COSEWIC
Assessment and Status Report

on the

Grizzly Bear
Ursus arctos

Western population
Ungava population

in Canada

Western population - SPECIAL CONCERN
Ungava population - EXTINCT
2012

COSEWIC
Committee on the Status
of Endangered Wildlife
in Canada

COSEPAC
Comité sur la situation
des espèces en péril
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

COSEWIC. 2012. COSEWIC assessment and status report on the Grizzly Bear *Ursus arctos* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xiv + 84 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

Previous report(s):

COSEWIC. 2002. COSEWIC assessment and update status report on the Grizzly Bear *Ursus arctos* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 91 pp.

Ross. P.I. 2002. Update COSEWIC status report on the grizzly bear *Ursus arctos* in Canada, *in* COSEWIC assessment and update status report on the Grizzly Bear *Ursus arctos* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-91 pp.

Banci, Vivian. 1991. Update COSEWIC status report on the Grizzly Bear *Ursus arctos* (Prairie, Alberta, British Columbia, Northwest Territories and Yukon Territory populations) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 188 pp.

Macey, Anne. 1979. Status Report on the Grizzly Bear *Ursus arctos horribilis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 69 pp.

Production note:
COSEWIC acknowledges Philip D. McLoughlin for writing the status report on the Grizzly Bear *Ursus arctos* in Canada, prepared under contract with Environment Canada. This report was overseen and edited by Justina Ray, Co-chair of the COSEWIC Terrestrial Mammals Specialist Subcommittee.

For additional copies contact:

COSEWIC Secretariat
c/o Canadian Wildlife Service
Environment Canada
Ottawa, ON
K1A 0H3

Tel.: 819-953-3215
Fax: 819-994-3684
E-mail: COSEWIC/COSEPAC@ec.gc.ca
http://www.cosewic.gc.ca

Également disponible en français sous le titre Évaluation et Rapport de situation du COSEPAC sur L'ours grizzli (*Ursus arctos*) au Canada.

Cover illustration/photo:
Grizzly Bear — photo by Emily Court.

Catalogue No. CW69-14/166-2012E-PDF
ISBN 978-1-100-20721-6

Recycled paper

COSEWIC
Assessment Summary

Assessment Summary – May 2012

Common name
Grizzly Bear - Western population

Scientific name
Ursus arctos

Status
Special Concern

Reason for designation
The global distribution of this large-bodied carnivore has declined by over 50% since the 1800s, with western Canada representing a significant core of the current North American range. A habitat generalist, its distribution and relative abundance in the absence of humans is largely driven by habitat productivity and seasonality. It is highly sensitive to human disturbance and is subject to high mortality risk in areas of human activity and where roads create access. Population estimates in much of the range are highly uncertain; the Canadian population is estimated at 26,000, but the number of mature individuals is uncertain and could be close to 10,000. While there is no evidence of a decline in the overall population during the past 20 years and increasing numbers of records indicating some range expansion in the north, a number of populations in the southern extent of its range in Alberta and southern BC are known to be declining and there are concerns about unsustainable mortality rates there and in parts of Yukon. There is strong evidence of genetic fragmentation in the southern parts of its range where some populations are increasingly isolated and subject to demographic stochasticity. Their poor condition in some parts of the range, combined with their naturally low reproductive rates and increasing pressures of resource extraction and cumulative impacts in currently intact parts of the range, heighten concern for this species if such pressures are not successfully reversed.

Occurrence
Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba

Status history
The species was considered a single unit and designated Not at Risk in April 1979. Split into two populations in April 1991 (Prairie population and Northwestern population). The Prairie population was designated Extirpated in April 1991. Status re-examined and confirmed in May 2000 and in May 2002. The Northwestern population was designated Special Concern in April 1991 and confirmed in May 2002. In May 2012, the entire species was re-examined and the Prairie and Northwestern populations were considered a single unit. This newly defined Western population was designated Special Concern in May 2012.

Assessment Summary – May 2012

Common name
Grizzly Bear - Ungava population

Scientific name
Ursus arctos

Status
Extinct

Reason for designation
This large carnivore existed as a relict population on the Ungava peninsula of northern Quebec and Labrador until the 20th century. It has not been documented since at least 1948, and is unlikely to be replaced through natural dispersal.

Occurrence
Quebec, Newfoundland and Labrador

Status history
The species was considered a single unit and designated Not at Risk in April 1979. Split into two populations in April 1991 (Prairie population and Northwestern population). In May 2012, the entire species was re-examined and split into two populations (Western and Ungava populations). The newly defined Ungava population was designated Extinct in May 2012.

COSEWIC
Executive Summary

Grizzly Bear
Ursus arctos

Western population
Ungava population

Wildlife Species Description and Significance

The Grizzly Bear (*Ursus arctos*) is believed to have crossed over from Asia to North America 50,000 – 100,000 years ago. Conspecific with extant Brown Bears in Europe and Asia, it is a large ursid, with body sizes in Canada ranging from 100–150 kg for adult females to 180–270 kg for adult males. Grizzly Bears have a heavy, dish-shaped skull with dentition indicative of both a predator and herbivore (large canines and crushing molars), a robust body with long fore-claws, and powerful digging muscles that give the species its characteristic shoulder hump. Colour ranges from blonde through shades of brown to nearly black, with the sometimes silver-tipped nature of the fur giving the species a 'grizzled' appearance.

In Western and Aboriginal cultures, the Grizzly Bear is a popular, revered, and sometimes feared animal. The species is often considered a flagship or umbrella species for conservation planning, and few mammals typify Canadian wilderness in as many minds as does the Grizzly Bear. Grizzly Bears interact directly with humans, cause real and perceived conflicts over property, and can endanger human life. Although relatively few people hunt Grizzly Bears, the species is a highly prized trophy animal. The Grizzly Bear can also be an important part of subsistence hunting by some Aboriginal people for both food and cultural purposes.

Distribution

The Grizzly Bear occurs in Canada, the United States, and in Europe and Asia. Current records of occupancy exist for approximately 48 countries. Many Eurasian populations are insular, small, and endangered.

All living Grizzly Bears comprise the continuous ‘Western’ population (BC, western Alberta, Yukon, Northwest Territories [NT], mainland Nunavut and parts of the southwest Canadian Arctic Archipelago, northern Saskatchewan, and northeast Manitoba). The Western population occupies an estimated area of 2.98×10^6 km^2. Observations indicate some expansion of the distribution of Grizzly Bears northwards and eastwards in Northwest Territories, Nunavut, northern Saskatchewan, and northern Manitoba, although a lack of systematic surveys tracking occupancy over time in these areas prevent quantification of such trends. The bears occupying the Prairies, previously assessed by COSEWIC as an independent population, are now considered to have formed part of the Western population. The Ungava population of Grizzly Bears, which once occupied a discrete unit in northern Quebec and Labrador at the time of European colonization, has not been recognized by COSEWIC prior to this report.

Habitat

The Grizzly Bear is a habitat generalist. Grizzly Bears occur from sea level to high-elevation alpine environments. The species occupies habitats as diverse as temperate coastal rain forests, alpine tundra, mountain slopes, and upland boreal forest, taiga, dry grasslands at the fringe of the Prairies and in central BC, and the Arctic tundra. Grizzly Bear habitat associations are strongly seasonal and typically reflect local plant development and prey concentrations. In mountainous regions, Grizzly Bears may undertake seasonal elevational migrations.

Biology

Grizzly Bears are omnivores with adaptations to digging and rooting, grazing, and hunting. In some areas they are effective predators of ungulates such as Moose, Elk, and Caribou; Pacific-coastal bears feed heavily on spawning salmon, and arctic Grizzly Bears scavenge along shorelines where they may feed on whale and seal carcasses, or even hunt seals. Grizzly Bears use refuse and livestock as food sources if they are available and accessible. Females usually have their first litters at 6 years of age; litter sizes are 1–3 cubs, and intervals between litters are commonly 3–4 years. Natural longevity is around 20–30 years. Grizzly Bears have large home ranges, averaging 1,800 km^2 for males and 700 km^2 for females; however, home range size varies widely across Canada, showing an inverse relationship with habitat productivity. Grizzly Bears den in winter and enter hibernation (dormancy) for up to 7 months, with length of hibernation related to latitude. Cubs are born in the den in January or February.

Population Size and Trends

Worldwide, Grizzly Bear range has decreased by about 50% since the mid-1800s; it has lost 98% of its range in the lower 48 states of the US. The species was extirpated by the late 19th–early 20th century from much of the dry interior of southern British Columbia (BC), the Prairies of Alberta, Saskatchewan, and Manitoba, and the Ungava region of Quebec and Labrador. The Western population is currently estimated to number about 26,000 animals, of which about 11,500 are mature individuals. However, estimates of Grizzly Bear population size and trends are uncertain in Canada, and are mostly based on expert opinion or extrapolations of estimates from small study areas to include large geographic regions. BC has the largest number of Grizzly Bears, with approximately 15,000 animals. The latest estimates include 6,000–7,000 bears in Yukon, 3,500–4,000 in NT, 700 in Alberta and between 1,500 and 2,000 in Nunavut. A few Grizzly Bears now occur in tundra regions of northeast Manitoba. Historical numbers in Canada are unknown, but were certainly much higher. The overall Western population is probably stable since 1990, when the first comprehensive and Canada-wide population inventory was reported, although there have been declines in Alberta, and possibly southern BC and in some parts of Yukon. On the other hand, some expansion of Grizzly Bear range in NT, Nunavut, Saskatchewan, and Manitoba appears to be underway. Population and trend information for the Western population is not available prior to 1990.

Threats and Limiting Factors

In the absence of human interference, the density of Grizzly Bears is largely determined by habitat productivity (food). However, anthropogenic mortality has important influences on area of occupancy and underlies functional habitat loss throughout much of the species' range. Bears generally avoid humans and experience higher rates of mortality near anthropogenic features like roads and residential developments. Human activity is believed to lead to fragmentation and isolation of demographic units, whereby population dynamics may become determined by stochasticity in survival and reproduction irrespective of other factors, increasing chances of local extinction. Populations in BC, Yukon, NT, and Nunavut are subject to legal hunting, and all regions support and/or formally recognize the right to First Nations, Métis, and/or Inuit subsistence hunting. Bears that are killed by humans die because of legal hunting, defence of life and property, and poaching and vehicle and train collisions. Undocumented killing remains an important problem for managers. Evidence of human-caused mortality from all sources appears to be consistent with a stable population of Grizzly Bears at the scale of the Western DU; however, at local scales (in Alberta, southern BC, and parts of Yukon) recent mortality trends indicate real or suspected declines. At high densities, in addition to food, Grizzly Bears may also be limited by intraspecific predation or conflict. Effects of climate change on habitat availability for Grizzly Bears and associated effects on seasonal food supply have yet to be quantitatively studied; hypothetical mechanisms are varied and unclear, and projected net effects uncertain.

Protection, Status, and Ranks

The legal status of Grizzly Bears is as a “Big Game” species in the provincial and territorial wildlife legislation of British Columbia, Yukon, the Northwest Territories, and Nunavut. Grizzly Bears lack specific legal status in Manitoba, Quebec, and Newfoundland and Labrador, other than that generally afforded to wildlife. The Grizzly Bear population in Alberta was recently listed as Threatened under Alberta’s *Wildlife Act* (June 2010), which resulted in a ban on licensed hunting of the species in that province. The species was assessed as Sensitive in the 2010 Wild Species General Status report, the same national conservation status as in 2005. In British Columbia, Yukon, Northwest Territories, and Nunavut, Grizzly Bears had a General Status conservation rank of Sensitive in 2010. In Alberta, the conservation status rank was May be at Risk in 2010, whereas in Saskatchewan and Manitoba it was Extirpated. The 2010 General Status conservation rank for Newfoundland and Labrador was “Not Assessed”. No rank was given for Quebec. Approximately 7.1% of the range currently occupied by the Grizzly Bear in Canada is classified as ‘protected’ from human activity (to varying degrees) by federal, provincial, or territorial governments.

TECHNICAL SUMMARY: Western Population

Ursus arctos
Grizzly Bear   Ours grizzli

Range of occurrence in Canada: British Columbia, Alberta, Yukon, Northwest Territories, Nunavut, Saskatchewan, Manitoba

Demographic Information

Generation time *(calculating using formulas provided by IUCN Petitions and Standards Committee 2011)*	13-14 yrs
Is there an observed continuing decline in number of mature individuals?	No
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	Unknown, but no evidence of an overall decline
Estimated percent reduction in total number of mature individuals over the last 10 years, or 3 generations. *There is some evidence of population declines and also of range expansion; DU-wide data not available prior to 1991.*	Unknown, but no evidence of an overall decline
Suspected percent reduction in total number of mature individuals over the next 10 years, or 3 generations.. *Some local or regional population declines of unknown magnitude may be inferred; it is not possible to predict whether or to what extent the current trajectory of expansion in the northern part of the DU will continue.*	Unknown
Suspected percent reduction in total number of mature individuals over any 10 years or 3 generation period, including both the past and the future. *See above*.	Unknown, but no evidence of an overall decline
Are the causes of the decline clearly reversible and understood and ceased?	n/a
Are there extreme fluctuations in number of mature individuals?	No

Extent and Occupancy Information

Estimated extent of occurrence	5.37×10^6 km^2
Index of area of occupancy (IAO) (Always report 2×2 grid value).	2.98×10^6 km^2
Is the total population severely fragmented?	No
Number of locations*	Widespread occurrence and diverse threats; number of locations indeterminable.
Is there an inferred continuing decline in extent of occurrence? *Only a very small proportion of Grizzly Bear habitat exists where occupied use of habitat has been tracked over time and could be used to assess range use/loss/expansion*	Unknown, although assumed no
Is there an inferred continuing decline in index of area of occupancy?	Possibly
Is there an inferred continuing decline in number of populations? *Some populations have decreased in size during the last 3 generations, whereas others may have increased*	No
Is there an inferred continuing decline in number of locations*?	N/A

∗ See Definitions and Abbreviations on COSEWIC website and IUCN for more information on this term.

Is there an inferred continuing decline in area, extent and/or quality of habitat?	Yes, in southern Alberta and BC where fragmentation at the southern extent of Grizzly Bear range is occurring.
Are there extreme fluctuations in number of populations?	No
Are there extreme fluctuations in number of locations?	No
Are there extreme fluctuations in extent of occurrence?	No
Are there extreme fluctuations in index of area of occupancy?	No

Number of Mature Individuals (in each population)

Population	**N Mature Individuals**
~26,000 (all ages)	~11,500
Total	
~26,000 (all ages)	~11,500

Threats (actual or imminent, to populations or habitats)

- Human-caused mortality (legal hunting, accidental killing, kills in defence of life or property, illegal hunting).
- Conversion of habitat from usable to permanently unsuitable, especially through residential development.
- 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 edge of current geographical range increases likelihood of local extinction events

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? Alaska, considered secure (>30,000 bears); Listed as threatened in the conterminous (lower 48) United States lower 48 United States (1,200 to 1,400 bears)	
Is immigration known or possible?	Yes
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	In some parts of the range
Is rescue from outside populations likely?	Possibly, but only from Alaska

Current Status

COSEWIC: Special Concern (May 2012)

Recommended Status and Reasons for Designation

Recommended Status: Special Concern	**Alpha-numeric code:** Not applicable
Reasons for designation: The global distribution of this large-bodied bear has declined by over 50% since the 1800s, with western Canada representing a significant core of the current North American range. A habitat generalist, its distribution and relative abundance in the absence of humans is largely driven by habitat productivity and seasonality. It is highly sensitive to human disturbance and is subject to high mortality risk in areas of human activity and where roads create access. Population estimates in much of the range are highly uncertain; the Canadian population is estimated at 26,000, but the number of mature individuals is uncertain and could be close to 10,000. Although there is no evidence of a decline in the overall population during the past 20 years and increasing numbers of records indicating some range expansion in the north, a number of populations in the southern extent of its range in Alberta and southern BC are known to be declining, and there are concerns about unsustainable mortality rates there and in parts of Yukon. There is strong evidence of genetic fragmentation in the southern parts of its range where some populations are increasingly isolated and subject to demographic stochasticity. Their poor condition in some parts of the range, combined with their naturally low reproductive rates and increasing pressures of resource extraction and cumulative impacts in currently intact parts of the range, heightens concern for this species if such pressures are not successfully reversed.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable. There is no evidence for an overall decline of mature individuals.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable. The EO and AO are both much larger than thresholds for this criterion, and there is no evidence for any declines.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable. The total number of mature individuals may be as low as 10,000, but there is no evidence of continuing decline.
Criterion D (Very Small or Restricted Total Population): Not applicable. The population is larger than 1,000 individuals and exists in many more than 5 locations.
Criterion E (Quantitative Analysis): Not applicable. No quantitative analyses have performed that can be applied to the whole DU.

TECHNICAL SUMMARY: Ungava Population

Ursus arctos
Grizzly Bear Ours grizzli
Range of occurrence in Canada: northern Quebec and Labrador

Demographic Information

Generation time *(calculating using formulas provided by IUCN Petitions and Standards Committee 2011)*	13-14 yrs
Is there an observed continuing decline in number of mature individuals?	No, no evidence of presence since early 20th century
Estimated percent of continuing decline in total number of mature individuals within 5 years or 2 generations	n/a
Estimated percent reduction in total number of mature individuals over the last 10 years, or 3 generations.	n/a
Suspected percent reduction in total number of mature individuals over the next 10 years, or 3 generations.	n/a
Suspected percent reduction in total number of mature individuals over any 10 years or 3 generation period, including both the past and the future.	n/a
Are the causes of the decline clearly reversible and understood and ceased?	n/a
Are there extreme fluctuations in number of mature individuals?	n/a

Extent and Occupancy Information

Estimated extent of occurrence	n/a
Index of area of occupancy (IAO) (Always report 2×2 grid value).	n/a
Is the total population severely fragmented?	n/a
Number of locations*	0
Is there an inferred continuing decline in extent of occurrence?	n/a
Is there an inferred continuing decline in index of area of occupancy?	n/a
Is there an inferred continuing decline in number of populations?	n/a
Is there an inferred continuing decline in number of locations*?	n/a
Is there an inferred continuing decline in area, extent and/or quality of habitat?	Unknown
Are there extreme fluctuations in number of populations?	n/a
Are there extreme fluctuations in number of locations?	n/a
Are there extreme fluctuations in extent of occurrence?	n/a
Are there extreme fluctuations in index of area of occupancy?	n/a

Number of Mature Individuals (in each population)

Population	N Mature Individuals
0	0
Total	
0	0

∗ See Definitions and Abbreviations on COSEWIC website and IUCN for more information on this term.

Quantitative Analysis

Probability of extinction in the wild is at least 20% within 20 years or 5 generations, or 10% within 100 years.	n/a

Threats (actual or imminent, to populations or habitats)

- Not known

Rescue Effect (immigration from outside Canada)

Status of outside population(s)? Alaska, considered secure (>30,000 bears); Listed as threatened in the conterminous (lower 48) United States (1,200 to 1,400 bears)	
Is immigration known or possible?	No
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Yes
Is rescue from outside populations likely?	**No**

Current Status

COSEWIC: Extinct (May 2012)

Recommended Status and Reasons for Designation

Recommended Status: Extinct	**Alpha-numeric code:** Not applicable
Reasons for designation: This large bear existed as a relict population on the Ungava peninsula of northern Quebec and Labrador until the 20th century. It has not been documented since at least 1948, and is unlikely to be replaced through natural dispersal.	

Applicability of Criteria

Criterion A (Decline in Total Number of Mature Individuals): Not applicable.
Criterion B (Small Distribution Range and Decline or Fluctuation): Not applicable.
Criterion C (Small and Declining Number of Mature Individuals): Not applicable.
Criterion D (Very Small or Restricted Total Population): Not applicable.
Criterion E (Quantitative Analysis): Not applicable.

PREFACE

This report is updated based on evidence collected since the 2002 COSEWIC Status Update for the Grizzly Bear *Ursus arctos* in Canada (COSEWIC 2002). In 1991, prior to the passage of SARA, Grizzly Bears in Canada were divided into a prairie population and Northwestern population, which were assessed by COSEWIC as Extirpated and Special Concern, respectively. In May 2002, based on an updated status report, COSEWIC recommended that the Northwestern population of Grizzly Bears be listed as Special Concern. Receipt of this recommendation was acknowledged by the Environment Minister in 2004, followed by a decision not to add Grizzly Bear to the SARA List in order better incorporate the best available community knowledge and Aboriginal traditional knowledge.

Considerable new research has been conducted on the species since the last report, including several new population inventories in BC, Alberta, and Yukon. This report also includes a reorganization of designatable unit (DU) status for the Grizzly Bear: The previously assessed DU of the ‘Prairie’ Grizzly Bear is now considered to have been part of the extant ‘Northwestern’ population. In addition, the population of Grizzly Bears that once occupied northern Quebec and Labrador is now assessed as a DU, the ‘Ungava’ population. This report includes substantial updating from traditional ecological knowledge collected and summarized from First Nations, Métis, and Inuit sources by the COSEWIC Aboriginal Traditional Knowledge (ATK) Subcommittee.

COSEWIC HISTORY

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. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS
(2012)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* 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. Definition of the (DD) category revised in 2006.

Environment Canada / Environnement Canada
Canadian Wildlife Service / Service canadien de la faune

Canada

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

COSEWIC Status Report

on the

Grizzly Bear
Ursus arctos

Western population
Ungava population

in Canada

2012

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

Name and Classification

Class: Mammalia

Order: Carnivora

Family: Ursidae

Subfamily: Ursinae

Scientific name: *Ursus arctos* Linnaeus (1758), subspecies *U. a. horribilis* Ord (1815)

Common names: Grizzly Bear, Brown Bear (English); ours brun (French). Aklaq/Aklak (Inuktitut/Inuvialuit – Uummarmiut dialect); Aghat, (Inuktitut - Inuinnaqtun); Aklah (Inuktitut); Shih (Gwich'in); Sahcho (Dene); Sahsho (North Slavey); Dlézi (Dene); Lik'inskw (Nisgaa); Sahtso (Tlicho); Xzltsl' or Xoots (Tlingit); Sha□r dottho (H a □ n) ; Shashcho□ (Tagish); Kelowna or Kee-lau-naw or Smxéycn (Salish); Qat'muk (Ktunaxa); Hyas itswoot or Siam or Shayam (Chinook); Skmxis (Shuswap); Xaw gas (Tla'amin); Mistahiya or Meestachaya (Cree), Mayuk (Sechelt), Nitakyaio (Blackfeet), Sass-tsho (Chipewyan), Matashu (Mushua-Innu), Midiik (Tsimshian); ʟā'uʟās (Kutenai), Səx□xux□ (Nlaka'pamux), L'shakkwalâ moshkwa (Cree Michif)

The Grizzly Bear has been long thought to have a most recent common ancestor with the Ussuri Brown Bear (*U. a. lasiotus*) of northeastern Asia. The term 'Brown Bear' is generally used to describe the species regardless of subspecies or local variant, and is often used to identify the species across its holarctic range. 'Grizzly Bear' is most often used in North America; however, the term Brown Bear is also common when describing populations from the west coast of British Columbia (BC) and Alaska. The term 'Black Grizzly Bear' is sometimes used to refer to the Ussuri Brown Bear. Common names of North American variants, such as 'Kodiak Bear', 'Alaskan Brown Bear', and 'Barren-ground Grizzly Bear' are used to describe the species regionally.

Phenotypic variation across the species' North American range originally resulted in the description of more than 90 subspecies in Canada, the United States, and Mexico (Merriam 1918). Refinement of taxonomic criteria (Rausch 1963) led to the widely accepted identification of two subspecies, *U. a. middendorffi*, identifying the very large Brown Bears from the Kodiak Island archipelago, and *U. a. horribilis*, for the remainder of North America. Subsequent reclassifications identified three (Kurtén 1973) or seven (Hall 1984) subspecies. The lack of genetic sampling from large portions of Grizzly Bear range (e.g., northern Pacific coast, Arctic, Prairie, and Ungava) preclude any resolution of taxonomic uncertainty at the subspecies level at this time.

Morphological Description

Grizzly Bears are large and muscular (Figure 1). Attributes that differentiate the species from the Black Bear, *Ursus americanus*, and Polar Bear, *U. maritimus*, include a prominent shoulder hump, concave facial profile, and long front claws (and colour in the case of Polar Bears). Pelage ranges from blonde through shades of brown to nearly black. In many instances, the guard hairs on the shoulders and back are tipped with white, grey, or silver, which gives the fur a 'grizzled' appearance. Typical body mass of an adult female in Canada ranges from approximately 100–150 kg (Ferguson and McLoughlin 2000), but in Alaska female Grizzly Bears can weigh more than 200 kg, (McLellan 1994; Ferguson and McLoughlin 2000; Schwartz *et al.* 2003a). Males are approximately 1.8 times as heavy as females (Hilderbrand *et al.* 1999a).

Figure 1. Grizzly Bear photo (Emily Court).

Population Structure and Variability

The ancestors of modern Grizzly Bears are believed to have migrated from eastern Asia to North America between 50,000 and 100,000 years ago (McLellan and Reiner 1994; Matheus *et al.* 2004). Sometime between 13,000–23,000 years ago, the route from Beringia (modern Alaska and Yukon) to areas of the continent farther south became blocked by glaciers. Whether bears existed south of the last continental ice sheet has been the subject of debate. Although most Grizzly Bear fossils south of Beringia (in southern Canada and the northern United States) are no more than 12,000–13,000 years old, recent evidence suggests that Grizzly Bears were present south of the ice sheet at a much earlier date. For example, Matheus *et al.* (2004) discovered a fossil near Edmonton, Alberta that dates to 26,000 years ago. Mitochondrial DNA recovered from the specimen shows that modern Brown Bears in this region are probably descended from populations that persisted south of the southern glacial margin during the last glacial maximum. The species was also once found much farther south and east of its recent historical range (Figure 2), with fossils occurring in Ontario, Ohio, and Kentucky (Peterson 1965; Guilday 1968).

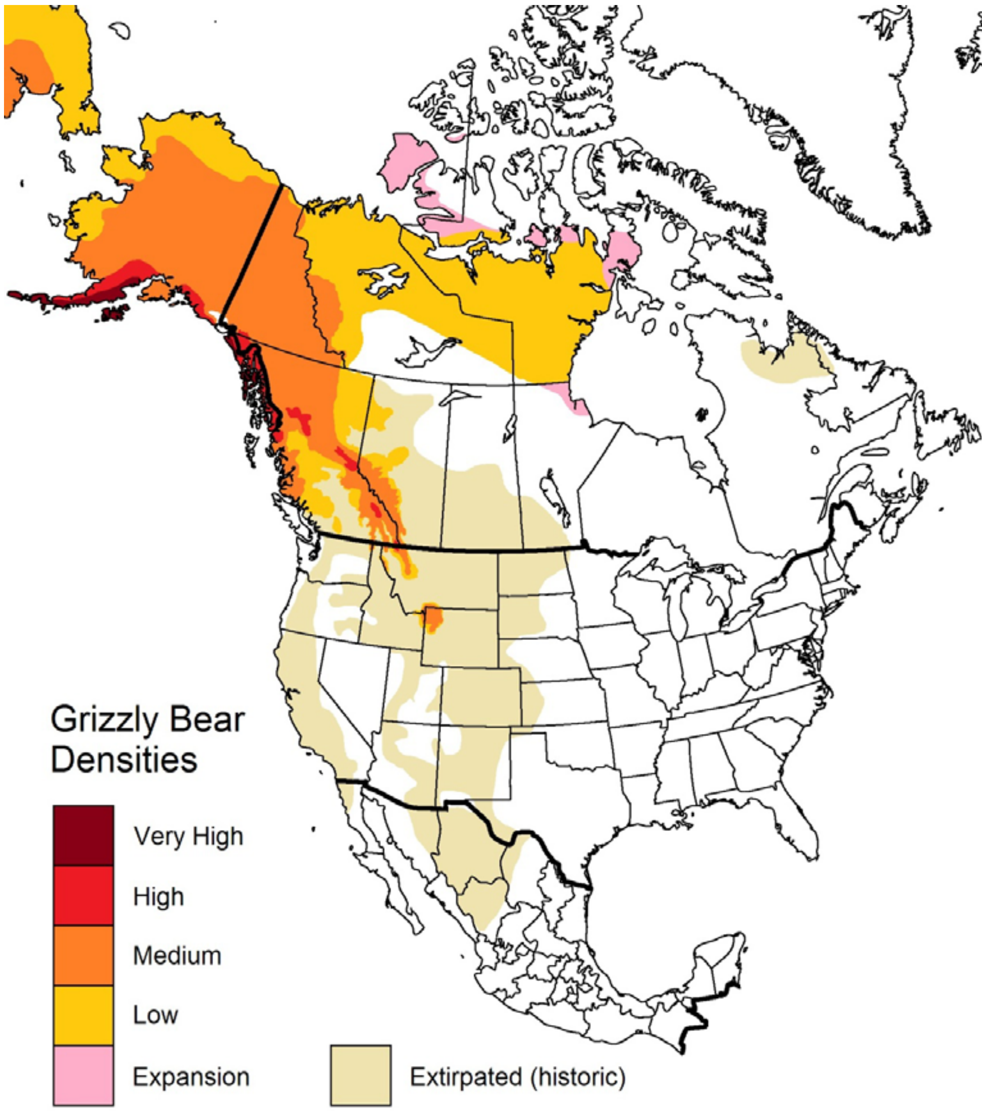

Figure 2. Approximate boundaries of the current and historic (i.e., 19th century) distribution of the Grizzly Bear, *Ursus arctos*, in North America, with contours of relative density. Areas in white are not known to have supported more than vagrant occurrences of Grizzly Bears in the past (including hot deserts, highly glaciated mountain ranges, Canadian shield, islands, taiga and boreal plains, and some highly productive coastal forests). Sources used to develop this map include McLoughlin (2001), Mattson and Merrill (2002), Hamilton *et al.* (2004), Proctor *et al.* (2005), Doupé *et al.* (2007), Loring and Spiess (2007), Environment Canada (2009), Rockwell *et al.* (2008), ASRDACA (2010), various jurisdictional ecoregion maps (e.g., Wiken 1986), ATK (see Canadian Range for references), and documented Grizzly Bear densities as reported in McLoughlin *et al.* (2000). Map produced by P. McLoughlin.

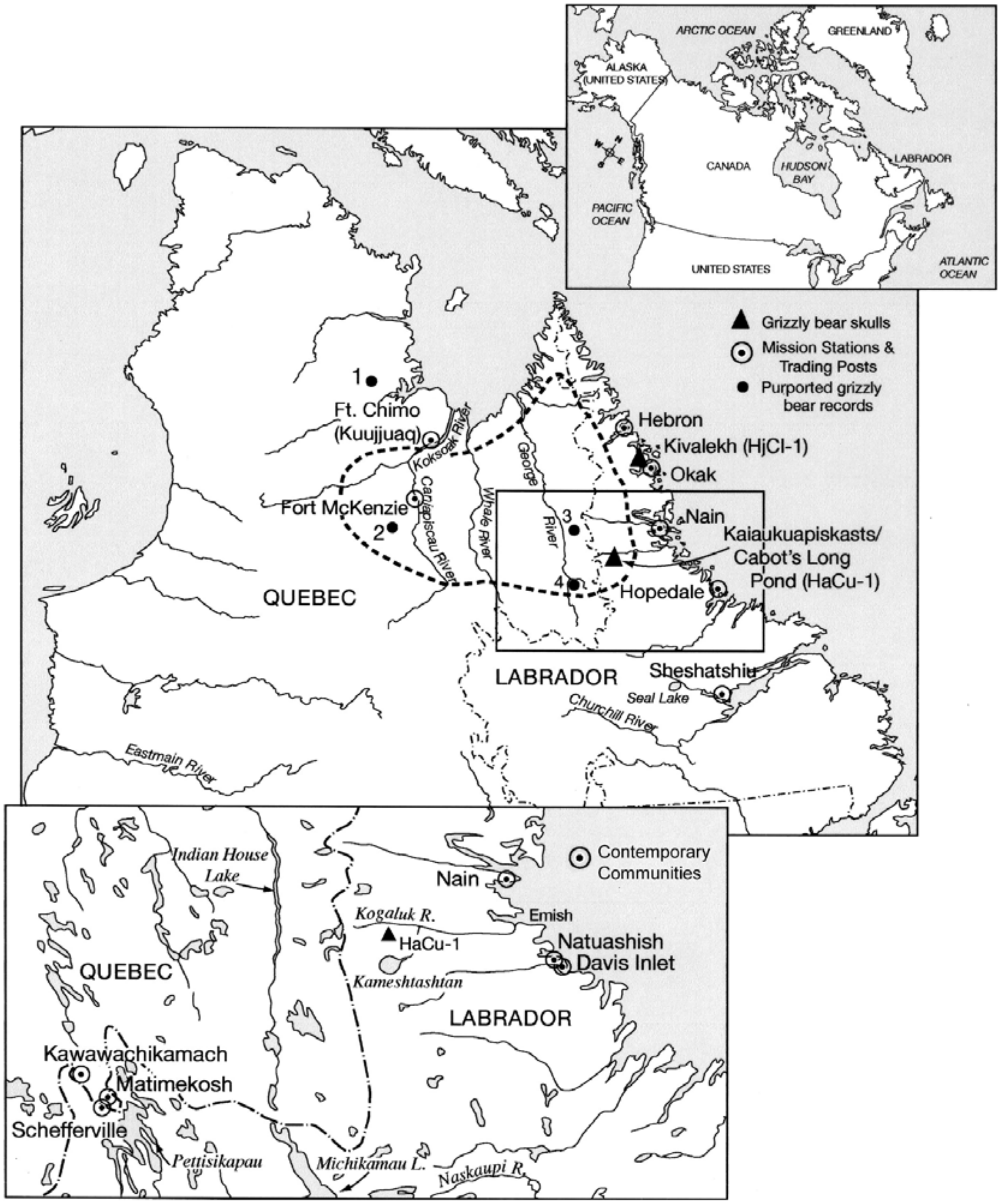

Figure 3. Map of the Ungava Peninsula of Quebec and Labrador showing the postulated range of the 'Ungava' Grizzly Bear in the late 19th and early 20th centuries (within dashed line). Numbers show locations of reported observations, including purported sightings of animals, tracks, and hunter kills. Figure reprinted from Loring and Spiess (2007); see Loring and Spiess (2007) for details of recorded observations.

The extant species sharing the nearest common ancestor is the Polar Bear, *Ursus maritimus*, which was thought to have evolved from the Grizzly Bear perhaps as recently as 200,000–250,000 years ago (Cronin *et al.* 1991; Talbot and Shields 1996a,b). More recent genetic studies, however, have placed Polar Bears outside the Brown Bear clade, dating the divergence to the middle Pleistocene, about 600,000 years ago (Hailer *et al.* 2012). Nevertheless, the close relationship between the two species is highlighted by instances of hybridization in the wild, including a hybrid that was shot by a hunter on Banks Island, NT in April 2006 (Slavik 2010), and one taken near Ulukhaktok, NT in 2010 (CBC news report 2010). Successful cross-matings in captivity have produced fertile offspring (Martin 1876, 1882; Kowalska 1962, 1965, 1969). Hybridization is also known from pre-historic times. C.J. Edwards *et al.* (2011) demonstrated that genetic exchange with extinct Irish Brown Bears forms the origin of the modern Polar Bear matriline, suggesting that interspecific hybridization may be relatively common.

Genetic studies on Grizzly Bears conducted over the past 15 years have demonstrated genetic variability within and among populations. For example, populations at the fringes of bear distribution in the south where habitats have been fragmented by human activity and settlement exhibit low levels of heterozygosity. The highest levels of within-population genetic diversity were found in the northern core of the current range of Grizzly Bears in Canada (Paetkau *et al.* 1998). This trend of increasing heterozygosity with latitude was confirmed in a recent compilation of genetic analyses of 3,134 bears across the species' core range in western North America (Proctor *et al.* 2012).

Microsatellite analyses and information on movements through radio-telemetry point to varying levels of population structure throughout the Grizzly Bear's range in western North America. Again, patterns differ as a function of geography: in the southeastern portion of the Canadian range, human development and settlement have transformed a once interconnected Grizzly Bear population into a number of relatively small subpopulations with little sign of demographic connectivity and evidence of pronounced genetic structure (McLellan 1998; Proctor 2003; Proctor *et al.* 2005; 2012). Genetic distances across developed valleys and major highways were elevated relative to those in undeveloped regions in central and northern BC (Proctor *et al.* 2012). By contrast, in the central and northern parts of the range where there has been significantly less human influence, bear movements were more extensive and individual genotypes follow an isolation-by-distance pattern, indicating substantial gene flow within a continuously distributed population (Paetkau *et al.* 1997; 1998; Proctor *et al.* 2012). Although both males and females demonstrated reduced movement rates with increasing human settlement and traffic, male movement rates were generally higher than those of females, with males demonstrating a higher tolerance for moving through disturbed areas (Proctor *et al.* 2012). There was some evidence for natural fragmentation, whereby topographic features appeared to slow gene flow between populations. Proctor *et al.* (2012) documented larger-than-average genetic distances associated with the extensive icefields and glaciers along the coastal mountains of BC and Yukon, the interior mountain and plateau habitats in northern BC, and the heavily glaciated sections of the Continental Divide in Alberta and BC.

The molecular phylogeography of modern Grizzly Bears in North America was studied by Waits *et al.* (1998; see also Davison *et al.* 2011) from analyses of samples from 22 localities in western Canada, Alaska, and Yellowstone. These samples were also combined with historical museum samples in a later study by Miller *et al.* (2006). However, the large core distributional range in BC was unsampled in either study. Four mitochondrial DNA clades were proposed through this work. However, analyses of nuclear microsatellite DNA have since provided substantial evidence of male-mediated gene flow across these proposed clade boundaries (Paetkau *et al.* 1997; 1998; Proctor *et al.* 2012). Moreover, contrary to Waits *et al.*'s (1998) hypothesis that these clades were formed prior to the species' migration into North America, mitochondrial DNA sequence variation from 7 permafrost-preserved bears revealed that these clades co-existed in Beringia 36,000 years ago (Leonard *et al.* 2000). This historical evidence implies that the geographical partitioning of mtDNA haplotypes, which reflects only female-mediated gene flow, is relatively recent.

Designatable Units

COSEWIC defines designatable units (DUs) for assigning status based on a hierarchy of criteria that consider populations or population groupings of the taxonomic species in Canada that are both discrete and evolutionarily significant (COSEWIC 2011). As a first step, discreteness may refer to distinctiveness in genetic characteristics or inherited traits, habitat discontinuity, or ecological isolation. Significance is also included in the definition of DU along various sub-criteria as a reflection of the opinion that isolation alone is insufficient for designation. Following this definition, this status report recognizes two identifiable DUs for Grizzly Bears: the ‘Western’ population (BC, Alberta, Yukon, NT, Nunavut, and Manitoba), and the ‘Ungava’ population (northern Quebec and Labrador).

The Prairie population of Grizzly Bears was previously classified as an extirpated DU by COSEWIC (COSEWIC 2002; Environment Canada 2009), separate and distinct from the Northwestern population. Rationalization for this DU was based on the loss of the species from the unique Prairie ecozone in the late 1800s, yet the Prairie Grizzly Bear was undoubtedly continuous in range with the current Western population. Although samples of Grizzly Bears from the prairie region exist in museums, they have yet to be genetically analysed, thereby precluding an assessment of their genetic distinctiveness relative to current members of the Western population. Genetic interchange among bears living in considerably different ecozones is well-documented (Proctor *et al.* 2012; see Population Structure and Variability), making it highly likely that interchange occurred between the Grizzly Bears of the Prairie and at least bears inhabiting the Rocky Mountains of Alberta. In present times, individuals from the Rocky Mountain foothills continue to foray on occasion into the Alberta prairie (Environment Canada 2009).

Of particular importance to the significance criterion for DU status, there are no noted adaptations that appear unique to the Prairie Grizzly Bear compared to adjacent mountain-dwelling Grizzly Bears. Although the loss of Grizzly Bears from the Prairie ecozone has resulted in an extensive gap in Grizzly Bear range in Canada, this gap is no different from other areas outside the ecozone from which they have disappeared. Grizzly Bears have not been able to re-establish a population because of inadequate habitat and high risk of mortality (Environment Canada 2009), rather than any characteristics of the ecological setting that require particular adaptations. There is, therefore, no evidence at this time to consider Grizzly Bears that once resided in the Prairie Ecozone as a separate DU from that of the Western population.

As for the possibility of subdividing the Western DU, there is no natural disjunction between substantial portions of the unit's geographic range in Canada. Although microsatellite analysis has demonstrated pronounced genetic structure in the southern portion of Grizzly Bear range in Canada (Proctor *et al.* 2012), this evidence for discreteness is a recent artifact of range disjunctions brought about by anthropogenic fragmentation of formerly continuous habitat and cannot therefore be considered to be evolutionarily significant. Bear movements, particularly by females, are limited by highways and human settlement corridors, with important demographic consequences. Whereas these remnant populations represent critical areas of focus for Grizzly Bear conservation and management efforts, there is no evidence for unique ecological settings that have given rise to local adaptations, thus these fragmented populations do not warrant DU status. Whereas there is some evidence of natural fragmentation within Grizzly Bear range (Proctor *et al.* 2012), there is no evidence that barriers (e.g., glaciers, icefields, and some rivers) are so significant as to have inhibited interchange altogether.

Waits *et al.* (1998) proposed the existence of three Grizzly Bear "evolutionarily significant units" (clades) as a result of their mitochondrial analyses (see Population Structure and Variability). However, several authors have since questioned this conclusion on grounds that this clade structure is predominantly reflective of recent and limited female movements between populations (Paetkau *et al.* 1997; 1998; Leonard 2000). For wide-ranging mammals such as Grizzly Bears, characterized by male-biased dispersal, identifying patterns that indicate evolutionary significance can be addressed only with appropriate consideration of male movements. Evidence from radio-telemetry and microsatellite nuclear DNA have demonstrated that male Grizzly Bears in Canada engage in extensive movements, readily crossing boundaries of putative clades, including between individual islands and the adjacent mainland (Paetkau *et al.* 1997; 1998; Proctor *et al.* 2012).

As detailed throughout this report, geographic variation in body size, life history parameters, and food habits are evident across certain parts of Grizzly Bear range. For example, Ferguson and McLoughlin (2000) found such factors to be highly correlated with habitat quality (primary productivity) and seasonality; they clustered broadly into 2–3 groups (depending on the analysis): coastal, interior, and barren-ground bears. Hence, any regional differences that exist are likely a product of environmental productivity leading to negative density dependence (e.g., Mowat *et al.* 2005). British Columbia was, moreover, largely unsampled in this study, which used ordination methods to cluster what could be interpreted as continuous data. The possibility of ecotypes being discrete is also refuted by evidence already described in this section of the actual gene flow pattern of bear populations, which has demonstrated that although some natural features may pose barriers to movement along the coast, connections clearly occur through the adjacent interior regions (Paetkau *et al.* 1997; 1998).

A population of Grizzly Bears that once resided in the Ungava region of northern Quebec and Labrador (Figures 2 and 3) has not previously been assessed by COSEWIC. However, a comprehensive body of evidence suggests that indeed Canada did lose, sometime in the late 19th or early 20th century, an isolated population of Grizzly Bears living in northern Quebec and Labrador, including the area of the Koksoak and Caniapiscau Rivers in the west and east toward the George River and Torngat Mountains. A small Grizzly Bear population, it was a remnant of a continuous distribution across Canada during the Pleistocene. Loring and Spiess (2007) describe the area as a forest-tundra ecotone that supports an unusual diversity and concentration of wildlife. As the most recent authors to write on the subject of the Ungava Grizzly Bear, their review builds on, and is supported by, several other reports attesting to the existence and disappearance of the Ungava Grizzly Bear, including a particularly convincing investigation by Elton (1954), as well as studies by Spiess (1976), Spiess and Cox (1976), Cox (1977), and Veitch and Harrington (1996). See Distribution – Canadian Range.

The argument for DU status for the Ungava Grizzly Bear has merit in terms of discreteness because there is a natural disjunction with little or no anthropogenic barriers between it and the nearest population of Grizzly Bears, i.e., bears of the Western DU inhabiting mainland Nunavut. In terms of significance of the Ungava DU, the loss of this population has resulted in an extensive gap in the species' distribution in Canada, including elimination of the species from two provinces (Quebec and Newfoundland and Labrador), and it is unlikely to be replaced through natural dispersal.

Special Significance

In Western cultures and those of many Aboriginal peoples, the Grizzly Bear is one of the most powerful, popular, and respected animals, though it is sometimes feared (Hallowell 1926; Shepard and Sanders 1985; Herrero 2002; Rockwell 1991; Clark 2007; Clark and Slocombe 2011). Throughout recorded history, spiritual aspects of the bear image have pervaded most cultures sympatric with the species (Black 1998). North American Aboriginal perspectives on Grizzly Bears and bear-human relationships are surveyed broadly in the monographs of Hallowell (1926), Rockwell (1991), and Shepard and Sanders (1985), and the dissertation of Clark (2007). Historically and at present, Grizzly Bears have been hunted by some Aboriginal peoples for sustenance and cultural purposes (e.g., Hallowell 1926; Shuswap Indian Band 2008; Clark and Slocombe 2011).

Canadians generally value the Grizzly Bear, despite real and perceived dangers to human life and conflicts over property including pets and livestock. Public attitude surveys (e.g., review in LeFranc *et al.* 1987; Bath 1989; Kellert 1994; Province of British Columbia 1995; Miller *et al.* 1998; Stumpf-Allen *et al.* 2004) indicate that most people feel enriched from observations of bears, or even from knowing they exist.

Compared to the number of people who hunt ungulates, relatively few people hunt Grizzly Bears; however, the species is a highly prized trophy. Licensed hunting opportunities currently exist in BC, Yukon, NT, and Nunavut; subsistence hunting of bears by Aboriginal people can occur throughout its range in Canada. In BC, guided outfitting operations with a Grizzly Bear-hunt component generate about $2.6–3.3 million per year (Province of British Columbia 1995; Parker and Gorter 2003). Grizzly Bears are also highly valued for ecotourism, and the economic benefits of the species in this respect can be substantial. For example, in BC, an additional $6.1 million in annual revenue is estimated to accrue from ecotourism activities involving viewing Grizzly Bears (Parker and Gorter 2003).

The Grizzly Bear is commonly considered a flagship species for conservation planning (Carroll *et al.* 2001) with relevance to continental conservation programs (e.g., Yellowstone to Yukon [Y2Y] corridor planning; Merrill 2005). Grizzly Bears are generally highly sensitive to habitat and population perturbations and have relatively low resilience (Weaver *et al.* 1996), and are therefore considered as 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 as an ‘umbrella’ species, whereby conservation attention is assumed to confer benefits to less-known co-occurring species (Herrero *et al.* 2001; Hood and Parker 2001).

DISTRIBUTION

Global Range

Grizzly Bear distribution is holarctic with extant populations occurring in Europe and Asia (Figure 4), and in Canada and the United States (Figure 2); current records of occupancy exist for approximately 48 countries (McLellan *et al.* 2008). Countries such as Russia support sizable populations of Brown Bears; however, many populations in Europe are insular, small, and endangered. In the Yellowstone region, Grizzly Bears have been isolated from other populations since the early 1900s. The Grizzly Bear was not known to exist in the hot desert regions of the continent (Mattson and Merrill 2002).

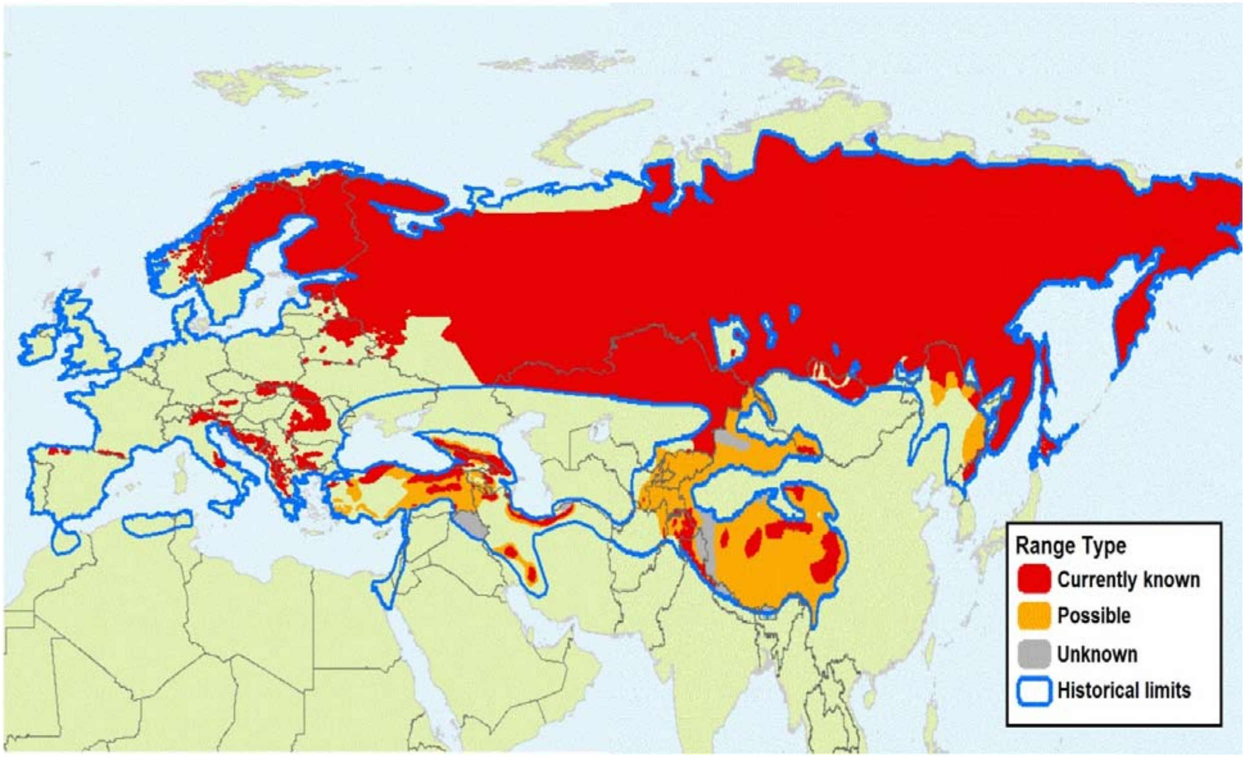

Figure 4. Eurasian distribution of the Brown or Grizzly Bear, *Ursus arctos* (McLellan *et al.* 2008).

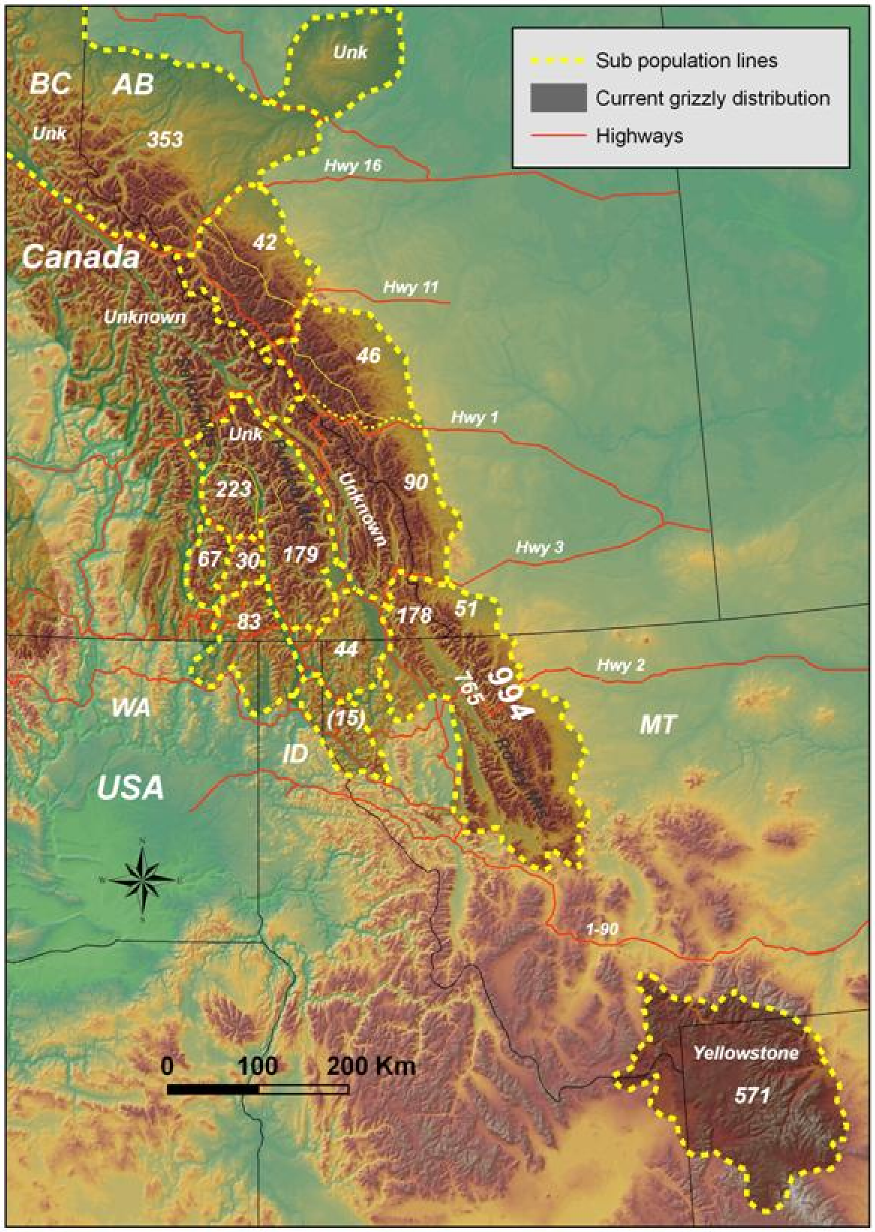

Figure 5. Map of subpopulations of grizzly bears in the trans-border area and Alberta derived from the fragmentation synthesis. Subpopulations are enclosed within dotted polygons. Numerical values represent survey-based subpopulation estimates. Where multiple numbers are within a subpopulation (dotted polygon), estimates are for separate jurisdictions delineated by a light solid line (i.e., provincial, international boundaries, or the limit of a survey effort). Figure and text from Proctor *et al.* (2012).

Canadian Range

The 19th century distribution of Grizzly Bears included nearly all higher elevation regions of western Canada, the Prairies and portions of the western boreal forest, particularly the Boreal Cordilleran, the dry interior of BC, and subarctic regions of Yukon, NT, Nunavut, and parts of Quebec and Labrador (Figure 2). Its range likely excluded the boreal forests of Saskatchewan and Manitoba. Regions of Grizzly Bear extirpation in Canada include the non-mountainous regions of Alberta and parts of southern British Columbia (McLellan 1998; Nielsen *et al.* 2004a). Reductions in the species' North American range were concurrent with the arrival of Europeans. The species currently occupies an estimated 2.98×10^6 km^2. No significant reduction in distribution in Canada has been documented since COSEWIC's original assessment of the Grizzly Bear in 1991 (Banci 1991).

Geographically isolated bear populations in the southern fringe of their distribution have significant differences in allele distributions, particularly in corridors of high human settlement and traffic (Proctor *et al.* 2005; 2012). Bears in the North Cascade Mountains of southern British Columbia, which may number fewer than 20 individuals, are separated from occupied bear habitat to the east and northeast by a broad stretch of unoccupied habitat (70–160 km); movement across this area has not been demonstrated except for a single translocated individual that returned (McLellan 1998; T. Hamilton, pers. comm. [cited in COSEWIC 2002]). The southern fringe of Grizzly Bear distribution consists of several peninsular extensions (Figures 2, 5). Where these peninsulas are constricted, bear movement is compromised. Examples include the Kettle-Granby, Valhalla, Central Monashee, and Yahk regions (provincial Grizzly Bear Population Units [GBPU]) in south-central to southeastern BC, and along the south Coast Ranges including the Cascades, Stein/Nahatlatch, and Garibaldi/Pitt units. A population study was recently completed across the southwestern lobe of Grizzly Bear range, as defined by the southern Coast Ranges (Apps *et al.* 2010). The region has a recent history of small, isolated and inbred populations that relates directly to the pattern of human activity, settlement and access. To varying degrees, several of these genetic population clusters have been in the process of expansion and reconnection, likely over the past decade or so. But the larger regional population remains highly fragmented as local densities vary greatly and bears have not recovered in many areas. For example, the Stein-Nahatlatch population is an isolated island of ~23 individuals and has lower genetic variability than any other mainland population in North America.

Members of the Willow Lake Métis Local 780, based in Anzac, Alberta, indicated in summer 2009 that they had seen Grizzly Bears around the Connacher Great Divide SAGD Expansion Project area that were not there previously (Connacher Oil and Gas 2010). The Whitefish Lake First Nation states that Grizzly Bears occupied S-9 Forest Management Area in north-central Alberta about 76 km northeast of High Prairie within living memory (p. 10, Hickey 1999). In BC, Grizzly Bears were common in *Sngaytskstx* territory (Lower Kutenai = Lake(s) Indians or Arrow Lakes Okanagan-Colville-speaking people) during and before the mid-19th century (Ray 1975 in Bouchard and Kennedy 2005).

Grizzly Bears have apparently expanded their range in the far north and east of their current range in Canada, including the NT, Nunavut, northern Saskatchewan, and tundra regions of Manitoba. This expansion is likely neither a result of increased sightings due to rising numbers of people on the land, nor of bears moving closer to communities because of attractants such as refuse. It should, however, be noted that overall lack of systematic survey efforts in these areas precludes knowledge of whether such trends equate to increases in abundance, as opposed to changes in movements or distribution. The analysis of Doupé *et al.* (2007) combined with ATK and other sources (e.g., Clark 2000; McLoughlin 2001; Rockwell *et al.* 2008) suggests that the Grizzly Bears are becoming more common in the Low to mid-Arctic tundra regions of northwest Canada (Figure 6). The species has been observed in parts of the Low Arctic mainland and Arctic Archipelago throughout the 20th century (review in Doupé *et al.* 2007); however, sightings are becoming more frequent. In Wapusk National Park, Manitoba, seven of nine known encounters have occurred since 2003 (Rockwell *et al.* 2008). Within Saskatchewan there have been recent reports of Grizzly Bears in the Taiga Ecozone from Aboriginal people who have routinely encountered Grizzly Bears near their camps in NT as well (T. Trottier, Saskatchewan Environment Resource Management, pers. comm., 2011). The Nunavut Wildlife Harvest Study, conducted by the Nunavut Wildlife Management Board between 1996 and 2001, indicates that the range of the Grizzly Bear into Nunavut is larger than previously thought. For example, there are recent kill records of Grizzly Bears in Inuit communities such as Baker Lake, Gjoa Haven, Arctic Bay, Pelly Bay, and Cambridge Bay (R. Jeppesen, Nunavut Wildlife Management Board, pers. comm. 2011). McLoughlin *et al.* (2003) noted the Grizzly Bear population in Nunavut was increasing in 1999 at an annual rate of 3%. Numerous sources have documented the occurrences of Grizzly Bears in areas of the Arctic where they had not previously been observed or unusually high occurrences of this animal in areas where they were seldom observed until recently. For example, Grizzly Bears have been most recently documented on northern Banks Island (Slavik 2010), travelling across ice on Holman Island (Slavik 2010), on the ice near Sachs Harbour (Ashford and Castleden 2001), crossing from the mainland to Victoria Island (Thorpe 2000), in Storis Passage (Ugjulik), on King William Island, and in the Gjoa Haven area in general (Keith and Arqviq 2006). A single Grizzly Bear was sighted by a crew conducting helicopter-based shorebird surveys on Melville Island, Nunavut in June 2007 (Jennie Rausch, Canadian Wildlife Service, pers. comm. 2012).

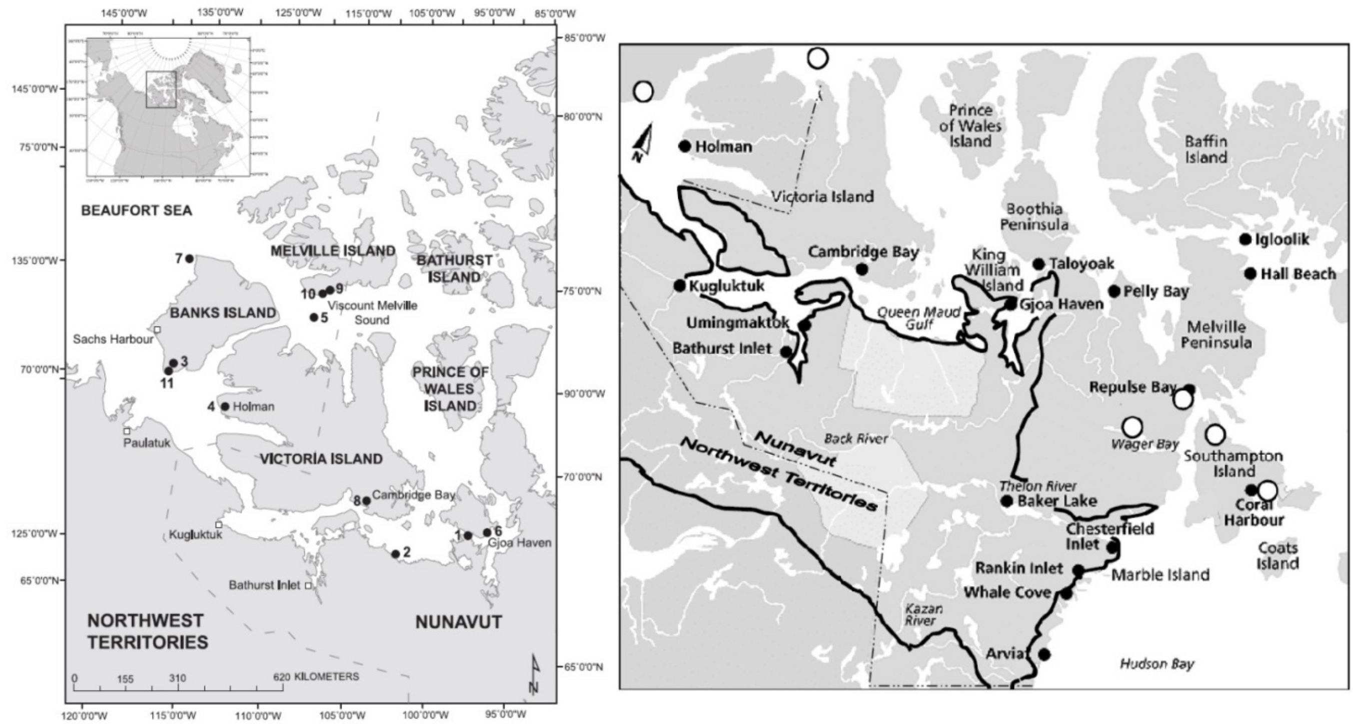

Figure 6. Confirmed instances of Grizzly Bear presence in the Canadian Arctic archipelago and in east mainland Nunavut (observations are black circles, left, and white circles, right). The thick line on the right indicates the bounds of non-vagrant Grizzly Bear distribution as interpreted by McLoughlin (2001). Left, reprinted with permission from Doupé *et al.* (2007); right, reprinted from McLoughlin (2001).

With respect to the Ungava Grizzly Bear, evidence that delineates the past distribution of the species in Quebec and Labrador includes skeletal remains (Spiess 1976; Spiess and Cox 1976), fur trade returns, a clearly identifiable photograph of a Grizzly Bear skull at an Innu campsite (dated 1910 and reproduced in Loring and Spiess 2007), several explorer accounts, and compiled Innu oral histories (review in Loring and Spiess 2007). Of particular importance is a report on the Ungava Grizzly Bear written by Smithsonian naturalist and explorer of the region, Lucien M. Turner (1848–1909), which was recently rediscovered. Turner had considerable first-hand experience with northern wildlife and the fur trade (from trips to Alaska and northern Canada), and in his writings he clearly recognized the presence of three distinct species of bears from northern Quebec and Labrador: the Polar Bear, American Black Bear, and Grizzly Bear (Loring and Spiess 2007). Turner writes at length about the latter species, including aspects of its biology and relationship with the Innu. A portion regarding the distribution of the bear in the Ungava region is reprinted from Loring and Spiess (2007):

> "*A species of Bear supposed to be the Barren Ground Bear is well known to inhabit the sparsely timbered tracts along George's River [George River] from within thirty miles of its mouth to the headwaters. This animal is not plentiful, although common enough and too common to suit some of the natives who have a wholesome dread of it. It may be somewhat strange but it is nevertheless a certainty that it is not an inhabitant of the Koksoak*

valley south of latitude 56 degrees, but confines itself in the more northern portion of its range to the area between the coast range of hills along the Labrador coast and the George's River valley, ascending that region to the headwaters and there striking across the country to the westward north of the "Height of Land". South of 55 degrees it is not known to occur that I have any trustworthy information of. The Indians affirm that only within recent years has this animal taken a freak ['whim, fancy'] to extend its range to the westward of the headwaters of Georges' River. The coloration of the Brown or Barren Ground Bear is so variable as at times to be a dirty yellowish brown to a dark grizzly...this animal is extremely savage, rushing up on its foe with a ferocity characterized by no other species of Bear."

Interviews from 1927–28 of Innu by anthropologist William Duncan Strong (Strong 1930) confirmed the people of the region knew of a Brown Bear much fiercer than both the Black Bear (*mésk-weh*) or Polar Bear (*wah-púsk-weh*), which they named (*métācū* or *méh-tah-shue*, or *matashu* ['red bear' in the language of the Mushua-Innu of Labrador and Nunavik]). The species was also known to experienced Hudson Bay Company traders working in the area during the 19th century who compiled inventories for the district of "Black, Brown, Grisly, and Polar Bears" (e.g., John Maclean cited in Elton 1954). Elton (1954) reports at length about small but not uncommon numbers of Grizzly Bear skins separated in the fur returns from Labrador posts in the mid-1800s, which could not have originated from elsewhere other than the Ungava Peninsula.

When this population was lost is unknown, but Loring and Spiess (2007) suggest that some older Innu hunters may still be familiar with the word *matashu* as a large, dangerous, yellow-brown bear that figures in Innu oral histories and legends (Lefebvre 1972; Savard 1985, 2004). These authors also note, however, that: "soon no memory of Grizzly Bears will remain among the people of the Ungava region, and the case for the bears' former existence in northern Quebec and Labrador will have to be based solely on recovered faunal remains, historical accounts, and Cabot's photograph from Long Pond (p. 14)." Stephen Loring noted of his ethnobiological survey in 2004: "...while older Innu recognized the association of *matashu* with a large brown bear and sometimes expressed surprise at the memory of the word, no one we talked to had much to say about its history or habits (Loring 2005)." The last recorded sighting was in 1948 (Wright 1962).

Search Effort

Search efforts used to locate Grizzly Bears and to measure population size across their range in Canada vary substantially, and have included methods as varied as surveys, ATK reports, harvest and fur returns, conventional and DNA-based mark-recapture analysis, and other population census techniques. Grizzly Bear presence in an area is unlikely to go unnoticed, and the bounds of Grizzly Bear range in Canada (Figure 2) are fairly well known. Scientific sources used to identify Grizzly Bear distribution in Canada are widely available, and include Mattson and Merrill (2002), Schwartz *et al*. (2003a), Austin *et al*. (2004), Proctor *et al*. (2005), Doupé *et al*. (2007), Environment Canada (2009), and ASRDACA (2010), although most of these depict coarse-scale "best guess" demarcations on maps based on sightings, mortality events, and/or perceived habitats with little to no confirmation of occupancy of these habitats over time.

HABITAT

Habitat Requirements

Grizzly Bears are habitat generalists. They can be found from sea level to high-elevation alpine environments. In Canada, the species occupies habitats as diverse as temperate coastal rain forests, alpine tundra, cordillera and upland boreal forest, dry grasslands in BC and on the Prairies (along the southeast front of the Rocky Mountains; Morton and Lester 2004), subarctic taiga, and Low Arctic tundra. Grizzly Bears are omnivorous but primarily herbivorous, although trophic position may vary substantially even within a population, from almost complete herbivory to near total carnivory (M.A. Edwards *et al.* 2011). Habitat associations are strongly seasonal and typically reflect regional plant phenology, timing of spring ungulate calving and runs of migratory fish (where available) (Schwartz *et al.* 2003a).

Physiographic and vegetative descriptions of habitat, using resource selection functions (RSFs) and remote sensing, exist for parts of Grizzly Bear range in Canada (McLoughlin *et al.* 2002a; Theberge *et al.* 2005; Theberge and Stevens 2005; Nielsen *et al.* 2006; Ciarniello *et al.* 2007a,b; Maraj 2007; Chetkiewicz and Boyce 2009; Collingwood *et al.* 2009; Milakovic *et al.* 2012). Increasingly, evaluation of Grizzly Bear habitat focuses on anthropogenic attributes as opposed to natural features of vegetation and terrain as drivers of habitat use and selection (Chruszcz *et al.* 2003; Apps *et al.* 2004; Nielsen *et al.* 2004a,b, 2006; Mueller *et al.* 2004; Waller and Servheen 2005; Linke *et al.* 2005; Johnson *et al.* 2005; Nielsen *et al.* 2006, 2010; Berland *et al.* 2008; Roever *et al.* 2008a,b, 2010; Graham *et al.* 2010). Human activities influence how bears use potential habitat; zones of human activity are generally avoided or characterized by high human-caused mortality (McLellan and Shackleton 1988; McLellan 1990). Reduction in habitat use by Grizzly Bears 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 functional habitat loss in consideration of the effects of human activities (e.g., Gibeau 1998, 2000).

Some disturbed habitats may attract bears (e.g., road allowances [Chruszcz *et al.* 2003; Roever *et al.* 2008a,b, Graham *et al.* 2010], although this use may be affected by traffic volume [Waller and Servheen 2005]). Seemingly productive areas, like road clearances and valley bottoms where human densities are high, may also expose bears to higher rates of human-caused mortality and thus act like ecological traps (Herrero *et al.* 2005; Nielsen *et al.* 2006; Roever *et al.* 2008a,b). Recently, efforts to model areas of relatively high security for Grizzly Bears (areas where bears can meet their energetic needs while avoiding human-caused mortality) have informed conservation-based land-use planning initiatives, including identification of habitat linkage zones (e.g., Gibeau *et al.* 2001; Gibeau 2005; Theberge and Stevens 2005; Nielsen *et al.* 2006; Apps *et al.* 2007; Chetkiewicz and Boyce 2009; Ciarniello *et al.* 2009; Maraj 2007; 2010). Security areas consist of suitable habitat, are large enough to meet minimum daily area requirements for foraging, and are outside zones of influence of human activity. Connectivity of small areas of suitable habitat is likely necessary for continued occupancy by Grizzly Bears (e.g., Proctor *et al.* 2005).

Habitat Trends

Though much research has been conducted with respect to the threats of habitat loss to Grizzly Bears (see Limiting Factors and Threats), trends in habitat availability for Grizzly Bears in Canada since the 2002 COSEWIC update are not readily quantified or detected. For the Western DU as a whole, Grizzly Bear habitat has likely remained close to the same as in past COSEWIC reports, dating back to Banci (1991), with the notable exception of the southern extent of the range in B.C. and Alberta, where habitat fragmentation and degradation through expanding human settlement, resource extraction, and recreation is ongoing and intensifying in some areas (Proctor *et al.* 2005; 2012; ASRDACA 2010). The northern half of Grizzly Bear range has remained relatively undisturbed, although this situation is changing with increasing pressures from natural resource development activities (See Threats - Habitat perturbations).

BIOLOGY

General

Reviews of Grizzly Bear biology have been written by LeFranc *et al.* (1987), Pasitschniak-Arts (1993), J. Craighead *et al.* (1995), Pasitschniak-Arts and Messier (2000), and Schwartz *et al.* (2003a). The following sections address recent advances in the knowledge of life-history characteristics that are pertinent to the species' status.

Life Cycle and Reproduction

Age at primiparity and interbirth interval for female Grizzly Bears are variable and influenced by habitat quality (Hilderbrand *et al.* 1999b; Ferguson and McLoughlin 2000). Age at first reproduction is related to body size, and body size is predicted from environmental factors such as primary productivity (Ferguson and McLoughlin 2000). Grizzly Bears living in Yellowstone National Park attained mean adult size in five of eleven body dimensions by 4 years of age, and all eleven by age 7 (Blanchard 1987).

Age at first reproduction varies substantially across the range of the Grizzly Bear. Successful first breeding has been documented for females as young as 3.5 years in the Rocky Mountains (Aune *et al.* 1994; Wielgus and Bunnell 1994) and as old as 9.5 years in the Low Arctic (Case and Buckland 1998). Schwartz *et al.* (2003b) observed major shifts in litter production occurring at 4–5 years of age (age at first reproduction) and at 28–29 years (senescence), with a litter every 3 years between those ages.

Litter size is 1–3 cubs; litter size and litter survival depend on the availability of food. For example, in Nunavut during a ‘bad year’, Inuit report that usually only one cub is seen (Nirlungayuk 2008), whereas in coastal British Columbia, where food is more predictable and abundant, litter size averaged 2.3 cubs per female (MacHutchon *et al.* 1993). At birth, cubs weigh approximately 0.5 kg. They are nursed inside the den until sometime between the end of February and the beginning of May, depending on latitude (e.g., in the Low Arctic tundra, females emerge from dens as late as the first week of May [McLoughlin *et al.* 2002b]). Cubs are sometimes weaned as yearlings but more often as 2-year-olds. J. Craighead *et al.* (1995) observed that for 44 litters followed in Yellowstone National Park, 31.8% of cubs were weaned as yearlings versus 68.2% weaned as 2-year-olds. Reproductive parameters for female Grizzly Bears from regions within or adjacent to Canada are presented in Table 1.

Table 1. Estimated reproductive parameters of Grizzly Bears in and adjacent to Canada. Rates were estimated using various methods.

	Age (yrs)[1] at first litter		**Litter size[2]**		**Interbirth interval (yrs)**		
Study Area	**Mean (*n*)**	**Range**	**Mean (*n*)**	**Range**	**Mean (*n*)**	**Range[3]**	**Reference**
Berland River, AB	—	6 - ?	1.8 (5)	1 - 3	—	—	Nagy *et al.* 1988
Bow River Watershed, AB	6.6 (9)	6 - 8	1.8 (38)	1 - 3	4.4 (15)	3 - 5	Garshelis *et al.* 2005
Yellowhead-Foothills, AB[5]	4.0[6]	—	1.8 (34)	1 - 3	—	—	Boulanger and Stenhouse 2009
Flathead River, BC	6.0 (5)	5 - 8	2.3 (31)	1 - 3	2.7 (9)	1 - 4	McLellan 1989c
Hart Ranges, BC	—	—	1.9 (13)	1 - 3	—	5 - 6	Ciarniello 2006
Khutzeymateen Valley, BC	—	—	2.4 (8)	1 - 3	—	—	MacHutchon *et al.* 1993
Parsnip Plateau, BC	4.3 (3)	4 - 5	2.0 (7)	1 - 3	—	3	Ciarniello 2006
Cabinet-Yaak, US / BC	6.6 (5)	6 - 7	2.1 (13)	—	3.0 (7)	2 - 4	Wakkinen and Kasworm 2004
Selkirk Mountains, US / BC	6.5 (8)	6 - 7	2.2 (17)	1 - 3	3.0 (8)	—	Wakkinen and Kasworm 2004
N. Continental Divide, MT	5.7 (10)	4 - 7	2.1 (56)	1 - 4	2.7 (16)	2 - 4	Aune *et al.* 1994
Swan Mountains, MT	5.7 (3)	4 - 8	1.6 (17)	1 - 2	3.0 (6)	2 - 4	Mace and Waller 1998
Brock-Hornady Rivers, NT	—	5 - 6	1.5 (?)	—	—	—	Nagy and Branigan 1998
Anderson-Horton Rivers, NT	10.8 (12)	6 - ?	2.3 (37)	1 - 3	4.3 (15)	3 - 5	Clarkson and Liepins 1994

	Age (yrs)[1] at first litter		Litter size[2]		Interbirth interval (yrs)		
Study Area	**Mean (*n*)**	**Range**	**Mean (*n*)**	**Range**	**Mean (*n*)**	**Range[3]**	**Reference**
Low Arctic tundra, NT and NU[4]	8.1 (10)	—	2.2 (35)	1 - 4	2.8 (17)	1 - 6	McLoughlin *et al.* 2003b,c
Mackenzie Mountains, NT	—	8 - ?	1.8 (6)	—	3.8 (5)	—	Miller *et al.* 1982
Richardson Mountains, NT	—	5 - 6	2 (?)	—	—	—	Nagy and Branigan 1998
Tuktoyaktuk Peninsula, NT	5.9 (10)	5 - 8	2.3 (18)	1 - 3	3.3 (8)	3 - 4	Nagy *et al.* 1983a
Kugluktuk, NU[4]	8.7 (6)	7 - 10	2.3 (19)	1 - 4	2.8 (8)	1 - 4	Case and Buckland 1998
Northern Yukon, YT	—	6 - 8	2.0 (6)	1 - 3	—	3 - 5	Nagy *et al.* 1983b
Kluane NP & Reserve, YT	8.10 (7)	7 - 9	1.97 (29)	1 - 3	2.75 (16)	1 - 5	McCann 1998

[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]Case and Buckland (1998) present a subset of data from the larger study area of McLoughlin *et al.* (2003).
[5]Includes data mainly from the Yellowhead and Grande Cache Grizzly Bear Management Units (GBMU), but also information from Clearwater, Swan Hills, Waterton, and Livingstone GBMUs (Boulanger and Stenhouse 2009). Data presented in ASRDACA (2010) as compiled by P. McLoughlin.
[6]The proportion of females having cubs if not nursing a previous litter was 0.42 at age four, with no records for earlier ages having cubs.

Male Grizzly Bears reach maturity at 3.5–5.5 years of age (White *et al.* 1998, 2005). Despite physiological maturity, younger males are not likely to reproduce because older males prevent them from doing so. Older adult male bears sire a disproportionate number of cubs compared to their representation in the population. J. Craighead *et al.* (1995) did not observe any male bears less than 5 years of age copulating, and no males under 9 years were successful breeders (compared to females as young as 5 years breeding successfully). In Yellowstone, males reached mean adult size in seven of eleven dimensions by 6 years, and all eleven by 9 years (Blanchard 1987). In the Brooks Range of Alaska, prime breeding condition for males was from ages 9–18: a full one-third of cubs with known fathers were sired by males 9–11 years old, and only one male over 18 years bred successfully (L. Craighead *et al.* 1995).

A calculation of generation length for Grizzly Bears (average age of parents in the population) yields an estimate of 13-14 years (using formula from IUCN Standards and Petitions Subcommittee, 2011). This estimate is derived by applying parameters presented in this document, i.e. (1) estimated annual survival rates are based on averages extracted from the columns in Table 2, and are therefore considered constant across the age-brackets shown on that table, (2) age of first reproduction is set at 6 or 7 years of age (6.7 being the average derived from summary data in Table 1, Ferguson and McLoughin 2000), and (3) survival and triennial reproductive frequency is held constant until animals reach 25-30 years of age (i.e. no reproductive senescence or increasing mortality rates assumed for aging adults). Adjusting values for either average age of first reproduction or maximum longevity did not appreciably influence the average age of the breeding female because either very old individuals or younger breeders were being removed. As such, this calculation is based on average or best-case scenarios, estimated from data collected through various methods, and therefore it should not be considered accurate or representative of any one individual population, but rather a general approximation based on information on hand.

Table 2. Estimated annual survival rates for radio-collared Grizzly Bears in and adjacent to Canada. Rates were estimated using various methods.

	Adult		Subadult				
Study Area	**Male**	**Female**	**Male**	**Female**	**Yearling**	**Cub**	**Reference**
Blackfeet-Waterton, MT / AB	0.63	0.92	0.80	0.86	—	—	McLellan *et al.* 1999
Bow River Watershed, AB[1]	0.87	0.95	0.69	0.92	0.91	0.79	Garshelis *et al.* 2005
Grande Cache, AB	0.80	0.91	—	—	—	—	Boulanger and Stenhouse 2009
Kananaskis, AB	0.70	0.93	0.89	0.89 0.93	—4	0.78	Wielgus and Bunnell 1994
Yellowhead, AB	0.79	0.90	—	—	—	0.53	Boulanger and Stenhouse 2009
Central Rockies, AB / BC	0.89	0.91	0.74	0.95	—	—	McLellan *et al.* 1999
Flathead River, BC [2]	0.92	0.94	0.92	0.94	0.88	0.82	McLellan 1989b
Flathead River, BC [2]	—	0.95	—	0.93	0.94	0.87	Hovey and McLellan 1996
Hart Ranges, BC [3]	—	0.96	—	—	—	—	Ciarniello 2006
Parsnip Plateau, BC [3]	—	0.92	—	—	—	—	Ciarniello 2006
North Fork Flathead, BC / MT [2]	0.89	0.96	0.78	0.94	—	—	McLellan *et al.* 1999
Cabinet-Yaak, US / BC	0.85	0.93	0.88	0.77	0.88	0.68	Wakkinen and Kasworm 2004
Selkirk Mountains, US / BC	0.91	0.94	0.77	0.90	0.78	0.88	Wakkinen and Kasworm 2004
South Fork Flathead, MT	0.89	0.89	0.78	0.87	—	—	McLellan *et al.* 1999
Swan Mountains, MT	—	0.90	—	0.83	0.91	0.79	Mace and Waller 1998
Low Arctic tundra, NT / NU	0.99	0.98	—	—	0.68	0.74	McLoughlin *et al.* 2003
Kluane NP & Reserve, YT	0.947	0.948	0.859	0.823	0.757	0.252	McCann 1998

[1]Based on known + suspected mortalities during the study, using the 'years pooled' method Included with cubs.
[2]Rates calculated within same study, sharing some data, over a different period or with different methods.
[3]Samples sizes were too small to adequately measure survival for other age categories (e.g., <10 animals).
[4]Included with cubs.

Annual survival can generally be distinguished based on sex and age or stage of life history (Table 2). Generally, researchers assess survival rates separately for cubs-of-the-year (COYs), yearlings (age 1), subadults (ages 2–4), and adults (ages ≥5). Maximum age ranges between 20 and 30 years for bears in the wild, depending on habitat and exposure to human-caused mortality (McLoughlin 2003), although longer lifespans are common in captivity (e.g., 40 years; Weigl 2005). The general pattern is for COYs and yearlings to have lower survival than subadults and adults (Table 2). Human-caused mortality is a major contributor to overall mortality in most areas where Grizzly Bears occur, and is related to sex and age. Males, especially young males, are more likely than females to die of non-natural causes. For example, in the Bow River Watershed, Alberta, Garshelis *et al.* (2005) observed that only one of 11 males died a natural death, whereas natural and non-natural mortality rates were similar for females. Males often have lower survival than females (Table 2), possibly due to a greater propensity for males to be hunted by and run into conflict with humans.

Rates and causes of natural mortality are difficult to assess, which is generally only possible by following radio-collared animals. For example, McLoughlin *et al.* (2003b), aside from a capture-related death, observed only natural mortalities for adult females during a study of Grizzly Bear mortality in the Low Arctic tundra of Nunavut and the NT; however, in the Rocky Mountains human-related mortality may account for 77% of documented deaths (McLellan *et al.* 1999). Confronted only with risks due to natural mortality, adult Grizzly Bear survival is generally high (above 90% per year), with natural rates of cub and yearling survival being lower. Grizzly Bears die from various natural causes, including natural accidents (e.g., den collapses, avalanches, drowning), senescence, starvation, and intraspecific predation for food and infanticide, whereby males that are not the father of cubs will kill cubs to bring a female back into estrus (e.g., McLellan 2005)

Physiology

The most notable aspect of Grizzly Bear physiology, in the context of assigning status to the species, is the vulnerability presented by denning (hibernation or dormancy). Although 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 compel most bears to ‘hibernate’ during winter. This is not true hibernation, however, but a form of winter sleep with less metabolic depression and higher body temperature than seen in true hibernators. 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 in a den (Wildlife Management Advisory Council [North Slope] and the Aklavik Hunters and Trappers Committee 2008). The duration of den occupancy is related to latitude, with bears at higher latitudes entering dens earlier and remaining denned longer (Schwartz *et al.* 2003a). Grizzly Bears in Banff National Park spend, on average, about 4.5 months each year in dens (Vroom *et al.* 1980). In the Low Arctic tundra of Nunavut, average duration of den occupancy is 185 days (6.2 months) for males and 199 days (6.6 months) for females (McLoughlin *et al.* 2002b). In Nunavut, Grizzly Bears hibernate from October or November to April or May; exact timing is weather-dependent (Nirlungayuk 2008). Even at high latitudes, Grizzly Bears may be active well into December if weather permits (Arctic Borderlands Ecological Knowledge Co-op 1997). In the far north there may be some recent changes in grizzly hibernation patterns, whereby bears are hibernating later in the year and emerging earlier (Wildlife Management Advisory Council [North Slope] and the Aklavik Hunters and Trappers Committee 2008). This may be due to the longer growing seasons experienced in the Arctic in recent years (Arctic Climate Impact Assessment 2004), although this hypothesis has not been tested.

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 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 ranges from 16 to 37% (Hellgren 1998). In Alaska, adult females in the study of Hilderbrand *et al.* (2000) lost an average of 73 kg (32%) of body mass over winter. Most of this mass loss (56%) 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 (Hilderbrand *et al.* 2000). Total body fat during early summer dropped to as low as 6.3% of body mass in Grizzly Bears of the central Canadian Arctic, and climbed to as high as 33.6% in autumn (Gau 1998).

Preparation for denning includes hyperphagia, particularly of carbohydrate-rich foods such as berries. This compulsion to generate fat stores adequate to minimize muscle catabolism during hibernation drives foraging and directs much Grizzly Bear behaviour during late summer and autumn. For example, Grizzly Bears in central coastal BC roamed widely during the berry season, using 10 berry species in divergent habitats (Hamilton and Bunnell 1987). Fall migrations to salmon streams have been widely reported for coastal bear populations (LeFranc *et al.* 1987).

Adaptability

In addition to surviving long periods without food, Grizzly Bears exhibit behavioural adaptations that allow them to survive in a variety of environments. Of particular importance, Grizzly Bears are highly capable of learning. For example, bears receiving anthropogenic food rewards in response to particular behaviours tend to quickly become food-conditioned (McCullough 1982). This as well as general association of Grizzly Bears with human settlements contributes to negative bear-human interactions (Herrero 2002; Inuuvik Community Corporation *et al.* 2006; Lutsel K'e First Nation *et al.* 2001). Aversive conditioning programs have been implemented in many places to take advantage of bears' ability to modify their behaviours (e.g., review in Schirokauer and Boyd 1998), and have been successful in some instances (Honeyman 2008).

Interspecific Interactions

Grizzly Bears share the basic digestive anatomy and physiology of other Carnivora (Rode *et al.* 2001), but consume relatively large amounts of vegetation. The degree of herbivory in Grizzly Bears varies across habitats, but in most areas a variety of plants are important foods; consequently, diets are strongly seasonal. In some regions Grizzly Bears are mostly carnivorous; they can be both efficient predators and scavengers. 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 and Reserve (Hilderbrand *et al.* 1999b). Food habits of Grizzly Bears, which underlie interspecific interactions, are widely variable among regions and seasons. Many food-habit studies have been reported, and thorough reviews are provided by LeFranc *et al.* (1987), Pasitschniak-Arts (1993), Pasitschniak-Arts and Messier (2000), and Schwartz *et al.* (2003a). .

In central coastal BC, 65 distinct food items of Grizzly Bears, including 49 plant species, were identified by MacHutchon *et al.* (1993). In spring, sedges are the most commonly eaten food. Several forb species dominate the summer diet and persist into the fall. From early August to mid-October, salmon (*Oncorhynchus* spp.) are critically important to Grizzly Bears in Pacific drainages and the Yukon River watershed (Hilderbrand *et al.* 1999a, 2004). Changes in runs of salmon stocks are of concern for Grizzly Bears as well as other species across most of their range (Horejsi *et al.* 2010). In western BC, bears as far inland as several hundred kilometres can show a >20% contribution by salmon to their yearly diets (Horejsi *et al.* 2010). Coastal bears in BC have seasonal diets ranging from 13–61% meat, consisting primarily of salmon (Christensen *et al.* 2005). This reliance on salmon is similar for female Grizzly Bears in coastal Alaska, which in summer and fall consume 10.8 and 59.6 kg/day of salmon, respectively (Hilderbrand *et al.* 1999b). Adult female Grizzly Bears on Alaska's Kenai Peninsula consume about 1,000 kg each of salmon every autumn (Hilderbrand *et al.* 2004).

Grizzly Bears in the Flathead drainage of southeast BC occur at a density at least twice as high as any other reported interior population (Table 3). McLellan and Hovey (1995) suggested that this high density was a result of the high quantity and diversity of bear foods in the Flathead. Typical of many mountainous interior areas (Hamer and Herrero 1987; LeFranc *et al.* 1987; Hamer *et al.* 1991), Grizzly Bears in the Flathead feed largely on roots (especially *Hedysarum* spp., which is the case throughout much of the Grizzly Bear range in Canada [Pengelly and Hamer 2006]) and ungulates in early spring and again in late fall (McLellan and Hovey 1995). Although Whitebark Pine (*Pinus albicaulus*) seeds can be an important food item to Grizzly Bears in adjacent Glacier National Park, USA, and other regions (Mattson *et al.* 2001), this food source was not observed by McLellan and Hovey (1995). A variety of forb species, along with grasses and horsetails (*Equisetum* spp.), dominate the species' summer diet in the Flathead, and during late summer berries comprise 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*), were considered particularly important by McLellan and Hovey (1995) in defining the high quality habitat of the Flathead.

Table 3. Estimated densities and adult home range sizes (generally 100% minimum convex polygons) for selected Grizzly Bear population studies in Canada. Density estimates are calculated using various methods.

Study area	Density[1] (bears/1,000 km²)	Home range size (km²)[1] Males	Home range size (km²)[1] Females	Source
Berland River, AB	4.6	1,918	252	Nagy *et al.* 1989; Nagy and Gunson 1990
Bow River Watershed, AB		1,405	520	Stevens and Gibeau 2005
Castle, AB	18.1			ASRDACA 2010
Clearwater, AB	5.2			ASRDACA 2010
Crowsnest, AB	15			Mowat and Strobeck 2000
Grande Cache, AB	18.1			ASRDACA 2010
Jasper National Park, AB	9.8 - 11.7	948[3]	331[2]	Russell *et al.* 1979
Kananaskis, AB[5]	16.2			Wielgus and Bunnell 1994
Kananaskis, AB[5]	12.2 - 14.5	1,183	179	Carr 1989
Livingstone, AB	11.8			ASRDACA 2010
South Wapiti, AB	7.4			cited in Nagy and Gunson 1990
Swan Hills, AB	7.4 - 9.6	244	113	Nagy and Russell 1978
Swan Hills, AB[7]	1.9			Boulanger *et al.* 2009
Yellowhead, AB[8]	14.9	1,733	668	Boulanger 2001; Stenhouse and Munro 2001
Yellowhead, AB[8]	4.8			ASRDACA 2010
Central Rockies, AB & BC	9.8 - 16	1,560	305	Gibeau *et al.* 1996; Gibeau and Herrero 1997
Flathead River, BC	57 - 80	668	253[3]	McLellan 1989a; B.N. McLellan, pers. comm. 2011[4]
Garibaldi-Pitt, BC	0			Apps *et al.* 2010
Hart Ranges, BC	49	627	58	Mowat *et al.* 2002; Ciarniello *et al.* 2009
Khutzeymateen Valley, BC	43 - 90	125	52	MacHutchon *et al.* 1993
Northern Boreal Mountains, BC[6]	29			Poole *et al.* 2001
Parsnip Plateau, BC	12	1,056	361	Mowat *et al.* 2002; Ciarniello *et al.* 2009
Prophet River, BC[6]	14.5 - 16.9			Boulanger and McLellan 2001
Selkirk Mountains, BC	14.1			Wielgus *et al.* 1994
South Chilcotin Ranges, BC	7.0			Apps *et al.* 2010

Study area	Density[1] (bears/1,000 km²)	Home range size (km²)[1] Males	Females	Source
Stein-Nahatlatch, BC	2.8			Apps *et al.* 2010
Squamish-Lillooet, BC	9.1			Apps *et al.* 2010
Taiga Plains, BC[6]	10			Poole *et al.* 2001
Toba / Powell-Daniels, BC	10.1			Apps *et al.* 2010
West Slopes, BC		318	89	Woods *et al.* 1997
Yahk, BC	7.5			Proctor *et al.* 2007
Purcell Mountains, BC (Central)	18.9			Proctor *et al.* 2007
Selkirk Mountains, BC (Central)	26.6			Mowat and Strobeck 2000
Purcell Mountains, BC (South)	13.3			Proctor *et al.* 2007
Selkirk Mountains, BC (South)	14.3			Proctor *et al.* 2007
Anderson-Horton Rivers, NT	8.2 - 9.1	3,433	1,182	Clarkson and Liepins 1994
Brock-Hornady Rivers, NT	6			Nagy and Branigan 1998
Mackenzie Mountains, NT	12		265	Miller *et al.* 1982
Mackenzie River Delta, NT		1,215	680	Edwards *et al.* 2009
Richardson Mountains, NT	19			Nagy and Branigan 1998
Tuktoyaktuk Peninsula, NT	4	1,154	670	Nagy *et al.* 1983a,
Low Arctic tundra, NT / NU	1	7,245	2,100	McLoughlin *et al.* 2000, 2003a
Kivalliq, NU	1.6 - 1.8			M. Awan, pers. com.[5]
Kluane NP & Reserve, YT	37	287	86	Pearson 1975
Kluane NP & Reserve, YT		1,602	305	McCann 1998
Ivvavik National Park, YT		435	144	MacHutchon 1996
Northern Yukon, YT	26 - 30	645	210	Nagy *et al.* 1983b
North Slope, YT		1,020	190	WMACNS 2008

[1]Techniques for calculation of densities vary across studies, so comparisons must be made cautiously.
[2]Weighted means as reported by McLoughlin *et al.* (2000).
[3]Includes only females with cubs.
[4]Cited in COSEWIC (2002).
[5]Derived from aerial surveys by the Government of Nunavut (data unpublished and preliminary).
[7]Derived from population estimate of 23.1 bears and combined area of core (5,322 km^2) and secondary habitat (6,662 km^2).
[6,8]Different analyses and/or interpretations of the same data set.

In Ivvavik National Park, Yukon, the seasonal food habits of Grizzly Bears generally parallel those of southern interior bears (MacHutchon 1996). *Hedysarum* roots, overwintered berries, and horsetails (*Equisetum* spp.) are important spring foods. Horsetails remain important during summer, but forbs are also heavily used. During fall, berries become important as they ripen, and roots return to the diet. Grizzly Bears in Ivvavik hunt for Arctic Ground Squirrels (*Urocitellus parryii*) during summer and fall, and for Caribou calves and adults (*Rangifer tarandus*) during the brief mid-summer period when available; however, most (96–98%) foraging time is spent feeding on vegetation. Grizzly Bears in alpine habitats also actively hunt both Hoary [*Marmota caligata*] and Yellow-bellied Marmots [*M. flaviventris*]), which may be seasonally important sources of meat, along with ground squirrels (T. Jung, Environment Yukon, pers. comm. 2011).

Gau (1998) and Gau *et al.* (2002) studied food habits of Grizzly Bears in the Low Arctic tundra of the NT and Nunavut. Caribou (both calves and adults) was the most prevalent food item, especially in spring, mid-summer, and autumn. In early summer, when caribou were essentially absent from the region, horsetails, sedges (*Carex* spp.) and cotton grass (*Eriophorum* spp.) dominated the diet of bears. During late summer berries became most important, and were judged by Gau *et al.* (2002) to be critical for fat reserves sufficient for denning. In the NT, diet of Grizzly Bears may be quite carnivorous:

"If caribou are plentiful, there will be many bears. Grizzlies help keep the river otter population down. They also eat mice; sometimes the stomach is just a bag full of mice when you open it up. It is said that they go up the Richardson Mountains in the west to hunt, as well as go out on the ice hunting pup seals. Grizzlies are also known to migrate up to Richards Island to get the nesting geese and reindeer there" (Inuuvik Community Corporation *et al*. 2006: 11-38-11-39).

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 are positively correlated with dietary meat content (Hilderbrand *et al.* 1999a). In most areas, pre-hibernatory mass gain depends upon the consumption of massive volumes of berries during late summer (Bullock 1987). However, energetic maintenance costs are lowest and rate of mass gain highest when dietary protein content is about 20–35%, indicating that even when berries are abundant, a mixed diet is most efficient for bears (Rode and Robbins 2000).

The availability of meat to Grizzly Bears varies regionally and seasonally. However, where and when meat is available, Grizzly Bears strongly prefer it. Salmon and ungulates are particularly important dietary components. In coastal Alaska, for example, adult female Grizzly Bears eat an average of 8.5 kg/day of meat in spring, primarily Moose (*Alces americanus*) carrion and calves (Hilderbrand *et al.* 1999b). In south-central 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. Grizzly Bears were the primary cause of adult Moose mortality in southwestern Yukon (Larsen *et al.* 1989), and are important Moose predators in other areas as well (e.g., Gasaway *et al.* 1988; Mattson 1997; Haszard and Shaw 2000; Bertram and Vivion 2002; Nacho Nyak Dun First Nation *et al.* 2003). Some individuals may be more successful predators of ungulates 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, Grizzly Bears killed four times more animal biomass than they scavenged.

Prey for Grizzly Bears also include Elk (*Cervus elaphus*; Hamer and Herrero 1991; Mattson 1997), Muskoxen (*Ovibos moschatus*; Gunn and Miller 1982; Case and Stevenson 1991; Wildlife Management Advisory Council (North Slope) and Aklavik Hunters and Trappers Committee 2003), Mule Deer (*Odocoileus hemionus*; Mattson 1997), Dall's Sheep (Shaw *et al.* 2005), Hoary Marmots (Barash 1989), Mountain Goats (*Oreamnos americanus*; Festa-Bianchet *et al.* 1994), Bison (*Bison bison*; Mattson 1997), and Black Bears (Boertje *et al.* 1988; Ross *et al.* 1988). In the Canadian Arctic, Grizzly Bear predation on Ringed Seals (*Phoca hispida*) has been documented (Clarkson and Liepins 1989; M.K. Taylor, pers. comm. and P.I. Ross, unpubl. data [both cited in COSEWIC 2002]). Scavenging of whale carcasses is known (Wildlife Management Advisory Council (North Slope) and the Aklavik Hunters and Trappers Committee 2008). Where available, Army Cutworm moths (*Euxoa auxiliaris*), ants, and earthworms may be important seasonal foods (Mattson *et al.* 1991; Mattson 2001; Mattson *et al.* 2002; Munro *et al.* 2006). Livestock can also be important prey for Grizzly Bears (COSEWIC 2002). Seasonal aggregations of fish species other than salmon may also serve as locally important food sources. For instance, Barker and Derocher (2009) documented Grizzly Bear predation of Broad Whitefish (*Coregonus nasus*) in the Northwest Territories. Carrion can also be seasonally important in the diet of Grizzly Bears. For example, in the Aklavik area Grizzly Bears may rely on carrion along river shores early in the fall (Wildlife Management Advisory Council (North Slope) and the Aklavik Hunters and Trappers Committee 2008).

Although Grizzly Bears have no natural predators, a potential limiting factor of population growth is intraspecific predation. The killing of cubs to bring females into estrus, or killing of cubs and adults for food, is not uncommon in Ursidae, including Grizzly Bears (McLellan 2005). Many studies of Grizzly Bear demography report instances of Grizzly Bears killing other bears, which may limit populations near carrying capacity (see Threats and Limiting Factors).

Grizzly Bears influence other species in ways aside from consuming 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 species' relationship with obligate predators is more one-sided; bears (Grizzly and Black) visited 24% of Mountain Lion (*Puma concolor*) kills in Yellowstone and Glacier National Parks, and displaced Mountain Lions from 10% of carcasses (Murphy *et al.* 1998). Bears gained up to 113%, and Mountain Lions lost up to 26%, of their respective daily energy requirements from these encounters. Near Kluane National Park and Reserve, a winter-active Grizzly Bear apparently killed a Wolverine near a Bison carcass, and Grizzly Bears likely influence the use of some carcasses by Wolverine (T. Jung, Environment Yukon, pers. comm., 2011). Bear predation and incomplete consumption of carcasses (especially salmon) provides food for a variety of scavengers.

Space Use

Population density varies substantially across the range of the Grizzly Bear in Canada. The lowest densities of viable populations are known for the Low Arctic tundra of Nunavut and NT (Table 3). The highest densities are found in BC, particularly along the Rocky Mountains, e.g., in the valley of the Flathead River, and on the Pacific coast (e.g., Pacific Coast, Khutzeymateen Provincial Park) (Table 3). Population density is determined by numerous factors, including seasonally available food like salmon and ungulate calves (McLoughlin *et al.* 2000). Density is related to several characteristics that define Grizzly Bear populations, including home range size and movements (Table 3). How population density translates into population size throughout the different jurisdictions in Canada is presented in Population Size and Trends.

Home range size in Grizzly Bears is negatively correlated with general habitat quality (McLoughlin *et al.* 2000). Bears with access to predictable and abundant, high-quality food (e.g., salmon) tend to have smaller home ranges (McLoughlin *et al.* 2000). Bears living in drier and colder interior or northern environments typically require much larger home ranges (McLoughlin *et al.* 2000), up to 2 orders of magnitude greater than the largest coastal Alaskan home ranges (Table 3). Home ranges are larger for male bears than for females, presumably because they seek to overlap the home ranges of several females, and perhaps are influenced by the increased energetic demands of larger body size (McLoughlin *et al.* 2000, 2003a; McLoughlin and Ferguson 2000).

Local climate affects home range size of Grizzly Bears through effects on primary productivity and seasonality, and thereby food availability and accessibility (McLoughlin and Ferguson 2000, McLoughlin *et al.* 2000). Home range overlap also appears to have a non-linear relationship with habitat, whereby high overlap may be expected in areas that are both highly predictable with high food availability (e.g., salmon runs) and unpredictable with low amounts of food (e.g., tundra), with less overlap of home ranges expected in moderate environments (McLoughlin *et al.* 2000).

In the Mackenzie Delta, NT, Grizzly Bear movements are related to diet, as identified from stable isotope analysis. M.A. Edwards *et al.* (2011) examined within-population differences in the foraging patterns of males and females and the relationship between trophic position (derived from $\delta^{15}N$ measurements) and individual movement. The range of $\delta^{15}N$ values in hair and claw samples (2.0–11.0‰) suggested a wide niche-width, and cluster analyses indicated the presence of three foraging groups within the study area, ranging from near-complete herbivory to near-complete carnivory. Although M.A. Edwards *et al.* (2011) found no relationship between home range size and trophic position when the data were continuous or when grouped by foraging behaviour, the movement rate of females increased linearly with trophic position (i.e., more carnivorous bears moved more frequently).

Dispersal and Migration

Grizzly bears have male-biased dispersal, with subadult male Grizzly Bears usually dispersing upon independence, whereas subadult females are commonly more philopatric (LeFranc *et al.* 1987; Blanchard and Knight 1991). Dispersal in Grizzly Bears is a gradual process, taking 1–4 years (McLellan and Hovey 2001b). Mean dispersal distance for four subadult males in Yellowstone National Park was 70 km (Blanchard and Knight 1991). In southeastern BC, male and female dispersal distances averaged 29.9 km and 9.8 km, respectively (McLellan and Hovey 2001b). Using genetic analysis in the same area, Proctor *et al.* (2004) observed that females dispersed 14.3 km and males dispersed 41.9 km from their natal home range. Grizzly Bears are, however, capable of moving over greater distances. One radio-marked subadult male Grizzly Bear in northeastern BC was shot 340 km from its maternal home range (P.I. Ross, unpubl. data, cited in COSEWIC 2002). In the Low Arctic of NT and Nunavut, a subadult male moved 471 km in less than one month (R. Gau, pers. comm. cited in COSEWIC [2002]; Gau *et al.* 2004).

Male Grizzly Bears generally travel at higher rates than do females (LeFranc *et al.* 1987). In landscapes that are unfragmented by settlement and roads, male and female movement rates do not differ strongly. In areas characterized by human settlement and traffic, females are known to decrease their movements dramatically beyond a certain intensity, whereas males (particularly subadults) exhibit more tolerance for moving through such hostile areas (Proctor *et al.* 2012). In the Low Arctic tundra of NT and Nunavut, male Grizzly Bears move faster than females in all seasons (McLoughlin *et al.* 1999). Movement rates of males are generally highest in spring, when energetic demands are high and males seek mates, and generally decline through autumn. Female movement rates peak during summer when, in this area, food availability is low.

In some mountainous areas, bears undergo annual altitudinal migrations in response to seasonal changes in vegetation phenology and the availability of other foods (LeFranc *et al.* 1987; Proctor *et al.* 2012). For example, bears may emerge from high-elevation dens and descend to valley bottoms to seek ungulate carcasses and plants. As snow melt proceeds upslope, bears ascend to follow the emergence of fresh vegetation.

POPULATION SIZE AND TRENDS

Sampling Effort and Methods

Estimating abundance of Grizzly Bears is costly, difficult, and generally imprecise, particularly in large and remote areas, which characterize much of the distribution. Low sightability and/or low densities in most bear habitats renders challenging the use of direct-observation techniques such as aerial surveys. The most broadly used techniques include capture-mark-resight with or without radio-telemetry (Miller *et al.* 1987, 1997), and mark-recapture techniques that include camera traps, wherein bears trip cameras and photograph themselves (Mace *et al.* 1994), and DNA fingerprinting of hair follicles from bears attracted to baited barbed-wire snags (e.g., Woods *et al.* 1999; Mowat and Strobeck 2000; Mowat *et al.* 2002; Boulanger *et al.* 2009). Each method requires rigorous experimental design to avoid or minimize biases and errors associated with unequal probability of capture or resight, assumptions of population closure, and measurement of the precision of estimates. These difficulties lead to low precision in most estimates of Grizzly Bear density.

Data from different jurisdictions or by recent publications represent the current state of knowledge within that jurisdiction upon which bear management decisions are based. Most jurisdictions have derived population estimates from a combination of 1) expert opinion and/or 2) extrapolation of densities from inventories conducted in relatively small areas (Table 3). Most management agencies monitor harvest and other known human-caused rates of mortality as a means of monitoring Grizzly Bear conservation status in individual jurisdictions. In Alberta and southern BC, estimates of Grizzly Bear populations are known from DNA surveys (Proctor *et al.* 2012; ASRDACA 2010).

It is not possible to evaluate recent trends in Grizzly Bear population size over any period beyond the past 20 years (prior to 1991), which coincides with the advent of more modern methods of inventorying populations (in particular, DNA-mark-recapture methods).

Abundance

The Western Grizzly Bear DU numbers approximately 26,000 bears (Table 4). No range of precision can be assigned to this number. Age structure in bear populations is influenced by population fecundity and by the management regime to which the population is subjected. The proportion of mature individuals tends to be lower in hunted than non-hunted populations, particularly adult males (Miller 1990). A meta-analysis of 6 studies from different parts of Grizzly Bear range yielded a range of 25.6-59%, with a midpoint of 42% bears (Schwartz *et al.* 2003). Notwithstanding the wide variability in relative proportions of adults, subadults, yearlings, and cubs across populations (Schwartz *et al.* 2003) and the lack of precision around the estimate of total number of individuals, a reasonable estimate of the Canadian population of mature individuals might be about 11,500, although there is much variance around this estimate.

Table 4. Population estimates of Grizzly Bear abundance by jurisdiction in Canada, 1991 to present.

Jurisdiction	1991[1]	2002[2]	2012	Comments
Alberta[3]	790	1,021	691	Most recent province-wide estimate reported in ASRDACA 2010.
BC	13,000	at least 14,000	15,000	Hamilton 2008 reported 16,041 in last provincial estimate. The most recent estimate was in April 2012 (BCMFLNRO 2012). The variation in estimates does not reflect a trend in bear numbers in the province, but rather modifications to modelling methodology.
Manitoba	n/a	n/a	few	Small numbers of bears occur in the tundra regions of the province; there is no official estimate.
Yukon	6,300	6,300	6,000-7,000	2011 territory-wide trend of 6,000-7,000 reported (Government of Yukon 2011), representing population estimates originally developed in 1984 using expert opinion. This estimate has not been updated, although harvest and other mortality data indicate that there may be regional population declines.
NT	5,050	5,100	3,500-4,000	Does not imply population change from 2002 to 2011. Estimate by Government of the NT (2011) in 2002 include present-day Nunavut. Land area and bear population of Nunavut excised in 1999.
Nunavut	n/a[4]	800-2,000	1,530-2,000	Provided is a 2011 estimate as a personal communication from M. Awan, Government of Nunavut.

Jurisdiction	1991[1]	2002[2]	2012	Comments
TOTAL	25,140	at least 27,221	at least 26,762 (assume 26,000)	Changes in estimates between 1991 and 2001/2002 are largely due to revised methodology and new data, although many remain crude. Overall, trends between 1991 and 2011 are perceived to have been stable, except in Alberta where the population has likely declined, and southern BC and Yukon where there have been declines in some areas, and in Nunavut where the population is likely increasing.

[1]Values reported in previous COSEWIC status report of Banci (1991). Actual date of original estimate varies.
[2]Point estimates presented in COSEWIC (2002), with an update for Nunavut based on an earlier review of this document by the Government of Nunavut.
[3]Includes provincial lands and the mountain national parks of Waterton, Banff, and Jasper. Previous COSEWIC reports separated these numbers.
[4]Nunavut was created in 1999. Previously, values were included with NT. The 2002 NT estimate may still include Nunavut bears, hence there is possible double-counting between NU and NT in 2002.

DNA survey-based estimates are available for Canadian or transboundary populations in Alberta and southeastern BC (Proctor *et al.* 2012; Figure 5). Population condition ranged from relatively secure units with >500 bears to several small units of <100 bears. The smallest populations are throughout the trans-border area, including Purcell South Yaak, Selkirk South, Cabinet Mts, Selkirk Kokanee, and Selkirk Valhalla. Their long-term persistence will be reliant upon their reconnection to the adjacent source population in the central Purcell–Selkirk area (Proctor *et al.* 2012). Apps *et al.* (2009) recently documented several isolated populations of <30 bears in the South Coast Mountains of southern BC.

Fluctuations and Trends

Grizzly Bears are known to be extirpated due to human agency within the last 500 years from 17 countries, and from another 10 countries >500 years ago (McLellan *et al.* 2008). Although some regions report range expansion and increasing numbers of bears (e.g., Sweden [Kindberg 2010], northern Canada [Clark 2000; Doupé *et al.* 2007; Rockwell *et al.* 2008), the species has lost an estimated 50% of its global range and abundance since the mid-1800s (Servheen 1990). Since 1800 the Grizzly Bear has been eliminated from 98% of its range in the lower 48 states (Servheen 1999a). Range contraction in the contiguous United States has left six isolated populations south of Canada (including a possible population occupying the North Cascades of Washington), four of which persist along the Canada-US border (Proctor *et al.* 2005; 2012; Figure 5).

The current point estimate of abundance for the DU as a whole (Table 4) represents no change from either the 2002 estimate (COSEWIC 2002) or the 1990 estimate (Banci 1991); no data exist prior to 1991 to estimate trends over three generations. Differences in estimates for broad jurisdictions may be related to genuine changes in bear numbers, or to estimating methodology, reporting precision, and new data. There is, however, variability in known trends for particular areas within Grizzly Bear range. A number of populations at the southern range extent in Canada (e.g., in Alberta and southern BC) are in decline (Tables 4 and 5; Proctor *et al.* 2012). In central and northern British Columbia, some Métis Traditional Knowledge (MTK) holders in that province feel that populations have generally increased in their traditional areas over the past few decades (Ducommun 2010).

In the Yukon in recent years, people have noticed that numbers of both Grizzly and Black Bears have been high, although it is not known why there seem to be more bears (Little Salmon/Carmacks First Nation *et al.* 2004), and "there are lots of grizzly in the Vuntut Park and along the Porcupine River" (Arctic Borderlands Ecological Knowledge Society 2008). On the other hand, McCann 1998 found that the southwestern Grizzly Bear population was in decline (i.e., point estimate of finite rate of increase of 0.97, or 3% per annum decrease with human-caused mortality rates increasing). Maraj (2007; 2010) demonstrated that this trend was the result of high human-caused mortality. Yukon's grizzly mortality data also indicate that there are numerous places where human-caused mortality is unsustainable, with up to 18% of the territory possibly falling into this category (R. Maraj, unpublished data). Most Aklavik Inuvialuit hunting in the Yukon North Slope interviewed said that the population had not changed very much over the past 20 years; none of the interviewees as part of Wildlife Management Advisory Council (North Slope) and the Aklavik Hunters and Trappers Committee (2008) believed that Grizzly Bear numbers were too low or that the population was in any danger. Near Tuktoyaktuk, recent comments show Grizzly Bears becoming more common in the area, and more frequently coming into contact with humans (Inuuvik Community Corporation *et al.* 2006). There is evidence of an expanding distribution and increasing local abundance of Grizzly Bears in mainland Nunavut and into Manitoba, and the Arctic Archipelago of NT and Nunavut (see Distribution – Canadian Range).

Within specific study areas of the Western DU, several recent scientific studies provide insight into changes in the number of bears. Results of studies where the finite rate of population increase (λ) has been estimated for Canadian study areas since 2002 are detailed in Table 5. Of the 5 studies cited, two in the southern extent of Grizzly Bear distribution indicate lambda < 1. The lack of any estimates of trends from BC, where more than half the bears are found (Table 3) is notable. Only those studies with current data and data specific to study areas are reported.

Table 5. Trends in Grizzly Bear population growth reported since 2002 for study areas in Canada.

Study Area (applicable years)	λ Point est.	λ 95% CI	Reference
Low Arctic, Nunavut/NT (1996–1999)	1.03	1.01-1.06	McLoughlin *et al.* 2003b,c
Selkirk Mtns, USA/BC (1983–2002)	1.02	0.92-1.01	Wakkinen and Kasworm 2004
Banff-Kananaskis, AB (1994–2002)	1.04	0.99-1.09	Garshelis *et al.* 2005
Flathead, BC (1998–2007)	0.88	.	McLellan 2008
High-use lands, AB[1] (1999–2009)	0.96	0.93-0.99	ASRDACA 2010

[1]Assumed to reasonably reflect population trend in areas with high human alteration of habitat, but would not likely apply to areas where habitat effectiveness remains high. Estimate based on balance between births and deaths and computed using a population viability analysis.

Few demographic studies of Grizzly Bears in Canada have been framed within the context of a population viability analysis (PVA), and there is no DU-wide PVA for Grizzly Bears of the Western population. PVA has been used to evaluate effects of hunting strategies on Canadian Grizzly Bear population dynamics, and to highlight how lack of precise data on Grizzly Bear vital rates precludes meaningful analyses of population viability. For example, McLoughlin (2003), Peek *et al.* (2003), and McLoughlin and Messier (2004) highlighted the importance of precision in estimating initial population size on outcomes of probability of persistence for simulations involving Grizzly Bears, and McLoughlin *et al.* (2005) presented a PVA that identified potential risks of male-biased hunting on future age and sex structure for a Grizzly Bear population.

In summary, following a significant range contraction during the last century in Canada, Grizzly Bear distribution has been relatively stable for the last few decades. A number of well-studied populations for which DNA-derived estimates have been derived in Alberta and southern British Columbia are small and/or in decline where their ranges are heavily fragmented by human settlement, intensive resource development and roads. Their continued persistence will be reliant on the extent to which they can either reconnect or maintain connections with more secure populations in the region. In the central and northern part of Grizzly Bear range in Canada, estimates are not available for individual populations, but general trends are assumed to be stable, with increasing trends and population expansion evident into arctic regions.

Rescue Effect

Source-sink dynamics are likely to occur throughout current Grizzly Bear ranges, with varied potential for natural augmentation and rescue of localized populations. Grizzly Bear populations in Alaska, where >30,000 bears are estimated to live (Schwartz *et al.* 2003a) and the population is deemed secure, may provide a rescue effect for the species in British Columbia and Yukon. However, Miller *et al.* (2011) recently drew attention to the liberalization of hunting regulations since 1980 in over 75% of Alaska for the purposes of stimulating increases in ungulate populations for human consumption, which has resulted in increased Grizzly Bear harvests. This has been accompanied by a cessation of research and monitoring of Grizzly Bears in the same area since 2000, even though the potential for overhunting is significant.

The Northern Continental Divide Ecosystem (United States) has, in places, relatively high densities of bears (e.g., in Glacier National Park, Montana), which regularly exchange individuals with the Flathead in British Columbia. Proctor *et al.* (2012) concluded that the bears south of Highway 3 in British Columbia belonged to one population of about 1,000 bears. Otherwise, populations in the lower 48 United States are generally small and fragmented (estimated to number in total approximately 1,200–1,400 bears; USFWS 2011).

No natural rescue effect from any source is likely possible for the extinct Ungava population.

THREATS AND LIMITING FACTORS

In the absence of human interference, the density of a Grizzly Bear population is largely determined by habitat productivity, including abundance and seasonality of food (Ferguson and McLoughlin 2000; McLoughlin *et al.* 2000). However, the main proximate threat affecting Grizzly Bear distribution and abundance in Canada is human-caused mortality, which is the known outcome of a variety of ultimate factors (Appendix 1). This has important influences on probability of area occupancy and thus can factor into functional habitat loss to Grizzly Bears—the ultimate factor limiting their abundance and distribution. Grizzly Bears may also be limited by availability of food and intraspecific predation, the latter of which may be density-dependent. Moreover, the recovery of at least some southern Grizzly Bear populations in largely forested landscapes may be limited in part by the influence of Black Bear densities on dispersed plant foods (Apps *et al.* 2006). Ultimate effects of anthropogenic climate change on Grizzly Bear habitat availability and effects on seasonal food supply may be important, especially in the Arctic and where important stocks such as salmon are impacted. Environmental contamination from persistent organic pollutants is a potential threat to Grizzly Bears, but is not known to be a main limiting factor to Grizzly Bear distribution or abundance (Christensen *et al.* 2005).

Although none of the individual threats facing Grizzly Bears currently and within the next ten years is expected to negatively affect populations in large parts of the current range, an analysis of the scope and severity of threats resulted in a moderate-high degree of threat facing the overall population (Appendix 1), reflecting the cumulative or collective nature of threats at play. The following sections describe in detail the most important limiting factors and threats to Grizzly Bears. These factors may influence bear population dynamics through survival or reproduction.

Overview of Direct Human-Caused Mortality

Throughout most of the species' range in North America, direct human-caused mortality figures largely in the dynamics of Grizzly Bear populations. For example, in the mountains of southern Alberta and interior BC, and northern Montana, Idaho, and Washington, humans caused 77% of known mortalities of radio-collared Grizzly Bears (McLellan *et al.* 1999). The reasons for which Grizzly Bears are killed by people vary with geography, but can include licensed sport hunting and Aboriginal subsistence hunting, kills in defence of life and property, deaths during the course of research, collisions with motor vehicles and trains, mistaking a Grizzly Bear for a Black Bear or other big game during a legal hunt, and illegal hunting (Table 6). Based on a 500-bear annual kill (Table 6) and a conservative (low-end of jurisdictional population point estimates) population estimate of 26,000 bears for the Western DU, approximately 1.9% of the Grizzly Bears within the DU as a whole are killed by humans each year (Tables 5 vs. 6), although this number does not estimate unreported mortalities. The pattern of mortality is, furthermore, highly variable across Grizzly Bear range in Canada, with most occurring in concentrated areas where human populations or access are highest and susceptibility to unsustainable hunting is most pronounced.

Table 6. Mean annual recorded (known) human-caused mortalities of Grizzly Bears (animals/year) in Canada from 1990–2010. Data compiled from material provided to the author by associated jurisdictions.

	Hunter kills[1]				Other human-caused mortality				
Jurisdiction and decade	**Males**	**Females**	**Unk sex**	**Pooled[2] mean**	**Illegal**	**Defence of life or property**	**Other[2]**	**Pooled[3] mean**	**Mean[3] annual kill**
Alberta 1990-1999[4]	9.1	4.7	0	13.8	3.7	4.2	3.1	11	24.8
Alberta 2000-2010[4]	6.4	2.7	0	9.1	5.8	3.2	3.7	12.7	21.8
British Columbia 1990-1999[4]	187.4	101.8	2.8	290.6	6.3	40.5	3.5	50.3	340.9
British Columbia 2000-2010[4]	169.4	82.4	1.1	252.5	11.2	46.5	5.9	63.6	316.2
Central Rockies 1990-2009[5]				0	0.1	0.7	1.9	2.7	2.7
Yukon 1990-1999	51	27.5	0	78.5	n/a	13.2[6]	1.5	14.7	93.2
Yukon 2000-2009	48.1	25.7	0	73.9	n/a	11[6]	1.9	12.9	86.8
NT and Nunavut 1990-1999[7]				50.6		included in hunter kills			50.6
NT 2001-2010[8]				29.1	n/a	12.7	0.3	13.0	42.4
Nunavut 2000-2010	12.1	2	1.3	15.4		6.6	1.5	8.1	22.6
					Canada-wide mean annual kill for 1990s:				512.2
					Canada-wide mean annual kill for 2000s:				492.5

[1]Includes licensed sport and Aboriginal subsistence hunting.
[2]Any other type of kill, including, but not limited to, vehicular collision, accident, and research-related.
[3]Means from actual data. Due to rounding error, pooled means may not add exactly to the mean annual kill for a table record; however, the presented means are accurate and derived from actual counts of kills provided to the author by associated jurisdictions and governments.
[4]Excludes information from mountain national parks in Alberta and BC (Banff, Jasper, Waterton Lakes, Yoho, Mt. Revelstoke, Kootenay, and Glacier).
[5]A total of 49 human-caused mortalities were reported over the period 1990–2009 in the central Rockies national parks of Banff, Jasper, Waterton Lakes, Yoho, Mt. Revelstoke, Kootenay, and Glacier National Parks (Bertch and Gibeau 2010).
[6] DLP kills in Yukon are commonly tagged as regular harvest so are under-represented, while hunt numbers are over-represented. Kills from the national parks (e.g., Kluane and Vuntut) are also excluded.
[7]Includes all kills occurring in Nunavut, the Inuvialuit Settlement Region, Gwich'in Settlement Area, and remaining Northwest Territories.
[8]Includes all kills occurring in the Inuvialuit Settlement Region, Gwich'in Settlement Area, and remaining Northwest Territories.

Licensed Hunting

Grizzly Bears are legally hunted in Canada through the managed sale of licences in BC, Yukon, the NT, and Nunavut. Sport-licensed hunting of Grizzly Bears in Alberta has been prohibited since 2006 (see Protection, Status, and Ranks), and there is no recognized hunt for the species in Manitoba.

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 of 5.7% (Miller 1990). Taking into account uncertainty with respect to data used to manage hunts, McLoughlin (2003) calculated 4.9% as the maximum sustainable kill (assuming 2:1 [M:F] harvest sex ratio and protection for cubs and females with offspring) in optimal habitat where bears have a low age at first reproduction and thus higher net reproductive rate (e.g., in areas where primary productivity is >1,000 g/m^2/year; Ferguson and McLoughlin 2000). However, McLoughlin (2003) suggested 2.8% as a sustainable kill where conditions are less than ideal, and only 1.1% in low-quality habitats where primary productivity is very low, such as in the Low Arctic tundra regions of Canada (where Grizzly Bears have very late ages at first reproduction and primary productivity is <600 g/m^2/year; Ferguson and McLoughlin 2000). Many jurisdictions have less than optimal habitat despite high primary productivity, where fragmentation has reduced the functionality of habitat (e.g., at the fringes of Grizzly Bear range in Alberta). Hence, a hunting strategy that causes less than 3% total annual mortality may be appropriate throughout much of Grizzly Bear range in Canada, although factors such as management scale and habitat productivity may affect this number (McCullough 1996). For example, a Grizzly Bear population in southeastern British Columbia increased at a rate of $\lambda = 1.07$ from 1978 to 1997 while hunting was occurring (McLellan 1989c).

Currently, there are several areas in the southern part of Grizzly Bear distribution where hunting is not allowed due to concerns about status. In Alberta, this constitutes the entire Grizzly Bear range in the province, and a large portion of the southern range in British Columbia. In Yukon, the mean mortality rates of Grizzly Bear over the past 25 years has exceeded 2% (and as high as 16%) in an area covering about 18% of the territory (Government of Yukon, unpublished data).

As with many polygynous species, more male Grizzly Bears can usually be hunted than females without leading to overall population decline (Caughley and Sinclair 1994). Most management agencies direct harvest toward male bears by protecting females and family groups and by scheduling hunting seasons when males are relatively active. There may be some unanticipated changes to local population dynamics with sex-biased hunting. For example, some of the interviewees of the report from the Wildlife Management Advisory Council (North Slope) and the Aklavik Hunters and Trappers Committee (2008) were concerned that the number of bears around Aklavik and in the Richardson Mountains, Yukon, had decreased, and that the bears in this area were smaller than people remembered them being; they suggested that when hunters remove all the large, old males, younger and smaller bears move into the vacant territory. It has been suggested that in the Yukon, spring bear hunts of bigger, older bears may result in younger bears moving into these areas when the older individuals are removed (Little Salmon/Carmacks First Nation *et al.* 2004).

A topic of recent debate with respect to sex-biased hunting concerns the infanticidal role of young, immigrant males that may move into areas where hunting pressure is heavy. In Sweden, Brown Bear cub survival was lower in an area with higher hunting rates of adult males, and immigrating males were implicated as the cause of cub deaths (Swenson *et al.* 1997). Cub survival was reduced for 1.5 years after adult males were removed, indicating social disruption persisted for some time. 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. Wielgus and Bunnell (1995, 2000) found lower reproductive rates, mean litter size, and age at first parturition in a hunted Canadian population compared to an un-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. However, Miller *et al.* (2003) and McLellan (2005) found no evidence for such an effect in North America.

Grizzly Bears are accidentally shot at times, especially by hunters of Black Bears that misidentify their quarry. For example, in Alberta 4.9% of known reported human-caused mortalities for Grizzly Bears from 2000–2009 were the result of hunter inability to properly identify their target, almost as many deaths as by accidental collision. Mace and Waller (1998) suggest that kills due to mistaken identity with Black Bears are more likely for subadult Grizzly Bears than adults.

Aboriginal Subsistence Hunting

Many First Nations, Métis, and Inuit groups within the range of the Grizzly Bear hunt bears for subsistence. Subsistence hunting as a relative proportion of hunter take tends to be higher in some areas of the North than in BC or Alberta, accounting for 49.6% of reported mortalities of Grizzly Bears in NT (including the Gwich'in Settlement Area and Inuvialuit Settlement Region) from 2000–2010 (R. Mulders, Government of NT, unpublished data), but only 5.9% in Alberta from 2000–2009 (Government of Alberta 2011).

In the past, subsistence hunting occurred throughout the year, including summer; however, most subsistence hunting now occurs either in spring or in fall. For example, in the Yukon North Slope portion of the Inuvialuit Settlement Region, people hunt Grizzly Bears in the spring when their hides are worth the most (Wildlife Management Advisory Council (North Slope) and the Aklavik Hunters and Trappers Committee 2008). In the late 1980s, Aklavik Inuvialuit became concerned that the harvest of Grizzly Bears on parts of their lands was too high, undermining productivity and the long-term abundance of Grizzly Bears. To address this issue, a Grizzly Bear hunting area was created for the community of Aklavik by the Inuvialuit Game Council (IGC) in 1994 (Wildlife Management Advisory Council (North Slope) and the Aklavik Hunters and Trappers Committee 2008).

The use of Grizzly Bears by Aboriginal peoples varies. For example, Grizzly Bears in Nunavut have played only a minor role in the economy and culture of Inuit relative to other species such as seals, Caribou, and Polar Bear (though bears are still important to Inuit where they occur), most likely a reflection of their low relative abundance in the region until recently. Although Grizzly Bears were hunted by Inuit in the past, the species is rarely mentioned in exhaustive volumes on Inuit ATK (Milton Freeman Research Ltd. 1976a,b,c). This observation is supported by Oakes (1991) who mentions Grizzly Bear fur only once in her 277-page analysis of clothing production by Copper and Caribou Inuit. Further, Grizzly Bears were probably not widely used as meat by Inuit because of the risk of trichinosis (Ryan 1981).

Kills in Defence of Life or Property

Management responses to Grizzly Bear/human conflicts may include capture and translocation rather than killing the offending bear (Schwartz *et al.* 2003a); however, non-lethal removals are often not effective and kills in defence of life or property (DLP) of Grizzly Bears are generally the outcome of conflicts where they occur in Canada. All jurisdictions have active programs to educate the public about ‘safety in bear country’ and being ‘bear aware’. Nevertheless, the kill of Grizzly Bears in defence of life or property remains a substantial proportion of all known human-caused mortalities throughout Grizzly Bear range in Canada (Table 6). Ducommun (2010) suggested Métis Traditional Knowledge holders in BC expect there will be more Grizzly-human interactions as time progresses, as Grizzly Bears appear less cautious regarding humans now compared to the past 20–30 years when hunting pressure was greater. Mowat (2007) pointed out that the number of bears killed for control reasons in the Kootenay region, BC, was likely influenced by the closure of dumps and other large food sources. To illustrate, the single largest number of bears involved in human-bear conflicts killed in the region was in 1995, the year following the closure of the Revelstoke dump (Proctor and Neumier 1996). Annual mean rates of kill in response to conflicts with humans for the past decade were, as a proportion of total known kill, 21.7% in Alberta, 14.7% in BC, at least 12.7% in Yukon, 30.0% for the NT including the Gwich’in and Inuvialuit Settlement Areas (data provided by R. Mulders, Government of the NT), and 29.2% for Nunavut. In Yukon at least, because it is not uncommon for DLP kills to be tagged as hunter kills, mortality statistics likely under-represent actual DLP rates and over-estimate harvest rates.

Vehicle-Related Deaths

In Canada, particularly in the south, many Grizzly Bears are killed each year by vehicles and trains. Obtaining reliable data on the numbers of bears killed on highways and railways is difficult because: 1) not all vehicle-wildlife collisions are reported, and reports that are filed may be inconsistent or incomplete (Tardif and Associates 2003); and 2) not all bears die immediately from their injuries at collision sites. The greatest relative risk of dying by accidental collision for a bear occurs in southern BC and Alberta, where human densities are highest and where both Grizzly Bear and human transportation corridors are concentrated in mountain valleys (Figure 5). Accidental collisions account for up to 5.9% of the known human kills each year in Alberta (2000–2009). Trains appear to be particularly lethal to Grizzly Bears. For example, although from 1985 to 1995 only one Grizzly Bear was known to die from a vehicle collision in Banff National Park, Alberta (Gibeau *et al.* 1996), from 2000–2007 seven Grizzly Bears were killed by Canadian Pacific Railroad trains, and none of the five cubs orphaned by these train collisions survived in the park (Pissot 2007). In mountain parks on the whole, motor vehicle collisions rank slightly below railway collisions in terms of overall known human-caused mortality (28.6% [14/49] and 32.7% [16/49], respectively, for 1990–2009; Bertch and Gibeau 2010). Low numbers (7 mortalities in 20 years; Bertch and Gibeau 2010) of motor vehicle collisions in Banff National Park, relative to the very high visitation rate by humans, may, in part, be due to the construction of wildlife fences and wildlife underpasses and overpasses (Clevenger and Waltho 2000). However, this observation may also be due to reduced propensities for bears to cross busy corridors (Gibeau *et al.* 1996; Chruszcz *et al.* 2003).

Research-Related Deaths

Each year, researchers with goals of developing a better understanding of Grizzly Bear biology and management can contribute to mortality rates. Capture programs can pose a risk to Grizzly Bears, which can die during handling from various causes, including deaths due to falls, drowning, suffocation, capture myopathy, and to protect handlers (Cattet *et al.* 2008). In Alberta, research-related deaths from 2000–2009 accounted for 3.2% of the total reported mortality (7 of 221 reported deaths [not to be confused with deaths per number of captures, which is much lower]). Specific to the BC-Alberta mountain national parks of Banff, Jasper, Kootenay, Yoho, Waterton Lakes, Mt. Revelstoke, and Glacier, from 2000–2009 a total of 4/49 human-caused deaths (8.1%) were related to captures and handling (Bertch and Gibeau 2010). Rates of capture-related deaths are variable, but can be reduced to very low levels with experience of handlers (e.g., <0.1% of handling incidents in BC; B. McLellan, Government of BC, pers. comm. 2011).

Undocumented and Illegal Killing

In all jurisdictions, Grizzly Bear deaths 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 mortalities of radio-collared Grizzly Bears in the interior mountains of BC, Montana, Alberta, Idaho, and Washington would have been unrecorded. For only human-caused deaths (including suspicious, unknown-cause deaths), 34–46% of mortalities would have been undocumented. Unreported mortalities have also been documented in west-central Alberta (e.g., McDiarmid 2002). In Alberta, the highest rates of known illegal kills occur during the fall ungulate hunting season (69% occurred in September, October, and November; AGRP 2008). It should be noted, however, that the rates of undocumented killing cited above are for areas with high human densities.

Grizzly Bear anatomical parts are valuable, and trade (for many reasons, including traditional Asian medicines) may be an underlying motive for some illegal killing, although this is likely a relatively small contribution to the overall unreported/illegal kill of Grizzly Bears in Canada. Documented retail prices can reach US$500/gram for bear bile, and US$2,000 for whole gall bladders (Servheen 1999b). Reports of successful prosecutions of illegal trade in bear parts (e.g., BCMOE 2001a) indicate that it does occur, and efforts to curtail trafficking in bear parts (including Black Bear parts) have been enacted in some regions. For example, BC passed legislation in 1997 that prohibits possession of bear gall bladders or any part or derivative of a bear gall bladder. The trophy value of Grizzly Bears also inspires some poaching and commercial trafficking (e.g., BCMOE 2001b).

Habitat Perturbation

Habitat perturbations can influence an area's capacity to support Grizzly Bears. In some cases, 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 that result in functional habitat loss. Foremost in importance among habitat alterations are those that convert Grizzly Bear habitat to areas that will not be suitable for bears either permanently or over long periods of time (Horejsi 1989; Stronen 2000; Shuswap Indian Band 2008). Included in this category are many resource extraction activities, agriculture, residential development, and associated transportation corridors. For many years, such developments proceeded throughout much of Grizzly Bear range without mitigation. Recently, however, in response to declines in distributions of Grizzly Bears, proposed developments have been increasingly subject to enhanced scrutiny through established federal, provincial, and territorial environmental assessment legislation. It is unknown whether such processes are resulting in increased effective protection of Grizzly Bears from development, particularly in areas with multiple projects and associated infrastructure, and what will be the consequences of recent changes to the *Canadian Environmental Assessment Act*.

Mining and hydrocarbon extraction are a major concern for Grizzly Bear conservation (Cristescu and Boyce 2010). Resources such as oil, gas, coal, and diamonds are driving economies on the provincial, territorial, or federal scale, affecting current habitat and exerting considerable pressure against the need to preserve Grizzly Bear habitat. Similarly, mining claims and exploration activities are escalating in most of the northern Grizzly Bear range, with full-scale mine development projects likewise increasing. For example, exploration activity measured in levels of expenditure and metres drilled in northwest British Columbia reached record levels in 2011, with similar trends elsewhere in the province (BCMEM and BCMFLNRO 2011). Although the footprints of individual projects are often regarded as inconsequential in and of themselves, concerns are growing with the cumulative impacts of such developments into Grizzly Bear range (e.g., Johnson *et al.* 2005). The construction of the Northern Gateway Pipeline is a cause for additional concern. The proposed route cuts directly through medium to high density areas of their distribution, much of which is currently inaccessible by road.

Commercial timber harvest in Canada also alters a substantial amount of Grizzly Bear habitat each year, especially in Alberta and BC (COSEWIC 2002). 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 southeast BC, because few bear foods occurred there, although in other areas bears preferentially select disturbed areas (e.g., Berland *et al.* 2008). Although bears may find more food in some clear-cut areas, logging roads enable higher levels of human access and traffic, leading to unsustainable mortality (Nielsen 2005; Nielsen *et al.* 2006).

Traffic-related effects on bears may also include aerial transportation: there is some concern that activities that make use of helicopters in northern Canada are negatively affecting bears and hunters' ability to hunt bears (Inuvik Community Corporation *et al.* 2006). Golder Associates Ltd. (2003) documented ATK that suggested "…grizzlies are chased away by helicopters and disturbance needs to be minimized."

Agricultural development has been responsible for most of the permanent contraction of Grizzly Bear range in Canada. Conversion to cropland typically permanently removes that land as Grizzly Bear habitat, although some bears may venture into croplands at the fringe of their range during summer months (Collingwood *et al.* 2009). 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 current Grizzly Bear range, the most disruptive is probably residential development and accompanying road traffic. Residential developments are particularly disruptive because of the sustained human presence. 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, including road networks that inevitably develop in concert. Additionally, the attractants usually associated with human homes (refuse, pet food, livestock) dictate that bears with home ranges overlapping permanent human habitation are at elevated risk of mortality (McLellan 1994; Ciarniello *et al.* 2009). Within areas characterized by high human settlement, Grizzly Bears may be attracted to some roads, but they were also more likely to die there (Gibeau *et al.* 2002; Chruszcz *et al.* 2003), making them attractive sink habitats (Nielsen *et al.* 2006).

Natural disturbances such as fire also have the potential to affect habitat quality for Grizzly Bears in forested regions. Wildfire is a common occurrence in drier forests where Grizzly Bears are found (e.g. upland boreal and mountain forests), it can positively influence the abundance and distribution of various foods consumed by bears (Milakovic *et al.* 2012). Insect infestations negatively affect forest habitat for Grizzly Bears: effects of Mountain Pine Beetle (*Dendroctonus ponderosae*) on forests of interior BC are substantial, including tree mortality in more than 9 million hectares in 2009 (Westfall and Ebata 2009). Impacts of these substantial changes in forest structure on Grizzly Bears are, however, unknown.

In most cases, effects of human activities and natural disturbances do not operate in isolation to influence Grizzly Bear habitat or populations (Herrero and Herrero 1996; Johnson *et al.* 2005; Nielsen *et al.* 2006). Grizzly Bears tend to be subjected to high rates of mortality in human-dominated landscapes. For example, in west-central Alberta, human activities including timber harvest and coal mining apparently reduced Grizzly Bears during 1971–1995 (Herrero and Herrero 1996). This apparent population decline was likely due to a combination of excessive human-induced mortality and habitat loss due to development. Overall, existing human developments and activities in the area appeared to have been the primary factors leading to carnivore population declines. Landscape-level habitat fragmentation brought about by major transportation corridors penetrating occupied habitat tend to both constitute mortality zones and create barriers to movement (Garshelis *et al.* 2005; Proctor *et al.* 2012).To illlustrate, the distance to and size of human population centres are strongly correlated with Grizzly Bear habitat quality (Merrill *et al.* 1999) and population persistence (Apps *et al.* 2004). Inasmuch as such trends are tied to increasing human population numbers, human access into Grizzly Bear habitat to service both settlement and resource extraction activities leads even more directly to decreases in survival and consequent population declines.

Pacific Salmon Declines

Mounting concerns regarding the viability of many Pacific salmon runs (Price *et al.* 2008) have important potential implications for coastal Grizzly Bear populations, in light of the reliance of many on salmon as a principal food source and the fidelity of individuals to salmon streams (McHutchon *et al.* 1993; Hilderbrand *et al.* 1999). Several authors have pointed out links between salmon abundance and Grizzly Bear productivity, as measured by litter and body sizes, population densities, and/or reproductive output (Hilderbrand *et al.* 1999; Mowat & Heard 2006). The consequences of declining salmon stocks on Grizzly Bear populations has received little study. However, in the Owikeno Lake area of southern BC, where there have been historical declines in numbers of salmon reaching spawning areas, Boulanger *et al.* (2004) found changes in the demography of bear populations at salmon streams in association with observed levels of salmon availability.

Demographic Stochasticity

At the fringe of Grizzly Bear distribution, especially in southern BC and Alberta where population fragmentation due to highways, human settlement, and agricultural expansion is noted (e.g., Proctor *et al.* 2005; 2012; ASDRACA 2010), the trajectory of small populations may be determined not by direct limiting factors *per se*, but rather by random variation in sex ratios at birth or other parameters that arise from random variation among individuals in their tendency to survive or reproduce (including genetics). Many demographic processes have probabilistic components; hence, as a basic rule, the smaller the population, the greater the variation in birth and death rates, even if the underlying mean rates are not changing (Boyce 1992). Genetic isolation of Grizzly Bears in areas where anthropogenic mortality is high is not as great or immediate a concern as interruption of demographic processes. Increased variation in population dynamics generally leads to greater probabilities of extinction, and demographic stochasticity is expected to be an important component of Grizzly Bear population dynamics when small populations become isolated (Proctor *et al.* 2005; 2012). For Grizzly Bears in particular, several ecological characteristics render them susceptible to population fragmentation in human-dominated landscapes, including their naturally low population density, slow reproductive rate, short dispersal, male-biased dispersal, and sensitivity to anthropogenic mortality and habitat degradation (Proctor *et al.* 2012). Most critical is for small populations to have a sufficient number of females so as to decrease the risk of population extirpation (Proctor *et al.* 2012).

Climate Change

Identifying the influence of climate change on projected Grizzly Bear numbers is not possible at this time (Bertreaux *et al.* 2006). It is likely, however, that with climate warming we can anticipate a lengthening of the growing season at high latitudes (Arctic Climate Impact Assessment 2004). This warming may improve bear habitat in the north and allow the species to expand its range, for example into the Canadian Arctic Archipelago (although evidence of recent expansion of Grizzly Bear range into northern NT, Nunavut, and Manitoba, has yet to be quantitatively tied to climate change). Though largely investigated with respect to impacts of climate change on Polar Bears, a few authors have considered the results of increasing range overlap between Polar Bears and Grizzly Bears, including hybridization and competitive exclusion. For example, Slater *et al.* (2010) suggest that if increased range overlap were to occur, Grizzly Bears should displace Polar Bears for morphological reasons, specifically because of weaker skull strength in Polar Bears despite similar bite strength. In the southern range of the Grizzly Bear, changes in forest structure due to climate change (e.g., Westfall and Ebata 2009) may influence bear habitat use and hence bear population dynamics.

A changing climate may also challenge other Grizzly Bear populations. For example, it is expected to exacerbate fragmentation (Fleishman and MacNalley 2007) and negatively influence salmon runs in coastal BC (Horejsi *et al.* 2010). Increasing incidence of berry crop failures and other seasonal foods, competition between Black Bears and Grizzly Bears as tree lines move further north and higher in altitude, decreasing den stability with the changing nature of permafrost, and effects on prey species such as Caribou and Moose, and increasing intensity in human development as activity in the Northwest Passage increases or as parts of the North become more amenable to agriculture and other activities, are all potential concerns for Grizzly Bears. It must be emphasized, however, that very little quantitative research on climate change and its effects on Grizzly Bears has been conducted to date.

PROTECTION, STATUS, AND RANKS

International Protection and Status

Globally, the Grizzly (Brown) Bear is listed by IUCN (The World Conservation Union) as Least Concern (McLellan *et al.* 2008). 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. NatureServe provides a rounded global status rank for Brown Bears as G4 – Apparently Secure, even though its S-rank is SX - Extirpated in 16 of 26 North American states, provinces and territories where it occurred historically (NatureServe 2011).

Grizzly Bears in the lower 48 states were listed in 1975 under the *Endangered Species Act* as Threatened (USFWS 1993), a status the species retains to this day.

Protection and Status in Canada

Grizzly Bears have not been listed under SARA. In Canada, the national NatureServe N-rank was N3 – Vulnerable (NatureServe 2011). The 2010 General Status rank for Grizzly Bears nationally was “Sensitive”, the same national rank as in 2005 and 2000 (T. Jung, Environment Yukon, pers. comm., 2011). The Grizzly Bear was listed as ‘Threatened’ under Alberta’s *Wildlife Act* in June 2010. The regulated hunt in Alberta ceased in 2006, although Aboriginal subsistence hunting is still allowed.

In BC, NatureServe and General Status conservation rank in the province is “S3 – Vulnerable”, and Sensitive”, respectively. Austin *et al.* (2004) summarize current regulations and management concerning Grizzly Bears in BC, which have a legal status as ‘Big Game’ under the provincial *Wildlife Act*. All hunting in BC is limited by the number of hunting authorizations issued to resident hunters through a random draw, and by quotas issued to guide outfitters for either resident or non-resident hunters. The number of authorizations available for each area (bag limit 1) is determined based on technical input of provincial wildlife biologists. Non-resident hunters must be accompanied by a licensed guide outfitter or assistant guide to hunt Grizzly Bears. Quotas set the maximum number of bears an outfitter’s clients may take within their Guide Outfitter Area. In BC, it is illegal to kill a bear <2 years old, or any bear in its company (usually its mother). It is illegal to possess bear gall bladders or to possess bear genitalia separated from the carcass or hide, or to traffic in, import or export bear paws separated from the carcass or hide. It is also illegal for a hunter to kill a bear and fail to remove the hide. The maximum fine for illegally killing a Grizzly Bear is $100,000 and six months in jail for a first offence. BC designates status at the ‘population’ level: there are 9 threatened populations identified in the province.

Grizzly Bears are legally listed as “Big Game” in the *Yukon Wildlife Act*. Their NatureServe and General Status conservation rank in the territory is “S3 – Vulnerable”, and Sensitive”, respectively. Outside of the Inuvialuit Settlement Region, a sex ratio system is in place that provides incentives for selective hunting of male Grizzly Bears by outfitters. This system uses the probability of killing a female bear in any given hunt to determine the total harvest allocation. In this sex-ratio system, outfitters do not have to stop hunting when they hit the maximum sustainable harvest for females. However, if they continue hunting and exceed their quota for female bears, their quota in the following three-year term will be affected. The degree to which the quota is affected offers a strong incentive to either discontinue hunting once the female quota is reached or to be very selective in hunting males only. Outfitting areas are allocated a base quota for male and female Grizzly Bears which represents 6% and 2% of the estimated male and female population respectively (Environment Yukon, unpublished data). There is no spatial management of resident harvest. Residents are only required to ensure that their personal harvest does not exceed a one Grizzly Bear in three years restriction. The absence of spatial restrictions on resident harvest, in combination with all other sources of mortality has placed substantial pressure on Grizzly Bear populations adjacent to highways and in areas of higher human density. Some of these populations are suspected to be in decline (Maraj 2007; McCann 1998) or acting as mortality sinks (Maraj 2007, Environment Yukon, unpublished data 2011).

In the Northwest Territories, Grizzly Bears are considered “Big Game” in territorial legislation. Their NatureServe and General Status conservation ranks in the territory is “SNR – Not Ranked”, and Sensitive”, respectively. Throughout the NT kills must be reported, and cubs, bears accompanied by cubs, and bears in dens are protected. The demand and harvest rate by residents for Grizzly Bears in NT is low. Grizzly Bear hunting in most of the Mackenzie Mountains is available only to NT residents, and there is a lifetime bag limit of one bear for non-residents. The majority of the reported Grizzly Bear harvest in the NT comes from Aboriginal subsistence hunting in the Inuvialuit Settlement Region and the Gwich’in Settlement Area.

In the Gwich’in Settlement Area within NT, the Gwich’in Renewable Resource Board (GRRB) and Gwich’in Renewable Resource Councils (RRC) have a detailed set of non-binding rules that apply to the hunting of Grizzly Bears by beneficiaries, known as the Grizzly Bear Management Agreement (Gwich’in Renewable Resource Board 2002), stipulating the use of tags, quotas, bans, and restrictions. The RRCs oversee the use of tags used by their hunters annually, but all other Grizzly Bear harvest is restricted unless permission is given to allocate a tag by one of the RRCs (including non-Aboriginal residents).

In the Inuvialuit Settlement Region—an area that includes both the Yukon North Slope and the Western Arctic of NT—Grizzly Bear hunting is regulated by quota as recommended by the Wildlife Management Advisory Councils (North Slope and NT) to the appropriate ministers. The Inuvialuit Grizzly Bear quota is sub-allocated between Inuvialuit communities by the Inuvialuit Game Council and administered by Inuvialuit Hunters and Trappers Committees in each of the six Inuvialuit communities. In 1998, a co-management plan for Grizzly Bears in the ISR was adopted and implemented by the territorial and federal governments, Wildlife Management Advisory Councils, and the Inuvialuit Game Council (Nagy and Branigan 1998). Grizzly Bear management goals are "to maintain current population size by ensuring that the total number of bears removed through harvest, defence kills, and illegal hunting each year is sustainable; to allow recovery of populations in the event that over-hunting occurs by reducing quotas or closing areas for hunting; and to maintain current areas of Grizzly Bear habitats" (Nagy and Branigan 1998). The annual total allowable harvest quota, which includes kills in defence of life and property and from which research-related kills are deducted, is established as 3% of the estimated sub-regional population of bears older than 2 years. The benchmark for female-biased harvesting is two males per female harvested. Quotas are administered and tags issued by the Inuvialuit Game Council. Residents and non-residents may hunt in the Inuvialuit Settlement Region with permission.

In Nunavut, under s. 5.6.1. of the *Nunavut Land Claims Agreement*, each Inuk has the right to harvest Grizzly Bears up to the full level of his or her economic, social, and cultural needs. There are no formal agreements to harvest other than as stated in the *Nunavut Land Claims Agreement*, although some Hunters and Trappers Organizations may impose restrictions on harvest, at their discretion, within their respective communities. For example, tags may be issued, which can be used by local subsistence hunters or sold to non-resident hunters as part of a guided hunting package. Beneficiaries of the *Nunavut Land Claims Agreement* do not need a licence, permit, or tag to hunt Grizzly Bears. The Grizzly Bear hunting season in Nunavut is July 1 to June 30 (i.e., all year). Hunting regulations stipulate that restrictions apply to non-beneficiaries (residents and non-residents), including a requirement to obtain a licence and tag(s) to hunt Grizzly Bears (only adult bears not accompanied by a cub) during August 15 – October 31 and April 15 – May 31 in a Grizzly Bear management zone. Non-residents are subject to a trophy fee, and harvest reporting is mandatory. Their NatureServe and General Status conservation rank in the territory is "SNR – Not Ranked", and Sensitive", respectively. However, a General Status rank for the Grizzly Bear in Nunavut has not yet been brought to the Nunavut Wildlife Management Board for decision.

There is no specific legal status for Grizzly Bears in Manitoba, Quebec or Newfoundland and Labrador, under either provincial species at risk or wildlife legislation. In spite of recent confirmed records in the province, the species is still listed as "Extirpated" under the *Saskatchewan Wildlife Act*.

Habitat Protection and Ownership

The majority of Grizzly Bear habitat in Canada is publicly owned. Almost all land in the Yukon, NT, and Nunavut is publicly owned, though in some places large tracts are part of settled land claims (e.g., the Gwich'in own 22,422 km^2 of land in and around the Mackenzie Delta region of the NT, and the Sahtu own approximately 41,000 km^2 of land in the Sahtu Settlement Area of the NT). Public land comprises 92% of BC and 60% of Alberta. Private lands in both of these provinces are concentrated in the south and in urban areas, and thus disproportionately include areas outside Grizzly Bear distribution. However, the largest continuous stretch of private land in Canada occurs along the Crowsnest Highway transportation and development corridor that bisects Grizzly Bear range through the southern Canadian Rocky Mountains, adding to the challenge of ensuring long-term connectivity (Apps *et al.* 2007). Grizzly Bear habitat in northeast Manitoba is almost entirely publicly owned (contained within Crown lands and Wapusk National Park).

For this report, a protected area refers to an area, such as a park or reserve, which includes in its mandate the protection of Grizzly Bears and/or their habitat. As such, parks or reserves typically prohibit resource extraction, such as mining and timber harvest, and prohibit hunting of Grizzly Bears or restrict hunting to Aboriginal peoples. Because activities including intensive recreational, residential, and infrastructure developments may exist in identified protected areas (e.g., mountain parks like Banff National Park), not all portions of protected areas are Grizzly Bear sanctuaries (Bertch and Gibeau 2010).

Protected areas occur throughout Grizzly Bear distribution in Canada, including 15 national parks. Approximately 211,378 km^2 of land within the current distribution is protected to some degree, either through hunting restrictions or through restrictions on use of an area by humans (Table 7). These areas represent about 7.1% of the area of occupancy in Canada. The total excludes numerous small (<50 km^2) protected areas and ecological reserves that are too small to contain sizeable numbers of Grizzly Bears. Throughout Canada, settled Aboriginal land claims may provide special protections to Grizzly Bears that are not indicated in Table 7. For example, in BC the St'at'imc designed the St'at'imc Grizzly Protection Area using traditional ecological knowledge regarding Grizzly Bear habitat, food sources and movement corridors, to design a connected system of Grizzly Protection Areas that include a prohibition on hunting Grizzly Bears (St'at'imc Land and Resource Authority 2004). On a similar note, the Gwich'in Land Use Plan regulates development activities in the Gwich'in Settlement Area, which helps to protect habitat for Grizzly Bears in areas such as the Northern Richardson Mountains.

Table 7. Large (>50 km²) protected areas with a mandate to protect Grizzly Bears and/or their habitat.

Name and Area	Land Area (km²)
National Parks/Protected Areas	
Waterton Lakes National Park, AB	525
Banff National Park, AB	6,641
Jasper National Park, AB	10,878
Kootenay National Park, BC	1,406
Yoho National Park, BC	1,310
Glacier National Park, BC	1,350
Mt. Revelstoke National Park, BC	260
Kluane National Park and Reserve, YT	22,015
Ivvavik National Park, YT	10,170
Vuntut National Park, YT	4,345
Nahanni National Park, NT	4,766
Tuktut Nogait National Park, NT	16,340
Thelon Wildlife Sanctuary, NT/NU	73,106
Ukkusiksalik National Park, NU	20,466
Wapusk National Park, MB	11,475
Provincial/Territorial Parks	
Alberta	1,884
British Columbia	9,959
Yukon	14,482
Total	**211,378**

ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED

Preparation of this report was funded by Environment Canada. The writer (Philip D. McLoughlin) thanks Justina Ray and the members of the COSEWIC Terrestrial Mammals Subcommittee, the ATK Subcommittee (especially Donna D. Hurlburt and Dean Trumbley), and invited reviewers for their professional, courteous, and insightful review of this document.

The following experts generously provided information, advice, insight, and opinion toward the writing of the current update status report (please see COSEWIC 2002 for acknowledgements related to an earlier version of this living document):

Alberta Conservation Information Management System. August 2010. Alberta Tourism, Parks and Recreation, 2nd Floor, Oxbridge Place, 9820 - 106 Street, Edmonton, AB T5K 2J6.

Apps, Clayton. June 2011. Independent Biologist.

Armstrong, Jeannette. August 2010. En'owkin Centre, RR#2, Site 50, Comp. 8, Penticton BC V2A 6J7.

Awan, Malik. December 2010. Carnivore Biologist, Government of Nunavut.

B.C. Conservation Data Centre. August 2010. Wildlife Inventory Section, Resources Inventory Branch, Ministry of Environment, Lands and Parks, P.O. Box 9344, Station Provincial Government, Victoria, BC V8W 9M1.

Boyce, Mark. March 2010. University of Alberta.

Campbell, Mitch. Kivalliq Area Biologist, Government of Nunavut.

Carrière, Suzanne. August 2010. Department of Environment and Natural Resources (ENR), Government of the Northwest Territories, 600 - 5102 50th Avenue, P.O. Box 1320 Scotia Centre, 5th Floor, Yellowknife NT X1A 2L9.

Chetkiewicz, Cheryl. Wildlife Conservation Society Canada.

Christensen, Michelle. August 2010. Secretariat, Wildlife Management Advisory Council - North Slope (WMAC-NS), P.O. Box 31539, Whitehorse YK Y1A 6K8.

Court, Gordon. August 2010. Provincial Wildlife Status Biologist, Dept. of Sustainable Resource Development Government of AB, 9920 - 108 Street, Edmonton AB T5K 2M4.

Duncan, Dave. August 2010. Canadian Wildlife Service, Environment Canada, Room 200 - 2nd Floor 4999 - 98 Avenue Edmonton AB T6B 2X3.

Dumond, Mathieu. December 2010. Kitikmeot Area Biologist, Government of Nunavut.

Festa-Bianchet, Marco. Département de biologie, Université de Sherbrooke, Sherbrooke, Québec J1K 2R1.

Fraser, F. David. August 2010. Ecosystem Branch Conservation Planning Section, Ministry of Environment Government of British Columbia, P.O. Box 9358 - Station Prov Govt, Victoria BC V8W 9M2

Gau, Robert. August 2010. Department of Environment and Natural Resources (ENR), Government of the Northwest Territories.

Gibeau, Mike. December 2010. Carnivore Specialist, Mountain National Parks.

Gillespie, Lynn. August 2010. Research Scientist, Canadian Museum of Nature, P.O. Box 3443 - Station D, Ottawa ON K1P 6P4.

Hamilton, Tony. December 2010. Senior Large Carnivore Biologist, Ministry of Environment, Government of British Columbia.

Han, Siu-Ling. August 2010. Canadian Wildlife Service, Box 1714 Qimugjuk Bldg, Iqaluit NU X0A 0H0.

Hopkins, Chris. October 2010. Executive Director, Sahtu Renewable Resources Board (SRRB), P.O. Box 134, Tulita NT X0E 0K0.

Hotson, Christopher. December 2010. Assistant Director of Wildlife, Department of Environment Government of Nunavut, P.O. Box 209 Igloolik NU X0A 0L0.

Hurlburt, D. Donna. August 2010. P.O. Box 114, Annapolis Royal NS B0S 1A0.

Jung, Thomas. December 2010. Senior Biologist, Fish and Wildlife Branch, Government of Yukon, P.O. Box 2703, Whitehorse YT Y1A 2C6.

Kidd, Robert. August 2010. Director of Wildlife Management, Nunavut Wildlife Management Board (NWMB), P.O. Box 1379, Iqaluit NU X0A 0H0.

Lam, Jennifer. August 2010. Resource Biologist, Wildlife Management Advisory Council - Northwest Territories (WMAC-NT), Inuvialuit Settlement Region, P.O. Box 2120, Inuvik, NT X0E 0T0.

Larsen, Karl. January 2012. Associate Professor, Wildlife Ecology & Management, Department of Natural Resource Sciences Thompson Rivers University, P.O. Box 3010 / 900 McGill Road, Kamloops BC V2C 5N3.

MacDonald, Bruce. August 2010. Canadian Wildlife Service, Suite 301, 5204 - 50th Ave., Yellowknife NT X1A 1E2.

Maraj, Ramona. December 2010. Fish and Wildlife Branch, Government of Yukon, P.O. Box 2703, Whitehorse YT Y1A 2C6.

Marshall, Shelley. January 2011. Carnivore Technician, Fish and Wildlife Branch, Government of Yukon, P.O. Box 2703, Whitehorse YT Y1A 2C6.

Millikin, L. Rhonda. August 2010. Pacific Wildlife Research Centre, Canadian Wildlife Service, Environment Canada, R.R. # 1, 5421 Robertson Road, Delta BC V4K 3N2.

Mulders, Donna. August 2010. Species at Risk Biologist, Canadian Wildlife Service, Environment Canada, P.O. Box 2310, 5019 - 52nd Street, Yellowknife, NT X1A 2P7.

Mulders, Robert. Department of Environment and Natural Resources (ENR), Government of the Northwest Territories.

Nantel, Patrick. August 2010. Species at Risk Program, Ecological Integrity Branch, Parks Canada 25 Eddy St., 4th Fl., 25-4-S, Gatineau QC K1A 0M5.

Nyce, Harry. August 2010. Director of Fisheries & Wildlife, Sr. Nisga'a Lisims Government P.O. Box 231, New Aiyansh BC V0J 1A0.

Paetkau, David. January 2012. President, Wildlife Genetics International, Nelson, BC.

Proctor, Michael. Independent Biologist. Birchdale Ecological Ltd., Kaslo, BC, Canada Rowland, Jennifer. August 2010. Species at Risk Officer, Directorate of Environmental

Stewardship, 4-3 Director General Environment National Defence Headquarters, Ottawa Ontario K1A 0K2.

Snortland Pellissey, Jody. August 2010. Executive Director, Wek'eezhii Renewable Resources Board (WRRB), 4504-49 Avenue, Office 102A, Yellowknife, NT X1A 1A7.

Spiess, Arthur. February 2011. Independent Biologist.

Stenhouse, Gord. December 2010. Foothills Institute.

Seutin, Gilles. August 2010. Coordinator Species at Risk Program, Parks Canada, 4th Floor - 25 Eddy St., Gatineau QC K1A 0M5.

Thompson, Amy. October 2010. Gwich'in Renewable Resources Board (GRRB), P.O. Box 2240, 105 Veterans' Way, Inuvik NT X0E 0T0.

Van Tighem, Graham. October 2010. Executive Director, Yukon Fish and Wildlife Management Board (YFWMB), 106 Main Street, 2nd Floor Burns Building, P.O. Box 31104, Whitehorse YK Y1A 5P7.

Watkins, Bill. August 2010. Wildlife and Ecosystem Protection Branch, Manitoba Department of Conservation Box 24, 200 Saulteaux Crescent, Winnipeg MB R3J 3W3.

INFORMATION SOURCES

AGRP. 2008. Alberta Grizzly Bear Recovery Plan 2008-2013. Alberta Sustainable Resource, Development, Fish and Wildlife Division, Alberta Species at Risk Recovery Plan No. 15. Edmonton, AB. 68 pp.

Apps, C.D., B.N. McLellan, J.G. Woods, and M.F. Proctor. 2004. Estimating grizzly bear distribution and abundance relative to habitat and human influence. Journal of Wildlife Management 68: 138-152.

Apps, C.D., B.N. McLellan, and J.G. Woods. 2006. Landscape partitioning and spatial inferences of competition between black and grizzly bears. Ecography 29:561-572.

Apps, C.D., J.L. Weaver, B. Bateman, P.C. Paquet, and B.N. McLellan. 2007. Carnivores in the southern Canadian Rocky Mountains: core areas and connectivity across the Crowsnest Highway. Wildlife Conservation Society Canada Conservation Report No. 2, Toronto, Ontario, Canada.

Apps, C., D. Paetkau, S. Rochetta, B. McLellan, A. Hamilton, and B. Bateman. 2010. Grizzly bear population abundance, distribution, and connectivity across British Columbia's southern Coast Ranges. Version 1.2. Ministry of Environment, Victoria, British Columbia.Arctic Borderlands Ecological Knowledge Co-op. 1997. Community-based Ecological Monitoring: A Summary of 1996-97 Observations & Pilot Project Evaluation. Northern Yukon Ecological Knowledge Co-op.

Arctic Borderlands Ecological Knowledge Society. 2008. Arctic Borderlands Ecological Knowledge Co-op Community Reports 2006-2007. Arctic Borderlands Ecological Knowledge Society, Whitehorse, Yukon.

Arctic Climate Impact Assessment. 2004. Impacts of a warming Arctic: Arctic Climate Impact Assessment. Cambridge University Press, Cambridge.

Ashford, G., and J. Castleden. 2001. Sila Alangotok: Inuit Observations on Climate Change. International Institute for Sustainable Development.

ASRDACA (Alberta Sustainable Resource Development and Alberta Conservation Association). 2010. Status of the Grizzly Bear (*Ursus arctos*) in Alberta: Update 2010. Alberta Sustainable Resource Development. Wildlife Status Report No. 37 (Update 2010). Edmonton, AB. 44 pp.

Aune, K.E., R.D. Mace, and D.W. Carney. 1994. The reproductive biology of female grizzly bears in the Northern Continental Divide Ecosystem with supplemental data from the Yellowstone Ecosystem. International Conference on Bear Research and Management 9:451-458.

Austin, M.S., D.C. Heard, and A.N. Hamilton. 2004. Grizzly bear (*Ursus arctos*) harvest management in British Columbia. Report prepared for B.C. Ministry of Water, Land and Air Protection, Victoria, BC. 9 pp.

Ballard, W.B., J.S. Whitman, and D.J. Reed. 1991. Population dynamics of moose in south-central Alaska. Wildlife Monographs 114. 49pp.

Banci, V. 1991. Updated status report on the grizzly bear *Ursus arctos horribilis* in Canada. Unpublished report written for the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 171 pp.

Barash, D. P. 1989. Marmots: social behavior and ecology. Stanford University Press, Palo Alto, California.

Barker, O.E., and A.E. Derocher. 2009. Brown bear (Ursus arctos) predation of broad whitefish (Coregonus nasus) in the Mackenzie Delta region, Northwest Territories. Arctic, 62: 312-316.

Bath, A.J. 1989. Public attitudes towards bears: implications to the management of black and grizzly bears in the Yukon. Report to Yukon Renewable Resources, Fish and Wildlife Branch, by Bath Associates, Canyon, WY, USA. 81 pp.

BCMEM and BCMFLNRO (Ministry of Energy and Mines and Ministry of Forests, Lands, and Natural Resource Operations). 2011. Exploration and Mining in British Columbia 2011. Available at: http://www.empr.gov.bc.ca/Mining/Geoscience/PublicationsCatalogue/ExplorationinBC/Documents/2011/BCEx-Mining2011.pdf

BCMFLNRO (Ministry of Forests, Lands, and Natural Resources Operations). 2012. British Columbia Grizzly Bear Population Estimate for 2012. Available at: http://www.env.gov.bc.ca/fw/wildlife/docs/Grizzly_Bear_Pop_Est_Report_Final_2012.pdf.

BCMOE (Ministry of Environment, Lands and Parks). 2001a. Former assistant guide fined for trafficking in bear gall bladders. Press Release 330-30:ELP2001-203. March 2, 2001.

BCMOE (Ministry of Environment, Lands and Parks). 2001b. Moricetown residents convicted of grizzly bear trafficking. Press Release 330-30:ELP2001-702. March 2, 2001.

Berland, A. T. Nelson, G. Stenhouse, K. Graham, and J. Cranston. 2008. The impact of landscape disturbance on grizzly bear habitat use in the Foothills Model Forest, Alberta, Canada. Forest Ecology and Management 256: 1875-1883.

Bertch, B., and M. Gibeau. 2010. Grizzly bear monitoring in and around the mountain national parks: mortalities and bear/human encounters 1980–2009. Third annual report, March 2010. Parks Canada Agency, 28 pp.

Bertram, M.R. and M.T. Vivion. 2002. Moose mortality in eastern interior Alaska. Journal of Wildlife Management 66:747-756.

Black, L.T. 1998. Bear in human imagination and ritual. Ursus 10:343-347.

Blanchard, B. M. 1987. Size and growth patterns of the Yellowstone grizzly bear. Int. Conf. Bear Res. and Manage. 7:99-107.

Blanchard, B.M. and R.R. Knight. 1991. Movements of Yellowstone grizzly bears. Biological Conservation 58:41-67.

Boertje, R.D., W.C. Gasaway, D.V. Grangaard, and D.G. Kelleyhouse. 1988. Predation on moose and caribou by radio-collared grizzly bears in east central Alaska. Canadian Journal of Zoology 66:2492-2499.

Bouchard, R. and D. Kennedy. 2005. First Nations' Aboriginal Interests and Traditional Use in the Waneta Hydroelectric Expansion Project Area: A Summary and Analysis of Known and Available Information. Waneta Expansion Power Corporation, 146 pp.

Boulanger, J. 2001. Analysis of the 1999 Foothills grizzly bear DNA mark-recapture data. In G. Stenhouse and R. Munro. 2001. Foothills Model Forest Grizzly Bear Research Project. 2000 Annual Report. Foothills Model Forest. 92 pp.

Boulanger J, S. Himmer, and C. Swan. 2004. Monitoring of grizzly bear population trend and demography using DNA mark-recapture methods in the Owikeno Lake area of British Columbia. Canadian Journal of Zoology. 82:1267-1277.

Boulanger, J. , J. Cranston, S. Nielsen, and G. Stenhouse. 2009. Estimation of grizzly bear population size for the Swan Hills management unit using DNA smapling and habitat-relative occupancy models. Unpublished report. 16 pp. Available at: http://www.srd.alberta.ca/ManagingPrograms/FishWildlifeManagement/BearManagement/GrizzlyBears/documents/GrizzlyBear-PopulationEstimate-SwanHills-Oct2009.pdf

Boyce, M.S. 1992. Population viability analysis. 1992. Annual Review of Ecology and Systematics 23:481-506.

Bullock, S.J. 1987. Traditional Use of Grizzly Bear in the Richardson Mountains, NT. Government of the Northwest Territories Department of Renewable Resources, unpublished manuscript, Yellowknife, NT.

Carr, H.D. 1989. Distribution, numbers, and mortality of grizzly bears in and around Kananaskis Country, Alberta. Wildlife Research Series No. 3. Forestry, Lands and Wildlife, Fish and Wildlife Division, Edmonton. 49 pp.

Carroll, C., R.F. Noss, and P.C. Paquet. 2001. Carnivores as focal species for conservation planning in the Rocky Mountain region. Ecological Applications 11:961-980.

Case, R. and J. Stevenson. 1991. Observation of barren-ground grizzly bear, *Ursus arctos*, predation on muskoxen, *Ovibos moschatus*, in the Northwest Territories. Canadian Field-Naturalist 105:105-106.

Case, R.L. and L. Buckland. 1998. Reproductive characteristics of grizzly bears in the Kugluktuk area, Northwest Territories, Canada. Ursus 10:41-47.

Cattet, M., J. Boulanger, G. Stenhouse, R. A. Powell, and M. Reynolds-Hogland. 2008. An evaluation of long-term capture effects in Ursids: Implications for wildlife welfare and research. Journal of Mammalogy 89:973-990.

Caughley, G., and A.R.E. Sinclair. 1994. Wildlife ecology and management. Blackwell Scientific Publications, Inc., Cambridge, Mass. 337 pp.

Chetkiewicz, C.-L. B., and M. S. Boyce. 2009. Use of resource selection functions to identify conservation corridors. Journal of Applied Ecology 46:1036–1047.

Christensen, J. R., MacDuffee, M., Macdonald, R. W., Whitecar, M., and P.S. Ross. 2005. Persistent organic pollutants in British Columbia Grizzly bears: consequence of divergent diets. Environmental Science Technology 39:6952-6960.

Chruszcz, B. A.P. Clevenger, K.E. Gunson, and M.L. Gibeau. 2003. Relationships among grizzly bears, highways, and habitat in the Banff-Bow Valley, Alberta, Canada. Canadian Journal of Zoology 81: 1378-1391.

Ciarniello, L.M., M.S. Boyce, D.C. Heard, and D.R. Seip. 2007a. Components of grizzly bear habitat selection: Density, habitats, roads, and mortality risk. Journal of Wildlife Management 71: 1446-1457.

Ciarniello, L.M., M.S. Boyce, D.R. Seip, and D.C. Heard. 2007b. Grizzly bear habitat selection is scale dependent. Ecological Applications 17: 1424-1440.

Ciarniello, L.M., M.S. Boyce, D.R. Seip, and D.C. Heard. 2009. Comparison of grizzly bear *Ursus arctos* demographics in wilderness mountains versus a plateau with resource development. Wildlife Biology 15: 247-265.

Clark, D.A. 2000. Recent reports of grizzly bears, *Ursus arctos*, in northern Manitoba. Canadian Field-Naturalist 114:692-696.

Clark, D. 2007. Local and regional-scale societal dynamics in grizzly bear management. Doctoral Dissertation, Wilfrid Laurier University, Waterloo, Ontario.

Clark, D. & D.S. Slocombe. 2011. Grizzly Bear Conservation in the Foothills Model Forest: Appraisal of a Collaborative Ecosystem Management Effort. Policy Sciences. 44(1): 1-11.

Clarkson, P.L. and I.S. Liepins. 1989. Inuvialuit wildlife studies: grizzly bear research. Progress Rep. 1987-1988. Wildlife Management Advisory Council (NWT) Tech. Rep. No. 3. Inuvik.

Clarkson, P.L. and I.S. Liepins. 1994. Grizzly bear population estimate and characteristics in the Anderson and Horton Rivers area, Northwest Territories, 1987-89. International Conference on Bear Research and Management 9:213-221.

Clevenger, A.P., and N. Waltho. 2000. Factors influencing the effectiveness of wildlife underpasses in Banff National Park, Alberta, Canada. Conservation Biology 14: 47-56.

Collingwood, A., S.E. Franklin, X.L. Guo, and G. Stenhouse. 2009. A medium-resolution remote sensing classification of agricultural areas in Alberta grizzly bear habitat. Canadian Journal of Remote Sensing 35: 23-36.

Connacher Oil and Gas Ltd. 2010. Appendix 7 – Traditional Land Use. Great Divide SAGD Expansion Project Environmental Impact Assessment, Calgary, AB. http://www.connacheroil.com/en/documents/eia/17 appendix 7.pdf

COSEWIC 2002. COSEWIC assessment and update status report on the Grizzly Bear *Ursus arctos* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 91 pp.

COSEWIC 2011. Guidelines for Recognizing Designatable Units as approved by COSEWIC. Available at: http://www.cosewic.gc.ca/eng/sct2/sct2_5_e.cfm. Committee on the Status of Endangered Wildlife in Canada, Ottawa.

Cox, S. 1977. Prehistoric settlement and culture change at Okak. Labrador. PhD dissertation, Department of Anthropology, Harvard University, Cambridge, Massachusetts.

Craighead, J.J., J.S. Sumner, and J.A. Mitchell. 1995. The grizzly bears of Yellowstone: their ecology in the Yellowstone ecosystem, 1959-1992. Island Press. Washington, DC.

Craighead, L., D. Paetkau, H.V. Reynolds, E.R. Vyse, and C. Strobeck. 1995. Microsatellite analysis of paternity and reproduction in arctic grizzly bears. Journal of Heredity 86:255-261.

Cristescu, B., and M.S. Boyce. 2010. Grizzly bears and mining: rationale and objectives of a study on the effects of industry on bears. International Bear News 19:20-22.

Cronin, M.A., S.C. Amstrup, G.W. Garner, and E.R. Vyse. 1991. Interspecific and intraspecific mitochondrial DNA variation in North American bears (*Ursus*). Canadian Journal of Zoology 69:2985-2992.

Davison, J., S.Y.W. Ho, S.C.Bray, M. Korsten, E. Tammeleht, M. Hindrikson, K. Østbye, E. Østbye, S-E. Lauritzen, J. Austin, A. Cooper, and U. Saarma. 2011. Late-Quaternary biogeographic scenarios for the brown bear (*Ursus arctos*), a wild mammal model species. Quaternary Science Reviews, 30(3-4), 418 - 430.

Doupé, J.P., J.H. England, M. Furze and D. Paetkau. 2007. Most northerly observation of a grizzly bear (*Ursus arctos*) in Canada: photographic and DNA evidence from Melville Island, Northwest Territories. Arctic 60:271-276.

Ducommun, G. 2010. Summary of British Columbia Métis Traditional Knowledge for Grizzly Bear *(Ursus arctos horribilis)* contained in the MNBC Species at Risk Database. Métis Nation BC. 7 pp.

Edwards, C.J., M.A. Suchard, P. Lemey, J.J. Welch, I. Barnes, T.L. Fulton, *et al.* 2011. Ancient hybridization and an Irish origin for the modern polar bear matriline. Current Biology 21:1251-1258.

Edwards, M.A. J.A. Nagy, and A.E. Derocher. 2009. Low site fidelity and home range drift in a wide-ranging, large Arctic omnivore. Animal Behaviour 77: 23-28.

Edwards, M.A., A.E. Derocher, K.A. Hobson, M. Branigan, and J.A. Nagy. 2011. Fast carnivores and slow herbivores: differential foraging strategies among grizzly bears in the Canadian Arctic. Oecologia, *in press.*

Elton, C.S. 1954. Further evidence about the barren-ground grizzly bear in northeast Labrador. Journal of Mammalogy 35:345-356.

Environment Canada. 2009. Recovery Strategy for the Grizzly Bear (*Ursus arctos*), Prairie Population, in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. v + 28 pp.

Ferguson, S.H. and P.D. McLoughlin. 2000. Effect of energy availability, seasonality, and geographic range on brown bear life history. Ecography 23:193-200.

Festa-Bianchet, M., M. Urquhart, and K.G. Smith. 1994. Mountain goat recruitment: kid production and survival to breeding age. Canadian Journal of Zoology 72:22-27.

Fleishman, E. and R. Mac Nally. 2007. Contemporary drivers of fragmentation and measurement of their effects on animal diversity. Canadian Journal of Zoology, 85: 1080-1090.

Garshelis, D.L., M.L. Gibeau, and S. Herrero. 2005. Grizzly bear demographics in and around Banff National Park and Kananaskis Country, Alberta. Journal of Wildlife Management 69:277-297.

Gau, R.J. 1998. Food habits, body condition, and habitat of the barren-ground grizzly bear. Thesis. University of Saskatchewan, Saskatoon. 77 pp.

Gau, R.J., Case, R.L., Penner, D.F., and McLoughlin, P.D. 2002. Feeding patterns of grizzly bears in the central Canadian Arctic. Arctic 55: 339–344.

Gau, R.J., McLoughlin, P.D., Case, R.L., Cluff, H.D., Mulders, R., and Messier, F. 2004. Movements of subadult male grizzly bears in the central Canadian Arctic. Canadian Field-Naturalist 118: 239–242.

Gibeau, M.L. 1998. Grizzly bear habitat effectiveness model for Banff, Yoho, and Kootenay National Parks, Canada. Ursus 10:235-241.

Gibeau, M.L. 2000. A conservation biology approach to management of grizzly bears in Banff National Park, Alberta. PhD. Dissertation. University of Calgary. 129 pp.

Gibeau, M.L. 2005. Habitat effectiveness and security area analysis. Pages 194-199 in S. Herrero, editor. Biology, demography, ecology and management of grizzly bears in and around Banff National Park and Kananaskis Country. The final report of the Eastern Slopes Grizzly Bear Project. Faculty of Environmental Design, University of Calgary, Alberta, Canada.

Gibeau, M.L. and S. Herrero. 1997. Eastern Slopes grizzly bear project: a progress report for 1996. University of Calgary. 18 pp+app.

Gibeau, M.L., S. Herrero, J.L. Kansas, and B. Benn. 1996. Grizzly bear population and habitat status in Banff National Park: a report to the Banff Bow Valley Task Force by the Eastern Slopes Grizzly Bear Project. University of Calgary, AB. 62 pp.

Gibeau, M.L., S. Herrero, B.N. McLellan, and J.G. Woods. 2001. Managing for grizzly bear security areas in Banff National Park and the central Canadian Rocky Mountains. Ursus 12:121-129.

Gibeau, M.L., A.P. Clevenger, S. Hererro, and J. Wierzchowski. 2002. Grizzly bear response to human development and activities in the Bow River Watershed, Alberta. Biological Conservation 103:227-236.

Golder Associates Ltd. 2003. Report on Inuit Qaujimajatuqangit Literature Review, Gap Analysis and Workshop Results related to the Doris North Project Hope Bay Belt, Nunavut. Victoria, British Columbia. 214 pp.

Government of Alberta. 2011. Alberta SRD Grizzly Bear Mortality Statistics, website accessed August 1, 2011: http://www.srd.alberta.ca/ManagingPrograms/FishWildlifeManagement/BearManagement/GrizzlyBears/AlbertaGrizzlyBearMortalityRates.aspx)

Government of NWT. 2011. Website accessed August 1, 2011: http://www.enr.gov.nt.ca/_live/pages/wpPages/grizzly_bears.aspx

Government of Yukon. 2011. Website accessed August 1, 2011: http://www.environmentyukon.gov.yk.ca/huntingtrapping/biggame.php#grizzly

Graham, K, J. Boulanger, J. Duval, and G. Stenhouse. 2010. Spatial and temporal use of roads by grizzly bears in west-central Alberta. Ursus 21: 43-56.

Guilday, J.E. 1968. Grizzly bears from eastern North America. The American Midland Naturalist 79:247-250.

Gunn, A. and F.L. Miller. 1982. Muskox bull killed by a barren-ground grizzly bear, Thelon Game Sanctuary, N.W.T. Arctic 35:545-546.

Gwich'in Renewable Resource Board. 2002. Grizzly Bear Management Agreement. Gwich'in Renewable Resources Board, Inuvik, Northwest Territories. Report 02-06.

Hailer, F., V.E. B.M. Hallstrom, D. Klassert, S.R. Fain, J.A. Leonard, U. Arnason, and A. Janke. 2012. Nuclear Genomic Sequences Reveal that Polar Bears Are an Old and Distinct Bear Lineage. Science. 336: 344-347.

Hall, E.R. 1984. Geographic variation among brown and grizzly bears (*Ursus arctos*) in North America. Special Publication 13. Museum of Natural History, University of Kansas, Lawrence.

Hallowell, A. I. 1926. Bear ceremonialism in the northern hemisphere. American Anthropologist 28:1-175.

Hamer, D. and S. Herrero. 1987. Grizzly bear food and habitat in the front ranges of Banff National Park, Alberta. 1987. International Conference on Bear Research and Management 7:199-213.

Hamer, D. and S. Herrero. 1991. Elk, *Cervus elaphus*, calves as food for grizzly bears, *Ursus arctos*, in Banff National Park, Alberta. Canadian Field-Naturalist 105:101-103.

Hamer, D., S. Herrero, and K. Brady. 1991. Food and habitat used by grizzly bears, Ursus arctos, along the Continental Divide in Waterton Lakes National Park, Alberta. Canadian Field-Naturalist 105:325-329.

Hamilton, A.N. 2008. Grizzly bear population estimate for British Columbia, updated October 29, 2008. B.C. Ministry of Water, Land and Air Protection. Victoria, BC. 3 pp

Hamilton, A.N. and F.L. Bunnell. 1987. Foraging strategies of coastal grizzly bears in the Kimsquit River valley, British Columbia. International Conference on Bear Research and Management 7:187-197.

Hamilton, A.N.. D.C. Heard, and M.A. Austin, 2004. British Columbia Grizzly Bear (*Ursus arctos*) Population Estimate. B.C. Ministry of Water, Land and Air Protection, Victoria, BC. 7 pp.

Haszard, S., and J. Shaw. 2000. Rat River Biodiversity, Cultural and Historical Assessment. Gwich'in Renewable Resource Board (Report 00-01).

Hellgren, E.C. 1998. Physiology of hibernation in bears. Ursus 10:467-477.

Herrero, S. 2002. Bear attacks: their causes and avoidance (revised). Guilford: Globe Pequot Press.

Herrero, S. editor. 2005. Biology, demography, ecology and management of grizzly bears in and around Banff National Park and Kananaskis Country. The final report of the Eastern Slopes Grizzly Bear Project. Faculty of Environmental Design, University of Calgary, Alberta, Canada.

Herrero, S. and J. Herrero. 1996. Cheviot Mine Project: specific and cumulative environmental effects analysis for mammalian carnivores. Report for Cardinal River Coals Ltd. by BIOS Environmental Research and Planning Associates Ltd. Calgary, AB 122 pp.

Herrero, S., J. Roulet, and M.L. Gibeau. 2001. Banff National Park: science and policy in grizzly bear management. Ursus 12:161-168.

Hickey, C. G. 1999. Whitefish Lake First Nation Land Use and Occupancy Study. University of Alberta, Edmonton, Alberta.

Hilderbrand, G.V., C.C. Schwartz, C.T. Robbins, M.E. Jacoby, T.A. Hanley, S.M. Arthur, and C. Servheen. 1999a. The importance of meat, particularly salmon, to body size, population productivity, and conservation of North American brown bears. Canadian Journal of Zoology 77:132-138.

Hilderbrand, G.V., S.G. Jenkins, C.C. Schwartz, T.A. Hanley, and C.T. Robbins. 1999b. Effect of seasonal differences in dietary meat intake on changes in body mass and composition in wild and captive brown bears. Canadian Journal of Zoology 77:1623-1630.

Hilderbrand, G.V., C.C. Schwartz, C.T. Robbins, and T.A. Hanley. 2000. Effect of hibernation and reproductive status on body mass and condition of coastal brown bears. Journal of Wildlife Management 64:178-183.

Hilderbrand, G. V., S. D. Farley, C. C. Schwartz, and C. T. Robbins. 2004. Importance of salmon to wildlife: Implications for integrated management. Ursus 15:1-9.

Honeyman, J. 2008. A retrospective evaluation of the effectiveness of aversive conditioning on grizzly bears in Peter Lougheed Provincial Park, Alberta, Canada. Thesis, Royal Roads University, Edmonton, Alberta, Canada.

Hood, G. A., and K. L. Parker. 2001. Impact of human activities on grizzly bear habitat in Jasper National Park. Wildlife Society Bulletin :624-638.

Horejsi, B.L. 1989. Uncontrolled land-use threatens an international grizzly bear population. Conservation Biology 3:220-223.

Horejsi, B.L., B.K. Gilbert, and P.C. Paquet. 2010. Global climate disruption; bearing down on British Columbia`s coastal grizzlies! Unpublished report, provided by P.C. Paquet (Senior Scientist, Raincoast Foundation, Victoria, British Columbia, Canada).

Hovey, F.W. and B.N. McLellan. 1996. Estimating population growth of grizzly bears from the Flathead River drainage using computer simulations of reproduction and survival rates. Canadian Journal of Zoology 74:1409-1416.

IUCN Standards and Petitions Subcommittee. 2011. Guidelines for Using the IUCN Red List Categories and Criteria. Version 9.0. Prepared by the Standards and Petitions Subcommittee. Downloadable from http://www.iucnredlist.org/documents/RedListGuidelines.pdf.

Inuuvik Community Corporation, Tuktuuyaqtuuq Community Corporation and Akłarvik Community Corporation. 2006. Inuvialuit Settlement Region Traditional Knowledge Report. Mackenzie Project Environmental Group, Calgary, Alberta, 200 pp.

Johnson, C.J., M.S. Boyce, R.L. Case, H.D. Cluff, R.J. Gau, A. Gunn, and R. Mulders. 2005. Cumulative effects of human developments on arctic wildlife. Wildlife Monographs 160: 1-36.

Keith, D., and J. Arqviq. 2006. Environmental Change, Polar Bears and Adaptation in the East Kitikmeot: An Initial Assessment - Final Report.

Kellert, S.R. 1994. Public attitudes toward bears and their conservation. International Conference on Bear Research and Management 9:43-50.

Kowalska, Z. 1962. Intergeneric crossbreed of the brown bear *Ursus arctos* L., and the polar bear *Thalarctos maritimus* (Phipps). Przeglad Zoologiczny, 6:230, 1 pl. [Polish with English summary.]

Kowalska, Z. 1965. Cross breeding between a female European brown bear and a male polar bear in Lodz Zoo. Przeglad Zoologiczny, 9:313-319. [Polish with English summary.]

Kowalska, Z. 1969. A note on bear hybrids *Thalarctos maritimus* and *Ursus arctos* at Lodz zoo. Int. Zoo. Year. 9:89.

Kurtén, B. 1973. Transberingian relationships of *Ursus arctos* Linne (brown and grizzly bears). Commentation Biology 65:1-10.

Larsen, D.G., D.A. Gauthier, and R.L. Markel. 1989. Causes and rate of moose mortality in the southwest Yukon. Journal of Wildlife Management 53:548-557.

Lefebvre, M. 1972. Tshakapesh: Récits Montagnais-Naskapi. Série cultures amérindiennes 4. Quebec City: Ministère des affaires culturelles du Québec.

LeFranc, M.N. Jr., M.B. Moss, K.A. Patnode, and W.C. Sugg, III (editors). 1987. Grizzly bear compendium. Interagency Grizzly Bear Committee, Washington, DC.

Leonard J.A., R.K. Wayne, and A. Cooper (2000) Population genetics of ice age brown bears. Proceedings of the National Academy of Sciences, USA, 97, 1651–1654.

Linke, J., S.E. Franklin, F. Huettmann, and G.B. Stenhouse. 2005. Seismic cutlines, changing landscape metrics and grizzly bear landscape use in Alberta. Landscape Ecology 20: 811-826.

Little Salmon/Carmacks First Nation, Carmacks Renewable Resource Council, and Environment Yukon. 2004. Community-based Fish and Wildlife Management Plan - Little Salmon/Carmacks First Nation Traditional Territory 2004-2009. 44 pp.

Loring, S. 2005. Smithsonian fieldwork in Labrador: summary of 2004 fieldwork. Provincial Archaeology Office Newsletter, Archaeology in Newfoundland and Labrador 3: 20–21.

Loring, S., and A. Spiess. 2007. Further documentation supporting the former existence of grizzly bears (*Ursus arctos*) in Northern Quebec-Labrador. Arctic 60:7-16.

Lutsel K'e First Nation, B. Parlee, M. Basil, and N. Casaway. 2001. Traditional Ecological Knowledge in the Kaché Tue Study Region - Final Report. The West Kitikmeot Slave Study Society and Lutsel K'e Dene First Nation.

Mace, R.D. and J.S. Waller. 1998. Demography and population trend of grizzly bears in the Swan Mountains, Montana. Conservation Biology 12:1005-1016.

Mace, R.D., S.C. Minta, T.L. Manley, and K.E. Aune. 1994. Estimating grizzly bear population size using camera sightings. Wildlife Society Bulletin 22:74-83.

MacHutchon, A.G. 1996. Grizzly bear habitat use study, Ivvavik National Park, Yukon. Final Report. Western Arctic District, Parks Canada, Inuvik, NT.

MacHutchon, A.G., S. Himmer, and C.A. Bryden. 1993. Khutzeymateen Valley grizzly bear study. Final Report. Wildlife Report No. R-25, Wildlife Habitat Research Report No. 31. Ministry of Forests, Victoria, BC. 105pp.

Maraj, R. 2007. Evaluating the consequences of human land use on grizzly bears in southwest Yukon, Canada. Dissertation. University of Calgary, Calgary, Canada.

Maraj, R. 2010. Bears and humans: how Canadian park managers are dealing with grizzly bear populations in a northern landscape. Park Science 27. Published online http://www.nature.nps.gov/ParkScience/index.cfm?ArticleID=415&Page=1

Martin, P.L. 1876. *Ursus arctos* and *Ursus maritimus*. On bastards between these species born in Nill's menagerie at Stuttgart. Zoologische Garten 1876:20-22. [Zoologische Garten, 1877:135-136. W. Stendell and E. von Martens, tom. cit., pp.401-402.]

Martin, P.L. 1882. On a hybrid between a male *Ursus maritimus* and a female *Ursus arctos*. Zoologische Garten, 1882:xxiii, 370.

Matheus, P., J. Burns, J. Weinstock, and M. Hofreiter. 2004. Pleistocene brown bears in the mid-continent of North America. Science 306: 1150.

Mattson, D.J. 1997. Use of ungulates by Yellowstone grizzly bears. Biological Conservation 81:161-177.

Mattson, D.J. 2001. Myrmecophagy by Yellowstone grizzly bears. Canadian Journal of Zoology 79:779-793.

Mattson, D.J. and T. Merrill. 2002. Extirpations of grizzly bears in the contiguous United States, 1850-2000. *Conservation Biology* 16: 1123-1136.

Mattson, D.J., C.M. Gillin, C.M. Benson, and R.R. Knight. 1991. Bear feeding activity at alpine insect aggregation sites in the Yellowstone ecosystem. Canadian Journal of Zoology 69:2430-2435.

Mattson, D.J., K.C. Kendall, and D.P. Reinhart. 2001. Whitebark pine, grizzly bears, and red squirrels. Pages 121-136 *in* D.F. Tomback, S.F. Arno, and R.E. Keane, eds. Whitebark pine communities: ecology and restoration. Island Press, Washington, DC.

Mattson, D.J., M.G. French, and S.P. French. 2002. Consumption of earthworms by Yellowstone grizzly bears. Ursus 13: 105-110.

McCann, R.K.. 1998. Kluane National Park grizzly bear research project. Interim final report to accompany the project review, October 21 & 22, 1998. Parks Canada, Kluane National Park and Reserve, Haines Junction. 128 pp.

McCullough, D.R. 1982. Behavior, bears, and humans. Wildlife Society Bulletin 10:27-33.

McCullough, D. R. 1996. Spatially structured populations and harvest theory. Journal of Wildlife Management 60:1-9.

McDiarmid, Margo. 2002. Who killed Mary? Bear experts blame drive-by poaching for the illegal killing of grizzlies in Alberta. Feb. 19. Canadian Broadcasting Corporation.

McLellan, B.N. 1989a. Dynamics of a grizzly bear population during a period of industrial resource extraction. I. Density and age-sex composition. Canadian Journal of Zoology 67:1856-1860. 2314

McLellan, B.N. 1989b. Dynamics of a grizzly bear population during a period of industrial resource extraction. II. Mortality rates and causes of death. Canadian Journal of Zoology 67:1861-1864.

McLellan, B.N. 1989c. Dynamics of a grizzly bear population during a period of industrial resource extraction. III. Natality and rate of increase. Canadian Journal of Zoology 67:1865-1868.

McLellan, B.N. 1990. Relationships between human industrial activity and grizzly bears. International Conference on Bear Research and Management 8:57-64.

McLellan, B. 1994. Density-dependent population regulation of brown bears. Pages 15-25 *in* M. Taylor, ed. Density-dependent population regulation in black, brown, and polar bears. International Conference on Bear Research and Management Monograph Series No. 3. 43 pp.

McLellan, B.N. 1998. Maintaining viability of brown bears along the southern fringe of their distribution. Ursus 10:607-611.

McLellan, B.N. 2005. Sexually selected infanticide in grizzly bears: the effects of hunting on cub survival. Ursus 16: 141-156.

McLellan, B.N. 2008. Implications of 1970s salvage logging of mountain pine beetle trees and gas exploration on grizzly bears: vital rates and rate of change. Unpublished report. 29 pp.

McLellan, B.N. and D.M. Shackleton. 1988. Grizzly bears and resource-extraction industries: effects of roads on behaviour, habitat use and demography. Journal of Applied Ecology 25:451-460.

McLellan, B.N. and D. Reiner. 1994. A review of bear evolution. Int. Conf. Bear Res. and Manage. 9: 85-96.

McLellan, B.N. and F.W. Hovey. 1995. The diet of grizzly bears in the Flathead River drainage of southeastern British Columbia. Canadian Journal of Zoology 73:704-712.

McLellan, B.N. and F.W. Hovey. 2001a. Habitats selected by grizzly bears in a multiple use landscape. Journal of Wildlife Management 65:92-99.

McLellan, B.N. and F.W. Hovey. 2001b. Natal dispersal of grizzly bears. Canadian Journal of Zoology 79:838-844.

McLellan, B.N., F.W. Hovey, R.D. Mace, J.G. Woods, D.W. Carney, M.L. Gibeau, W.L. Wakkinen, and W.F. Kasworm. 1999. Rates and causes of grizzly bear mortality in the interior mountains of British Columbia, Alberta, Montana, Washington, and Idaho. Journal of Wildlife Management 63:911-920.

McLellan, B.N., Servheen, C. and Huber, D. 2008. *Ursus arctos*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4.

McLoughlin, P. D. 2001. The ecology of barren-ground grizzly bears in Nunavut. Volume I: State of knowledge. Department of Environment, Iqaluit, NU.

McLoughlin, P.D. 2003. Managing risks of decline for hunted populations of grizzly bears given uncertainty in population parameters. Final Report to the British Columbia Independent Scientific Panel on Grizzly Bears. Available at: http://www.env.gov.bc.ca/wld/documents/gbear_mcl.pdf

McLoughlin, P.D., and Ferguson, S.H. 2000. A hierarchical pattern of limiting factors helps explain variation in home range size. Écoscience 7: 123–130.

McLoughlin, P.D., and Messier, F. 2004. Relative contributions of sampling error in initial population size and vital rates to outcomes of population viability analysis. Conservation Biology 18: 1665–1669.

McLoughlin, P.D., Case, R.L., Gau, R.J., Ferguson, S.H., and Messier, F. 1999. Annual and seasonal movement patterns of barren-ground grizzly bears in the central Northwest Territories. Ursus 11: 79–86

McLoughlin, P.D., Ferguson, S.H., and Messier, F. 2000. Intraspecific variation in home range overlap with habitat quality: a comparison among brown bear populations. Evolutionary Ecology 14: 39–60.

McLoughlin, P.D., Case, R.L., Gau, R.J., Cluff, H.D., Mulders, R., and Messier, F. 2002a. Hierarchical habitat selection by barren-ground grizzly bears in the central Canadian Arctic. Oecologia 132: 102–108.

McLoughlin, P.D., Cluff, H.D., and Messier, F. 2002b. Denning ecology of barren-ground grizzly bears in the central Arctic. Journal of Mammalogy 83: 188–198.

McLoughlin, P.D., Cluff, H.D., Gau, R.J., Mulders, R., Case, R.L., and Messier, F. 2003a. Effect of spatial differences in habitat on home ranges of barren-ground grizzly bears. Écoscience 10: 11–16.

McLoughlin, P.D., Taylor, M., Cluff, H.D., Gau, R.J., Mulders, R., Case, R.L., Boutin, S., and Messier, F. 2003b. Demography of barren-ground grizzly bears. Canadian Journal of Zoology 81: 294–301.

McLoughlin, P.D., Case, R.L., Gau, R.J., Mulders, R., Cluff, H.D., Taylor, M., and Messier, F. 2003c. Population viability of barren-ground grizzly bears in Nunavut and the Northwest Territories. Arctic 56: 177–182.

McLoughlin, P.D., Taylor, M.K., and Messier, F. 2005. Conservation risks of male-selective harvest for mammals with low reproductive potential. Journal of Wildlife Management 69: 1592–1600.

Merriam, C.H. 1918. Review of the grizzly and big brown bears of North America (genus *Ursus*) with the description of a new genus, *Vetularctos*. North American Fauna 41:1-136.

Merrill, T., D.J. Mattson, R.G. Wright, and H.B. Quigley. 1999. Defining landscapes suitable for restoration of grizzly bears *Ursus arctos* in Idaho. Biological Conservation 87:231-248.

Merrill, T. 2005. Grizzly bear conservation in the Yellowstone to Yukon region. Technical Report #6. Yellowstone to Yukon Conservation Initiative, Canmore, Alberta.

Milakovic, B., K.L. Parker, D.D. Gustine, R.J. Lay, A.B.D. Walker, and M.P. Gillingham. 2012. Seasonal habitat use and selection by grizzly bears in northern British Columbia. Journal of Wildlife Management 76:170-180.

Miller, C.R., L.P. Waits, and P. Joyce. 2006. Phylogeography and mitochondrial diversity of extirpated brown bear (*Ursus arctos*) populations in the contiguous United States and Mexico. Molecular Ecology 15: 4477-4485.

Miller, S.D. 1990. Population management of bears in North America. International Conference on Bear Research and Management 8:357-373.

Miller, S.J., N. Barichello, and D. Tait. 1982. The grizzly bears of the Mackenzie Mountains, Northwest Territories. N.W.T. Wildlife Service. Completion Report No. 3. Yellowknife. 118pp.

Miller, S.D., E.F. Becker, and W.B. Ballard. 1987. Black and brown bear density estimates using modified capture-recapture techniques in Alaska. International Conference on Bear Research and Management 7:23-35.

Miller, S.D., G.C. White, R.A. Sellers, H.V. Reynolds, J.W. Schoen, K. Titus, V.G. Barnes, Jr., R.B. Smith, R.R. Nelson, W.B. Ballard, and C.C. Schwartz. 1997. Brown and black bear density estimation in Alaska using radiotelemetry and replicated mark-resight techniques. Wildlife Monographs 133. 55 pp.

Miller, S.D., J.W. Schoen, J. Faro, D.R. Klein. 2011. Trends in intensive management of Alaska's grizzly bears, 1980-2010. Journal of Wildlife Management 75:1243–1252.

Miller, S.M., S.D. Miller, and D.W. McCollum. 1998. Attitudes toward and relative value of Alaskan brown and black bears to resident voters, resident hunters, and nonresident hunters. Ursus 10:357-376.

Milton Freeman Research Ltd. 1976a. Inuit land use and occupancy project. Volume I: Land use and occupancy. Minister of Supply and Services Canada, Ottawa, Ontario.

Milton Freeman Research Ltd. 1976b. Inuit land use and occupancy project. Volume II: Supporting studies. Minister of Supply and Services Canada, Ottawa, Ontario.

Milton Freeman Research Ltd. 1976c. Inuit land use and occupancy project. Volume III: Land use atlas. Minister of Supply and Services Canada, Ottawa, Ontario.

Morton, K. and L. Lester. 2004. Prairie Grizzly Operation Strategy, 2004. Draft July 15, 2004. Draft report prepared for the Lethbridge Wildlife Management Area, Alberta Sustainable Research Development. Lethbridge, Alberta. 9 pp.

Mowat, G. and C. Strobeck. 2000. Estimating population size of grizzly bears using hair capture, DNA profiling, and mark-recapture analysis. Journal of Wildlife Management 64:183-193.

Mowat, G., K.G. Poole, D.R. Seip, D.C. Heard, R. Smith and D.W. Paetkau. 2002. Grizzly and Black Bear densities in interior British Columbia. Aurora Wildlife Research. 35 pp.

Mowat, G. D.C. Heard, D.R. Seip, K.G. Poole, G. Stenhouse, and D.W. Paetkau. 2005. Grizzly *Ursus arctos* and black bear *U. americanus* densities in the interior mountains of North America. Wildlife Biology 11: 31-48.

Mueller, C., S. Herrero, and M.L. Gibeau. 2004. Distribution of subadult grizzly bears in relation to human development in the Bow River watershed, Alberta. Ursus 15:35-47.

Munro, R.H.M., S.E., Nielsen, M.H. Price, G.B. Stenhouse, and M.S. Boyce. 2006. Seasonal and diel patterns of grizzly bear diet and activity in west-central Alberta. Journal of Mammalogy 87: 1112-1121.

Murphy, K.M., G.S. Felzien, M.G. Hornocker, and T.K. Ruth. 1998. Encounter competition between bears and cougars: some ecological implications. Ursus 10:55-60.

Nacho Nyak Dun First Nation, Mayo District Renewable Resources Council, and Yukon Department of Environment. 2003. Community-based fish and wildlife management plan (2002-2007) for Nacho Nyak Dun Traditional Territory. 46 pp.

Nagy, J.A. and R.H. Russell. 1978. Ecological studies of the boreal forest grizzly bear (*Ursus arctos* L.). Annual report for 1977. Canadian Wildlife Service, Edmonton. 72 pp.

Nagy, J.A. and J.R. Gunson. 1990. Management plan for grizzly bears in Alberta. Wildlife Management Planning Series No. 2. Forestry, Lands and Wildlife, Fish and Wildlife Division, Edmonton. 164 pp.

Nagy, J.A. and M. Branigan. 1998. Co-management plan for grizzly bears in the Inuvialuit Settlement Region, Yukon Territory and Northwest Territories. Wildlife Management Advisory Council, North Slope and Northwest Territories, Inuvik. 63 pp.

Nagy, J.A., R.H. Russell, A.M. Pearson, M.C.S. Kingsley, and C.B. Larson. 1983*a*. A study of grizzly bears on the barren-grounds of Tuktoyaktuk Peninsula and Richards Island, Northwest Territories, 1974 to 1978. Canadian Wildlife Service, Edmonton. 136 pp.

Nagy, J.A., R.H. Russell, A.M. Pearson, M.C.S. Kingsley, and B.C. Goski. 1983*b*. Ecological studies of grizzly bears in the Arctic Mountains, Northern Yukon Territory, 1972 to 1975. Canadian Wildlife Service, Edmonton. 102pp.

Nagy, J.A., A.W.L. Hawley, M.W. Barrett, and J.W. Nolan. 1989. Population characteristics of grizzly bears and black bears in west central Alberta. AEC Report V88-R1. Alberta Environmental Centre, Vegreville, AB. 33 pp.

NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: December 6, 2011).

Nielsen, S.E. 2005. Habitat ecology, conservation, and projected population viability of grizzly bears (*Ursus arctos* L.) in west-central Alberta, Canada. Ph.D. Thesis, University of Alberta, Edmonton, Alberta, Canada.

Nielsen, S.E., S. Herrero, M.S. Boyce, R.D. Mace, B. Benn, M.L. Gibeau, and S. Jevons. 2004a. Modeling the spatial distribution of human-caused grizzly bear mortalities in the Central Rockies ecosystem of Canada. Biological Conservation 120: 101-113.

Nielsen, S.E., M.S. Boyce, and G.B. Stenhouse. 2004b. Grizzly bears and forestry. I. Selection of clearcuts by grizzly bears in west-central Alberta. Forest Ecology and Management 120: 101-113.

Nielsen, S.E., G.B. Stenhouse, and M.S. Boyce. 2006. A habitat-based framework for grizzly bear conservation in Alberta. Biological Conservation 130: 217-229.

Nielsen, S.E., G. McDermid, G.B. Stenhouse, and M.S. Boyce. 2010. Dynamic wildlife habitat models: seasonal foods and mortality risk predict occupancy-abundance and habitat selection in grizzly bears. Biological Conservation 143:1623-1634.

Nirlungayuk, G. 2008. Aklah, Akha, Grizzly Bear, perspectives from Inuit of Kugluktuk and Baker Lake elders. 4 pp.

Oakes, J.E. 1991. Copper and Caribou Inuit skin clothing production. Canadian Museum of Civilization, Hull, Quebec.

Paetkau, D., L. P. Waits, P. L. Clarkson, L. Craighead, and C. Strobeck. 1997. An empirical evaluation of genetic distance statistics using microsatellite data from bear (Ursidae) populations. Genetics 147:1943–1957.

Paetkau, D., Waits, L.P., Clarkson, P.L. *et al.* 1998. Variation in genetic diversity across the range of North American brown bears. Conservation Biology 12: 418-429.

Parker, Z. and Gorter, R. 2003. Crossroads: Economics Policy, and the Future of Grizzly Bears in British Columbia. Victoria, BC. ISBN 0-9688432-3-9

Pasitschniak-Arts, M. 1993. *Ursus arctos*. Mammalian Species 439:1-10.

Pasitschniak-Arts, M. and F. Messier. 2000. Brown (grizzly) and polar bears. Pages 409-428 in: S. Demarais and P.R. Krausman, eds. Ecology and management of large mammals in North America. Prentice-Hall. Upper Saddle River, NJ.

Pearson, A.M. 1975. The northern interior grizzly bear *Ursus arctos* L. Canadian Wildlife Service Report Series No. 34. Ottawa.

Peek, J., J. Beecham, D. Garshelis, F. Messier, S. Miller, and D. Strickland. 2003. Management of grizzly bears in British Columbia: A review by an independent scientific panel. 90 pp.

Pengelly, I., and D. Hamer. 2006. Grizzly bear use of pink hedysarum roots following shrubland fire in Banff National Park, Alberta. Ursus 17: 124-131.

Peterson, R.L. 1965. A well-preserved grizzly bear skull recovered from a late glacial deposit near Lake Simcoe, Ontario. Nature 208:1233-1234.

Pissot, J. 2007. Trains, grains, and grizzly bears: reducing wildlife mortality on railway tracks in Banff National Park. In Proceedings of the 2007 International Conference on Ecology and Transportation, edited by C. Leroy Irwin, Debra Nelson, and K.P. McDermott. Raleigh, NC: Center for Transportation and the Environment, North Carolina State University. pp. 64-67.

Poole, K.G., G. Mowat, and D.A. Fear. 2001. DNA-based population estimate for grizzly bears in northeastern British Columbia, Canada. Wildlife Biology 7:105-115.

Price, M.H.H., C.T. Darimont, N.F. Temple, and S.M. MacDuffee. 2008. Ghost runs: management and status assessment of Pacific salmon (Oncorhynchus spp.) returning to British Columbia's central and north coasts. Canadian Journal of Fisheries and Aquatic Sciences 65: 2712–2718.

Proctor, M. F. 2003. Genetic analysis of movement, dispersal and population fragmentation of grizzly bears in southwestern Canada. Dissertation, University of Calgary, Calgary, Alberta, Canada.

Proctor, M. and L. Neumeier. 1996. Bear handling as a result of bear-human interaction in the Revelstoke, British Columbia are during 1986–1995. Report for Ministry of Water, Lands, and Air Protection, Nelson, BC.

Proctor, M. F., B. N. McLellan, C. Strobeck, and R.M.R. Barclay. 2004. Gender-specific dispersal distances of grizzly bears estimated from genetic analysis. Canadian Journal of Zoology. 82: 1108-1118.

Proctor, M.F., B.N. McLellan, C. Strobeck, and R.M.R. Barclay. 2005. Genetic analysis reveals demographic fragmentation of grizzly bears yielding vulnerably small populations. Proceedings of the Royal Society: Biological Sciences 272: 2409-2416.

Proctor, M., J. Boulanger, S. Nielsen, C. Servheen, W. Kasworm, T. Radandt, and D. Paetkau. 2007. Abundance and density of Central Purcell, South Purcell, Yahk, and South Selkirk Grizzly Bear Population Units in southeast British Columbia. B.C. Ministry of Environment. Nelson. BC. 30 pp.

Proctor, M., D. Paetkau, B.N. McLellan, G.B. Stenhouse, K.C. Kendall, R.D. Mace, W.F. Kasworm, C. Servheen, C. L. Lausen, M. L. Gibeau, W.L. Wakkinen, M.A. Haroldson, G. Mowat, C.D. Apps, L.M. Ciarniello, R.M.R. Barclay, M.S. Boyce, C.C. Schwartz, and C. Strobeck. 2012. Population fragmentation and inter-ecosystem movements of Grizzly Bears in western Canada and the Northern United States. Wildlife Monographs 180:1–46; 2012

Province of British Columbia. 1995. Conservation of grizzly bears in British Columbia: background report. BC Ministry of Environment, Lands and Parks, Victoria. 70 pp.

Rausch, R.L. 1963. Geographic variation in size of North American brown bears, *Ursus arctos* L., as indicated by condylobasal length. Canadian Journal of Zoology 41:33-45.

Rockwell, D. 1991. Giving voice to bear: North American Indian rituals, myths, and images of the bear. Roberts Reinhart Publications. Niwot, CO, USA. 224 pp.

Rockwell, R., L. Gormezano, and D. Hedman. 2008. Grizzly Bears, *Ursus arctos,* in Wapusk National Park, Northeastern Manitoba. Canadian Field-Naturalist 122: 323-326.

Rode, K.D. and C.T. Robbins. 2000. Why bears consume mixed diets during fruit abundance. Canadian Journal of Zoology 78:1640-1645.

Rode, K.D., C.T. Robbins, and L.A. Shipley. 2001. Constraints on herbivory by grizzly bears. Oecologia 128:62-71.

Roever, C., M.S. Boyce, and G.B. Stenhouse. 2008a. Grizzly bears and forestry I: Road vegetation and placement as an attractant to grizzly bears. Forest Ecology and Management 256:1253–1261.

Roever, C., M.S. Boyce, and G.B. Stenhouse. 2008b. Grizzly bears and forestry II: Grizzly bear habitat selection and conflicts with road placement. Forest Ecology and Management 256:1262–1269.

Roever, C., M.S. Boyce, and G.B. Stenhouse. 2010. Grizzly bear movements relative to roads: application of step selection functions. Ecography 33: (early view, doi: 10.1111/j.1600-0587.2010.06077.x).

Ross, P.I., G.E. Hornbeck, and B.L. Horejsi. 1988. Late denning black bears killed by grizzly bear. Journal of Mammalogy. 69:818-820.

Ryan, C. 1981. Trichinosis from frozen grizzly bear meat. Proceedings of 5th International Symposium on Circumpolar Health, Copenhagen, 9–13 August, 1981. B. Harvald and J.P.H. Hansen, eds. Nordic Council for Arctic Medical Research Report, 33, 1981, pp. 442–445.

Savard, R. 1985. La voix des autres. Montreal: Éditions de l'Hexagone.

Savard, R. 2004. La forêt vive: Récits foundateurs du peuple Innu. Montreal: Boréal.

Schirokauer, D.W. and H.M. Boyd. 1998. Bear-human conflict management in Denali National Park and Preserve, 1982-94. Ursus 10:395-403.

Schwartz, C. C., Miller, S. D. and Haroldson, M. A. 2003a. Grizzly bear. In: G. A. Feldhamer, B. C. Thompson, and J. A. Chapman (eds), *Wild mammals of North America: biology, management, and conservation*, pp. 556-586. Johns Hopkins University Press, Baltimore, Maryland, USA.

Schwartz, C.C., K. A. Keating, H.V. Reynolds, III, V. G. Barnes, Jr., R. A. Sellers, J. E. Swenson, S. D. Miller, B.N. McLellan, J. Keay, R. McCann, M. Gibeau, W. F. Wakkinen, R. D. Mace, W. Kasworm, R. Smith, and S. Herrero. 2003b. Reproductive maturation and senescence in the female brown bear. Ursus 14:109-119.

Servheen, C. 1990. The status and conservation of the bears of the world. International Conference on Bear Research and Management, Monograph Series No. 2. 32 pp.

Servheen, C. 1999a. Status and management of the grizzly bear in the lower 48 United States. Pages 50-54 in C. Servheen, S. Herrero, and B. Peyton, compilers. Bears. Status survey and conservation action plan. IUCN/SSC Bear and Polar Bear Specialist Groups. IUCN, Gland, Switzerland and Cambridge, UK.

Servheen, C. 1999b. The trade in bears and bear parts. Pages 33-38 in C. Servheen, S. Herrero, and B. Peyton, compilers. Bears. Status survey and conservation action plan. IUCN/SSC Bear and Polar Bear Specialist Groups. IUCN, Gland, Switzerland and Cambridge, UK.

Servheen, C. and R.R. Knight. 1993. Possible effects of a restored gray wolf population on grizzly bears in the Greater Yellowstone area. Pages 28-37 *in* R.S. Cook, editor. Ecological issues on reintroducing wolves into Yellowstone National Park. Scientific Monograph NPS/NRYELL/NRSM-93/22. U.S. Department of the Interior, National Parks Service, Denver, CO.

Shaw, J., B. Benn, and C. Lambert. 2005. Dall's sheep local knowledge study. Gwich'in Renewable Resource Board Report 05-02.

Shepard, P. and B. Sanders. 1985. The sacred paw: the bear in nature, myth and literature. Viking Penguin Press, Inc. New York, NY, USA. 244 pp.

Shuswap Indian Band. 2008. Our People Between the Two Mountain Ranges: Shuswap Indian Band Traditional Land Use Study. Fish Creek Press, Calgary, AB. 224 pp.

Slater G.J., B. Figueirido, L. Louis, P. Yang, and B. Van Valkenburgh. 2010. Biomechanical Consequences of Rapid Evolution in the Polar Bear Lineage. PLoS ONE 5(11): e13870. doi:10.1371/journal.pone.0013870

Slavik, D. 2010 Inuvialuit Knowledge of Nanuq: Community and Traditional Knowledge of Polar Bear in the Inuvialuit Settlement Region. WMAC – NS, Whitehorse, Yukon. 72 pp. http://www.wmacns.ca/pdfs/303_PolarBearTK%20WEB.pdf

Spiess, A. 1976. Labrador grizzly (*Ursus arctos* L.): First skeletal evidence. Journal of Mammalogy 57:787-790.

Spiess, A., and S. Cox. 1976. Discovery of the skull of a grizzly bear in Labrador. Arctic 29:194-200.

St'at'imc Land and Resource Authority. 2004. Nxekmenlhkalha lti tmicwa. St'at'imc Preliminary Draft Land Use Plan, Part 1. St'at'imc Land and Resource Authority , Lillooet, British Columbia. 26 pp.

Stronen, A.V. 2000. Habitat selection and calf survival in the Telkwa Caribou herd, British Columbia 1997–2000. University of Calgary, Calgary, Alberta.

Strong, W. 1930. Notes on mammals of the Labrador interior. Journal of Mammalogy 11:1–10.

Stumpf-Allen, R. C. G., B. L. Mcfarlane, and D. O. Watson. 2004. Managing for grizzly bears in the Foothills Model Forest: A survey of local and Edmonton residents. Foothills Model Forest, Hinton, AB.

Swenson, J.E., F. Sandegren, S. Brunberg, and P. Wabakken. 1997. Winter den abandonment by brown bears *Ursus arctos*: causes and consequences. Wildlife Biology 3:35-38.

Talbot, S.L., and G.F. Shields. 1996a. A phylogeny of the bears (*Ursidae*) inferred from complete sequences of three mitochondrial genes. Mol. Phyl. Evol. 5:567-575.

Talbot, S.L., and G.F. Shields. 1996b. Phylogeography of brown bears (*Ursus arctos*) of Alaska and paraphyly within the Ursidae. Mol. Phyl. Evol. 5:477-494.

Tardif, L.-P. and Associates. 2003. Collisions involving motor vehicles and large animals in Canada. Final Report to Transport Canada Road Safety Directorate. L.-P. Tardif and Associates Inc., Nepean, Ontario, Canada.

Theberge, J., and S. Stevens. 2005. Comparison of results regarding resource selection models for female grizzly bears in the eastern slopes based on coarse-filter and fine-filter approaches. Pages 178-180 in S. Herrero, editor. Biology, demography, ecology and management of grizzly bears in and around Banff National Park and Kananaskis Country. The final report of the Eastern Slopes Grizzly Bear Project. Faculty of Environmental Design, University of Calgary, Alberta, Canada.

Theberge, J., S. Herrero, and S. Jevons. 2005. Resource selection by female grizzly bears with consideration to heterogeneous landscape pattern and scale. Pages 161-177 in S. Herrero, editor. Biology, demography, ecology and management of grizzly bears in and around Banff National Park and Kananaskis Country. The final report of the Eastern Slopes Grizzly Bear Project. Faculty of Environmental Design, University of Calgary, Alberta, Canada.

Thorpe, N. L. 2000. Contributions of Inuit ecological knowledge to understanding the impacts of climate change on the Bathurst Caribou Herd in the Kitikmeot Region, Nunavut. Simon Fraser University.

U.S. Fish and Wildlife Service (USFWS). 1993. Grizzly bear recovery plan. Missoula, MT. 181 pp.

U.S. Fish and Wildlife Service (USFWS). 2011. Website: http://www.fws.gov/mountain-prairie/species/mammals/grizzly/

Van Daele, L.J., V.G. Barnes, Jr., and R.B. Smith. 1990. Denning characteristics of brown bears on Kodiak Island, Alaska. International Conference on Bear Research and Management 8:257-267.

Veitch, A.M., and Harrington, F.H. 1996. Brown bears, black bears, and humans in northern Labrador: An historical perspective and outlook to the future. Journal of Wildlife Research 1:245–250.

Vroom, G.W., S. Herrero, and R.T. Ogilvie. 1980. The ecology of winter den sites of grizzly bears in Banff National Park, Alberta. International Conference on Bear Research and Management 3:321-330.

Waits, L.P., S.L. Talbot, R.H. Ward, and G.F. Shields. 1998. Mitochondrial DNA phylogeography of the North American brown bear and implications for conservation. Conservation Biology 12:408-417.

Wakkinen, W.L. and W.F. Kasworm. 2004. Demographics and population trends of grizzly bears in the Cabinet-Yaak and Selkirk ecosystems of British Columbia, Idaho, Montana, and Washington. Ursus 15 Workshop Supplement: 65–75.

Waller, J.S., and C. Servheen. 2005. Effects of transportation infrastructure on grizzly bears in Northwestern Montana. Journal of Wildlife Management 69: 985-1000.

Weaver, J.L., P.C. Paquet, and L.F. Ruggiero. 1996. Resilience and conservation of large carnivores in the Rocky Mountains. Conservation Biology 10:964-976.

Weigl, R. 2005. Longevity of mammals in captivity; from the living collections of the world. Kleine Senckenberg-Reihe 48. Stuttgart, Germany. pp. 111-112.

Westfall, J., and T. Ebata. 2009. 2008 summary of forest health condition in British Columbia. Pest Management Report 15. British Columbia Ministry of Forests and Range, Forest Practices Branch, Victoria, BC. 85 pp.

White, D., Jr., J.G. Berardinelli, and K.E. Aune. 1998. Reproductive characteristics of the male grizzly bear in the continental United States. Ursus 10: 497-501.

White, D., Jr., J.G. Berardinelli, and K.E. Aune. 2005. Age variation in gross and histological characteristics of the testis and epididymis in grizzly bears. Ursus 16: 190-197.

Wielgus, R.B. and F.L. Bunnell. 1994. Dynamics of a small, hunted brown bear *Ursus arctos* population in southwestern Alberta, Canada. Biological Conservation 67:161-166.

Wielgus, R.B. and F.L. Bunnell. 1995. Tests of hypotheses of sexual segregation in grizzly bears. Journal of Wildlife Management 59:552-560.

Wielgus, R.B. and F.L. Bunnell. 2000. Possible negative effects of adult male mortality on female grizzly bear reproduction. Biological Conservation 93:145-154.

Wielgus, R.B., F.L. Bunnell, W.L. Wakkinen, and P.E. Zager. 1994. Population dynamics of Selkirk Mountain grizzly bears. Journal of Wildlife Management 58:266-272.

Wiken, E. 1986. Terrestrial ecozones of Canada. Ecological Land Classification Series, No. 19. Lands Directorate, Environment Canada. 26 pp.

Wildlife Management Advisory Council (North Slope) and the Aklavik Hunters and Trappers Committee. 2003. Aklavik Inuvialuit describe the status of certain birds and animals on the Yukon North Slope. Whitehorse, YK and Aklavik, NWT.

Wildlife Management Advisory Council (North Slope) and the Aklavik Hunters and Trappers Committee. 2008. Aklavik local and traditional knowledge about grizzly bears of the Yukon North Slope: Final Report. Whitehorse, Yukon: Wildlife Management Advisory Council (North Slope). 44 pp.

Woods, J.G., B.N. McLellan, D. Paetkau, M. Proctor, C. Strobeck. 1997. West slopes bear research project. Second progress report. Parks Canada, Revelstoke, BC.

Woods, J.G., D. Paetkau, D. Lewis, B.N. McLellan, M. Proctor, and C. Strobeck. 1999. Genetic tagging of free-ranging black and brown bears. Wildlife Society Bulletin 27:616-627.

Wright, B. 1962. Wildlife sketches. Fredericton: Brunswick Press.

BIOGRAPHICAL SUMMARY OF THE REPORT WRITER

Dr. Philip D. McLoughlin is an Associate Professor of Biology in the Department of Biology at the University of Saskatchewan in Saskatoon, Canada. Philip's main interests with respect to Grizzly Bears lies in conservation and the analysis of demography and population viability, habitat selection, and the role of harvesting and sex-biased harvesting in population management. Philip has published numerous papers on the ecology of Grizzly Bears, Polar Bears, and several ungulate species. He resides in Warman, SK, with his wife Tamara.

Philip's contact information is:

Philip D. McLoughlin
Department of Biology
University of Saskatchewan
112 Science Place
Saskatoon, SK S7N 5E2, Canada
ph. (306) 966-4451; fax (306) 966-4461
Email: philip.mcloughlin@usask.ca
Lab website: http://mcloughlinlab.ca/lab/

Appendix 1. THREATS ASSESSMENT WORKSHEET

Species or Ecosystem Scientific Name	GRIZZLY BEAR (*Ursus arctos*)			
Overall Threat Impact Calculation Help:			**Level 1 Threat Impact Counts**	
	Threat Impact		**high range**	**low range**
	A	Very High	0	0
	B	High	0	0
	C	Medium	2	0
	D	Low	6	8
Calculated Overall Threat Impact:			High	Medium

Threat		**Impact (calculated)**		**Scope (next 10 Yrs)**	**Severity (10 Yrs or 3 Gen.)**	**Timing**	**Comments**
1	Residential & commercial development	D	Low	Small (1-10%)	Extreme - Serious (31-100%)	High (Continuing)	
1.1	Housing & urban areas	D	Low	Small (1-10%)	Extreme - Serious (31-100%)	High (Continuing)	
1.2	Commercial & industrial areas		Negligible	Negligible (<1%)	Extreme (71-100%)		
1.3	Tourism & recreation areas		Negligible	Small (1-10%)	Negligible (<1%)	High (Continuing)	
2	Agriculture & aquaculture	D	Low	Small (1-10%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
2.1	Annual & perennial non-timber crops	D	Low	Small (1-10%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
2.3	Livestock farming & ranching	D	Low	Small (1-10%)	Extreme (71-100%)	Moderate (Possibly in the short term, < 10 yrs/3 gen)	
3	Energy production & mining	CD	Medium-Low	Restricted - Small (1-30%)	Extreme (71-100%)	High (Continuing)	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
3.1	Oil & gas drilling	CD	Medium-Low	Restricted - Small (1-30%)	Extreme (71-100%)	High (Continuing)	
3.2	Mining & quarrying	D	Low	Restricted - Small 1-30%)	Moderate - Slight (1-30%)	High - Moderate	Individual mines would be expected not to have as significant an impact as energy development, given the relative isolation of the mine sites where hunting is managed and can even attract bears. However, given the plans for mining development in much of northern Grizzly Bear range, the prospect of significant cumulative impacts (involving access and energy needs) is real within the next 10 years.
4	Transportation & service corridors	D	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	
4.1	Roads & railroads	D	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	
4.2	Utility & service lines	D	Low	Small (1-10%)	Moderate (11-30%)	High (Continuing)	
5	Biological resource use	CD	Medium-Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	
5.1	Hunting & collecting terrestrial animals	CD	Medium-Low	Large (31-70%)	Moderate - Slight (1-30%)	High (Continuing)	
5.3	Logging & wood harvesting	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
5.4	Fishing & harvesting aquatic resources	D	Low	Restricted (11-30%)	Moderate (11-30%)	High (Continuing)	Important, given importance of salmon in particular to coastal populations. The threat to Grizzly being evaluated here is salmon declines, which may or may not be because of overharvest. It is not being double-counted elsewhere.
6	Human intrusions & disturbance	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	
6.1	Recreational activities	D	Low	Small (1-10%)	Slight (1-10%)	High (Continuing)	Mountain sports
7	Natural system modifications		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	
7.1	Fire & fire suppression		Negligible	Restricted (11-30%)	Negligible (<1%)	High (Continuing)	
7.2	Dams & water management/use		Negligible	Restricted (11-30%)	Negligible (<1%)	High - Moderate	

Threat		Impact (calculated)		Scope (next 10 Yrs)	Severity (10 Yrs or 3 Gen.)	Timing	Comments
8	Invasive & other problematic species & genes	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	
8.2	Problematic native species	D	Low	Restricted (11-30%)	Slight (1-10%)	High (Continuing)	Forest insect pests (all of which are native species) and Black Bear competitors
9	Pollution						
9.5	Air-borne pollutants		Unknown	Unknown	Unknown	High (Continuing)	Environmental contaminants
11	Climate change & severe weather	D	Low	Restricted - Small (1-30%)	Moderate – Slight (1-30%)	Moderate - Insignificant/Negligible	
11.1	Habitat shifting & alteration		Unknown	Unknown	Unknown	High (Continuing)	Habitat changes as a result of climate change are unknown and could go in both directions depending on geography within range