below habitat carrying capacity, thus permitting growth, with no provision for assessing the point when carrying capacity has been reached and population growth decelerates and ends. Actual changes in bear habitat quality are not monitored or incorporated into revised estimates of changing habitat suitability. Although documented mortality rates have declined since 1987, it is doubtful that general habitat quality has improved over the same period.

In the portion of the province consisting of BMAs 5, 13, and 16 as well as small additional areas with cumulative population potential of <20 (Nagy and Gunson 1990), the bear population is estimated to have doubled from 73 to 150 since 1988 (H.D. Carr, pers. commun.). BMA 5 is Kananaskis Country, a popular multiple-use area within a 1-hour drive of about 1 million people, where the grizzly population was estimated at 34 in 1990 with a potential for 43. BMA 13 consists of agricultural fringe areas estimated to be devoid of grizzly bears in 1990 and unable to support a resident bear population (Nagy and Gunson 1990). BMA 16 is the boreal forest of northeastern Alberta, with an estimated supportable population of 33 bears and where the population estimate in 1990 was 8. Because of generally poor habitat conditions in the rest of this area, most of the reported 77-bear increase presumably occurred in BMA 5 (Kananaskis Country). However, the Kananaskis bear population was estimated at 50 or less in 1998 (ESGBP 1998), and the reproductive rate observed in this area (0.19) is the lowest for any reported grizzly bear population in North America (Garshelis *et al.* 2001). Using Population Viability Analysis (PVA) modelling, Herrero *et al.* (2000) predicted that the grizzly population in the Central Rockies Ecosystem, including Kananaskis Country, is not secure, and the management goal of maintaining or increasing the population in this area is unlikely to be met. This portion of the province is 1 example of where the management model may be optimistic.

It is also believed that grizzly bears have recently recolonized portions of their historic range in Alberta thereby increasing their distribution and provincial population size (H.D. Carr, pers. commun.). This assumption is based upon increases in reported incidents (*e.g.*, nuisance complaints) involving grizzly bears, rather than on any measured change in population status. However, in most cases increased incident reports reflect increased human activity in bear habitat (Miller 1990*b*), and should not be used to substantiate population expansion or growth. More commonly, increased conflicts between bears and people correspond to bear population declines, rather than increases (Miller 1990*b*).

Estimates of undocumented mortality rates in Alberta (equivalent to 25% of documented mortalities) are probably too low. Based on McLellan *et al.* (1999), only about one-half of total grizzly deaths would have been recorded without the use of radiotelemetry.

Because of the rate and intensity of human-induced degradation of much of grizzly bear habitat in Alberta, maintenance of adequate protected areas and linkage zones will be essential. This is particularly important in the southern half of the province where bear distribution is restricted to a narrow strip that is dissected by at least 2 major transportation and development corridors (Crowsnest Pass and Bow Valley) and is therefore relatively vulnerable to fracture. Because some existing “protected areas” have themselves been severely degraded (Gibeau 1998; 2000), proactive measures will be required to maintain population viability.

8.2.2 British Columbia

Grizzly bears in British Columbia are blue-listed (S3: Vulnerable), indicating they are considered to be at risk because of characteristics that make them particularly sensitive to human activities or natural events. The primary goal of the British Columbia Grizzly Bear Conservation Strategy is to “maintain the diversity and abundance of grizzly bear populations and ecosystems throughout British Columbia” (Province of British Columbia 1995:23). Toward that goal, the first principle of grizzly bear management in British Columbia is to restrict total human-caused mortality to sustainable levels and to not reduce the viability or distribution of populations (Province of British Columbia 1999).

Elements of grizzly bear harvest management in British Columbia are described in Province of British Columbia (1995; 1999). Harvest management is predicated upon a habitat-based model of grizzly population size (Fuhr and Demarchi 1990). This model estimates historic, potential, and current habitat capability based on Provincial biogeoclimatic mapping. Current grizzly bear populations are estimated from the Fuhr and Demarchi (1990) model using progressive step-downs to account for habitat loss, alteration, displacement, and fragmentation, as well as historic levels of man-caused mortality in each Grizzly Bear Population Unit (GBPU). Habitat capability ratings are generally revised every 3 years. Population estimates and harvests are kept at conservative levels in recognition of inherent uncertainty.

Total man-caused mortalities are capped at from 3 to 6% of population estimates, depending on average habitat capability. Unknown man-caused mortalities of 1-2%, and known non-hunting man-caused mortalities, are subtracted from this value to leave the area-specific harvest quota. No more than 30% of total man-caused mortality is to be female bears. No hunting is permitted in GBPUs designated Provincially as “Threatened” (population <50% of capability) until they have recovered. GBPUs with estimated populations <100 bears and that are not connected to other GBPUs are also closed to sport hunting.

All hunting has been conducted under limited entry permits since 1996, with spring or spring and fall seasons. Bait is prohibited, but dogs are allowed. It is illegal to hunt a grizzly bear less than 2 years old or any bear in its company, and harvested bears are subject to compulsory inspection.

In February 2001, the BC government announced a province-wide 3-year moratorium on grizzly bear hunting (BC M.O.E. 2001c). The moratorium was intended to provide an opportunity to collect bear inventory data and review conservation and management plans before potentially reinstating a hunting season. Since then, a general election installed a new government, and the moratorium, an election issue, was rescinded although hunting within some regions remains closed.

Critique

British Columbia uses an iterative process to monitor changes in habitat capability within grizzly bear range. Trends in habitat effectiveness are evaluated by regional wildlife biologists and land managers, and the process is probably as responsive as possible. The weakest link in the process is that population estimates are based on estimates of density that are extrapolated over large areas without supportive evidence. If density estimates are accurate, then the present rate of grizzly bear harvest is probably sustainable for current habitat conditions.

Assumptions of undocumented mortality rates in BC may be too low. In parts of BC, unreported mortalities may equal reported values (McLellan *et al.* 1999). In addition, First Nations kills in BC are not subject to compulsory reporting, so they remain an undocumented mortality source.

The intensity of industrial and other incursions into grizzly bear habitat is likely to continue in British Columbia. Maintenance of protected areas will be essential to ensure viability of the province's grizzly population. Because of the cumulative stresses associated with intensive, varied land-uses along the southern fringe of the Province's bear distribution, these peninsular ranges are especially vulnerable to fracture and isolation.

8.2.3 Yukon

Grizzly bears are considered a species of Special Concern in the Yukon. "The conservation of grizzly bears, as an integral part of northern ecosystems and biodiversity, is the primary principle of grizzly bear management" in the Yukon (Yukon DRR 1997:1). Populations were estimated for 22 management units in the Yukon, based on interviews with outfitters and on density estimates from 16 northern interior field studies. Adult sex ratio is assumed to equal 50:50, and of the estimated number of adult females, annual man-caused mortality of adult females of 2% is allowable. Conversely, the allowable man-caused mortality of males is 6%. From these man-caused mortality quotas, DLP kills are subtracted to leave the allowable resident sport harvest. Any remaining balance is allocated to outfitters for non-resident hunters.

A point system is in place that provides incentives for selective harvesting of male grizzly bears by outfitters (Smith 1990). Outfitting areas are allocated a quota of grizzly bear points, and each harvested female and male bear accounts for 3 points and

1 point, respectively, against this quota. Resident hunters are also encouraged to harvest male bears, although the point system does not apply to resident harvest.

Females accompanied by young, and young up to and including 2 years of age, are protected. Baiting is prohibited and all kills must be reported.

Critique

Field studies have been adequately representative to provide point estimates of bear density across the Territory, but monitoring is constrained to harvest characteristics rather than populations. However, unless Territorial population estimates are grossly inflated, mean annual harvest rates (1.1-1.3%) and total man-caused mortality rates (1.3-1.6%) are low and sustainable. Because human population and economy have declined since 1997, habitat pressures in Yukon should not increase substantially on the short term. The sex-weighted point system is innovative and provides protection for female bears. However, it has potential to result in male overharvest, and the system does not apply to resident harvest.

8.2.4 Northwest Territories

In the Northwest Territories, grizzly bears have been assigned “Sensitive” status, indicating that they are not at risk of extirpation but that they may require special attention or protection to prevent them from becoming at risk (RWED 2000). Grizzly bear hunting in the Mackenzie Mountains is available only to NWT residents, and there is a lifetime bag limit of 1 bear. Population estimates for the region are based on a single field study (Miller et al. 1982). The number of licences available to residents is unrestricted, but demand and harvest are low (A. Veitch, pers. commun.). There is no open season for grizzly bear hunting in the majority of the NWT, where bear population density is believed to be low.

In the Inuvialuit Settlement Region (ISR), grizzly bear management goals are “to maintain current population size by ensuring that the total number of bears removed through harvest, defense kills, and illegal hunting each year is sustainable; to allow recovery of populations in the event that over-harvest occurs by reducing quotas or closing areas for hunting; and to maintain current areas of grizzly bear habitats” (Nagy and Branigan 1998:4). Bear population estimates are based upon 7 field studies conducted within and adjacent to the ISR. The annual total allowable harvest (includes DLP kills) quota is established as 3% of the estimated sub-regional population of bears older than 2 years. The benchmark for female harvest is 33%. Quotas are administered, and tags are issued, by the Aklavik Hunters and Trappers Committee. In 1 management area, there is a maximum quota of 3 bears, but the third tag is available only if the first 2 bears killed are males. Residents and non-residents may hunt in the ISR.

Throughout NWT, cubs and bears accompanied by cubs are protected, as are bears in dens. Kills must be reported.

Critique

Relatively good population inventory data exist for the ISR, and the co-management plan regulates harvest with conservative quotas. However, because the absolute number of bears killed annually is quite large, the consequences of undetected declines in population size would be great. Population monitoring should be implemented.

Although mean annual harvests in the Mackenzie Mountains are low and non-resident hunting is prohibited, the population estimate for the area is outdated and should be revised. Grizzly bear hunting seasons are closed in the rest of NWT, but rapidly increasing rates of habitat alteration associated with resource development, combined with very low density and vulnerable populations, requires that bear population and habitat requirements be evaluated and considered.

8.2.5 Nunavut

Grizzly bear management in Nunavut is evolving. Population estimates are lacking throughout the Territory (B. Patterson; M. Campbell, pers. commun.). Currently, harvest quotas are recommended by the Nunavut Department of Sustainable Development, and administered by local Hunters and Trappers Organizations (HTO). Tags are issued at HTO discretion, and can be used by local subsistence hunters or sold to non-resident hunters as part of a guided hunting package. Cubs and bears accompanied by cubs are protected, and kills must be reported.

Critique

Because grizzly bears in Nunavut are managed as a game species, inventory data are required to ensure that harvests are sustainable. In addition, the potential for sudden and intense growth in resource extraction activities requires that adequate protection be implemented for grizzly bear populations and habitat.

9. SPECIAL SIGNIFICANCE OF THE SPECIES

In the cultures of many First Nations groups, the grizzly bear was, and remains, one of the most powerful, popular, revered, or feared icons (Shepard and Sanders 1986; Rockwell 1991). Many Native groups ascribed human attributes to bears, and they were commonly worshiped or ritualized. Grizzly bears were hunted and were important sources of food, pelts, and ornaments. Throughout recorded history, spiritual aspects of the bear image have pervaded most cultures that were sympatric with it (Black 1998).

The grizzly bear aura persists widely today, and the bear has assumed a highly symbolic role for environmental groups throughout North America. Few species typify Canadian wilderness in as many minds as the grizzly. Grizzly bears also interact

directly with humans and cause real and perceived conflicts over property and livestock. Humans are also occasionally injured or killed—and even eaten—by grizzly bears, and this image absolutely vilifies the bear for many people. It is doubtful that any wild species in Canada conjures impressions and emotions more vivid, heartfelt, divisive, and polarized than the grizzly bear.

Grizzly bears are popular. Public attitude surveys (e.g., review in LeFranc *et al.* 1987; Bath 1989; Kellert 1994; Province of British Columbia 1995; Miller *et al.* 1998) indicate that most people feel enriched from observations of bears, or even just knowing they exist. Conversely, to some extent perceptions of danger or nuisance influence some people toward a negative view.

Although few people hunt grizzly bears compared to most ungulate species, grizzlies are a highly prized trophy. In British Columbia, as of 1995, an annual average of \$2.8 million was spent on grizzly bear hunting by 1,200 to 1,400 provincial residents and 500 to 700 non-residents (Province of British Columbia 1995).

The grizzly bear is commonly considered a flagship species for conservation planning (Carroll *et al.* 1999). Grizzly bears are generally highly sensitive to habitat and population perturbations and have relatively low resilience (Weaver *et al.* 1996), and have therefore been widely considered as clear indicators of ecosystem integrity. Because of their large land-area requirements and use of a broad array of habitats, and the complexity of their relationships with other species, they have frequently been considered an umbrella species. Providing for the habitat needs of a top-level carnivore such as the grizzly ensures that elements of lower trophic levels are preserved as well. Conservation of the grizzly bear will be proof of our commitment to preserving biodiversity throughout western and northern Canada.

Others are counting on this commitment too. Persistence and recovery of threatened and endangered grizzly bear populations in the conterminous 48 United States is, in part, dependent on their connectivity to Canadian populations.

10. SUMMARY OF STATUS REPORT

There are fewer than 25,000 adult grizzly bears in Canada, and estimates of past or projected declines of up to 10% over 5 generations (50-75 years) are not unreasonable. General uncertainty and poor precision pertaining to most estimators of demography dictate a high degree of caution in management of all populations of grizzly bears.

Nearly all Canadian grizzly bears occupy a continuous population unit, but at least 8 isolated units have been identified in southern BC (Section 6.3). The isolation that has defined these population units is typical of the process responsible for the decline in grizzly bear populations throughout North America and elsewhere. That process involves the erosion of occupied bear habitat from 1 or more sides as a consequence of

human activities or, potentially, catastrophic natural events. An intermediate step is the resultant peninsular nature of bear distribution, as is currently the case in southern BC and Alberta (Figure 4). From this state, the viability of the peninsular population is threatened because the length of the front of conflict and elevated mortality risk is greater relative to the area of habitat than in more continuous, block habitats.

The final step in population isolation is the fragmentation of the peninsula, typically by anthropogenic activities. This has 2 primary consequences: it further increases direct threats to resident bears by increasing the relative length of the bear-human interface, as the front is now continuous around the unit's periphery, and it eliminates demographic and genetic immigration. Unless the population locked within the unit is large enough to remain viable in perpetuity, its slow extinction is ensured. This process is exemplified by the chronicle of grizzly bear extirpation from most of the contiguous lower 48 United States. In 1800, grizzly bear distribution was virtually continuous across all of the western states. By 1922, bears were confined to 37 isolated population units, representing a loss of more than 75% of their historic distribution (Servheen 1999a). Over the following 80 years, 31 of those populations were eliminated (Figure 16), leaving grizzlies in only 2% of their historic range. From an estimated population in 1800 of 50,000 bears, remnants now total about 1,000 (Servheen 1999a).

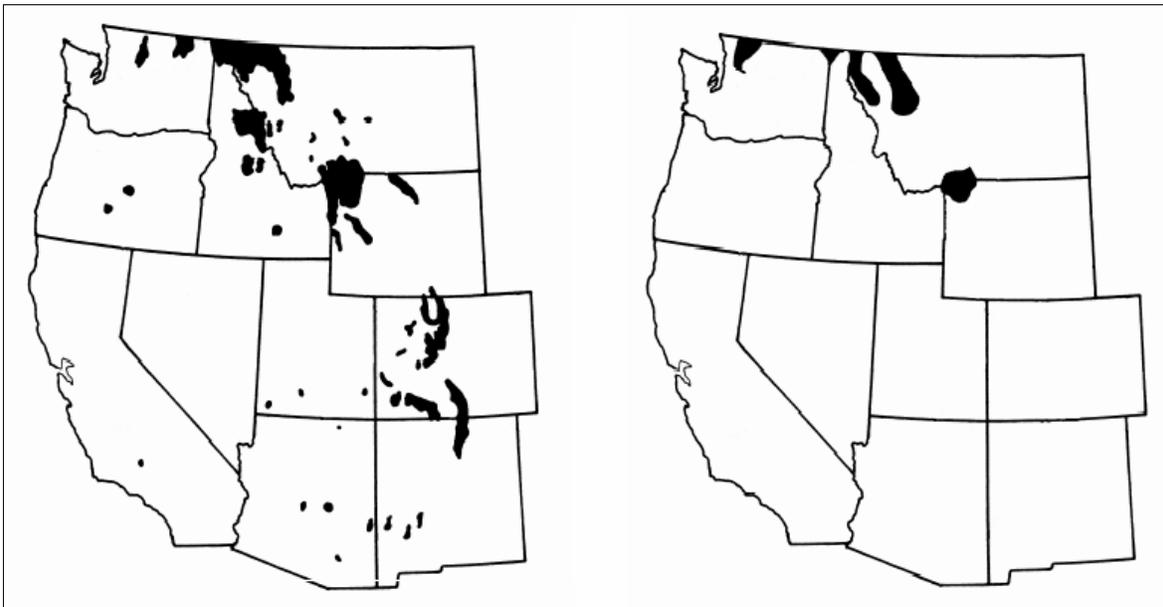


Figure 16. Estimated distribution of grizzly bears in the contiguous lower 48 United States in 1922 (left) and 1999 (right). From Merriam (1922) and Servheen (1990, 1999a).

Recognition of this process and its role in the extirpation of grizzly bears from nearly all of Europe and the lower U.S.A., as well as much of Canada and Asia, is critical to establishment of countermeasures. The isolated southern grizzly bear

population units represent the front lines—the current southern fringe of the bear’s distribution in Canada. Preventing the slow northward migration of this line depends on active steps to conserve these insular and peninsular populations.

Although COSEWIC criteria stipulate that all extant grizzly bears in Canada comprise a single population unit, the threats and limiting factors across this enormous area are not consistent. Bears in parts of the Arctic are relatively vulnerable due to their natural occurrence at very low densities, and the rapid and intensive growth in resource extraction activity. Bears living in portions of the southern fringe of Canadian distribution are far from secure from the consequences of burgeoning human populations and activities. The genetic and geographic continuity that currently prevents their identification as distinct population units is at risk.

TECHNICAL SUMMARY

Ursus arctos

Grizzly bear/Ours brun
Northwestern population
BC, AB, YT, NT, NU

DISTRIBUTION

Extent of occurrence: 3,470,000 km²

Area of occupancy: 2,574,000 km²

POPULATION INFORMATION

Total number of individuals in the population: 26,916+ to 29,150+

Number of mature reproducing individuals in the population: 6,890+ to 17,199+

Generation time: 10-15 years

Total population trend: stable

Rate of decline for total population: n/a

Number of known populations: 1

Is the total population fragmented? NO

number of individuals in smallest population:

number of individuals in largest population:

number of extant sites:

number of historic sites from which species has been extirpated:

Does the species undergo fluctuations in numbers? NO

If yes, what is the maximum number?

minimum number?

Are these fluctuations greater than one order of magnitude?

LIMITING FACTORS AND THREATS

- Hunting, poaching, accidental killing, nuisance/self-defence killing.
- Conversion of habitat from useable to permanently unsuitable.
- Development of access (especially roads) into previously inaccessible areas. Human activity associated with access into grizzly habitat degrades habitat effectiveness, reduces habitat security, and increases mortality risk for bears.
- Fragmentation and isolation of small populations at southern and eastern edges of current geographical range.

RESCUE POTENTIAL

Does the species exist outside Canada? YES

Is immigration known or possible? YES

Would individuals from the nearest foreign population be adapted to survive in Canada? YES

Would sufficient suitable habitat be available for immigrants? YES

TECHNICAL SUMMARY

Ursus arctos

Grizzly bear/Ours brun

Prairie population

AB, SK, MB

DISTRIBUTION

Extent of occurrence: formerly 400,000 km²

Area of occupancy: currently none

POPULATION INFORMATION

Total number of individuals in the population: 0

Number of mature reproducing individuals in the population: 0

Generation time: 10-15 years

Total population trend: n/a

Rate of decline for total population: n/a

Number of known populations: formerly 1

Is the total population fragmented? n/a

number of extant sites: 0

number of historic sites from which species has been extirpated: 1

Does the species undergo fluctuations in numbers? n/a

Are these fluctuations greater than one order of magnitude? n/a

LIMITING FACTORS AND THREATS

- Hunting, poaching, accidental killing, nuisance/self-defence killing.
- Conversion of habitat to agricultural, residential and urban areas.
- The last individuals of this population disappeared from the Cypress Hills area around 1900.

RESCUE POTENTIAL

Does the species exist outside Canada? YES

Is immigration known or possible? NO

Would individuals from the nearest foreign population be adapted to survive in Canada? YES

Would sufficient suitable habitat be available for immigrants? NO

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