

Grizzly Bear

Common Name: Grizzly bear

Scientific Name: *Ursus arctos* (Linnaeus)

Species Code: M-URAR

Status: Blue listed (Harper 1996)

1.1.1. Provincial Range

In BC, grizzlies inhabit most of the province except Vancouver Island and the Queen Charlotte Islands, the lower mainland and portions of the south-central interior. Only one subspecies, *U. arctos horribilis*, is recognized in BC (Nagorsen 1990). Grizzly bears on the west coast of BC are not differentiated from the interior species, however they do have different habitat preferences which are directly related to the availability of food.

Banci (1990) identified broad areas where the climate and landforms provided a common influence on grizzly bear behavior, populations, vegetation and land use activities. Although grizzly bears may move considerable distances and can occupy different zones at different times of the year, the coastal grizzly is generally confined to the Temperate Wet Mountains zone (a region primarily contained within the Coast and Mountains Ecoprovince in BC).

1.1.1.1. Elevation Range

Grizzly bears in the coastal regions of BC can be found from sea level to the alpine tundra (from 0 to 3000m).

1.1.1.2. Concentration/Best Region

BC is estimated to have half of Canada's grizzly bear population, or between 6,000 to 7,000. Of the BC population, the highest concentrations are found on the west coast. (BCE 1996a and 1996b).

The highest estimates of grizzly bear density in North America have been recorded in south coastal Alaska: 2.5 km² per bear on Admiralty Island (Schoen and Beier 1990) and 1.4 to 4 km² per bear on Kodiak and Afognak islands (LeFranc et al. 1987); and, from the Flathead Valley of southeast British Columbia: 6.4 km² per bear (McLellan 1989). A habitat capability model for the brown bear in southeast Alaska uses a density of 2.9 km² per bear (Schoen and Beier 1990).

Studies on the coast of BC have determined grizzly bear densities to be as high as 4.7 km² per bear (MacHutchon et al. 1993).

1.1.1.3. Ecosession/Ecoregion

Coastal grizzly bears are found in the following ecosessions of the Coast and Mountains Ecoprovince within BC:

- SPR, EPR, NPR, OUF ecosessions of the Pacific Ranges Ecoregion
- HEL, KIR ecosessions of the Coastal Gap Ecoregion
- NAB ecosession of the Nass Basin Ecoregion
- NAR ecosession of the Nass Ranges Ecoregion
- BOR, ecosession of the North Coastal Mountains Ecoregion

The best habitats are found in the NAR and KIR ecosessions on the mid-coast of BC.

1.1.1.4. Biogeoclimatic Zones (BEC)

Grizzly bears inhabit all subzones of the following biogeoclimatic zones found on the coast of BC:

- Coastal Western Hemlock (CWH);
- Mountain Hemlock (MH);
- Engelmann Spruce Sub-alpine Fir (ESSF); and
- Alpine Tundra (AT).

They are not found in the Coastal Douglas-fir (CDF).

Grizzly bears spend at least 60% of their active period in floodplain and low elevation fan habitats (Hamilton 1987). Evidence collected on the south coast (Lloyd 1979) also indicated heavy use of floodplains. Results of a study in the Khutzeymateen watershed suggest that valley bottom habitats may be even more heavily used in the wetter subzones of the CWH (Nagy and MacHutchon 1991).

1.1.2. Seasonal Habitat Use/Life Cycle:

Descriptions of seasonal feeding/habitat use by coastal grizzly bears has been described by Weaver et al. (1986) (Table 7). Feeding preferences during the growing season in the Khutzeymateen was further described by MacHutchon et al. (1993) (Table 8).

Table 1: Seasons of coastal grizzly bear activity (Weaver et al. 1986).

Season	Start	Definition
1	Early April	Den emergence to valley floor leaf flush to avalanche chute green-up.
2	Late May	Avalanche chute green-up to berry availability
3	Late June	Berry availability to salmon availability.
4	Late August	Salmon availability to den entrance.
5	Early November	Denning

Table 2: Seasons of grizzly bear activity in the Khutzeymateen (MacHutchon et al. 1993).

Season	Definition
1 Spring (P)	Den emergence until berries are the major source of food. During this period, herbaceous plants are the major source of food.
2 Summer (G)	From the end of season 1 until salmon become the major grizzly bear food item. During this period grizzlies eat a variety of berries as well as several different forbs.
3 Late summer/fall (G)	From the end of season 2 until grizzly bears enter winter dens. During this season grizzlies feed primarily on spawning salmon and their spawned out carcasses. In the late fall when salmon become scarce, bears eat a variety of forbs, especially skunk cabbage.

1.1.3. Key Habitat Requirements and Attributes

Grizzlies prefer landforms that produce wet ecosystems, such as floodplains, seeps, avalanche tracks and subalpine meadows. They avoid landforms that produce dry ecosystems, such as dry alpine areas, dry forests, rock bluffs and talus (Luttmerding et al. 1990).

Low elevation south facing slopes which often contain avalanche/riparian/forest complexes provide the best early spring ranges for grizzlies. Dense second growth forest with limited understory vegetation is considered very poor habitat for grizzlies (Simpson 1993).

Grizzly bears using the Khutzeymateen study area spent most of their active period on lower slopes or valley bottoms (Nagy and MacHutchon 1991). These included both non-forested and forested habitats. Forested habitats such as floodplain/old-growth and skunk cabbage/old-growth were consistently preferred in all seasons, as were non-forested wetlands and estuaries. Sidehill old-growth with high moisture and nutrient regimes and diverse, abundant understory was used in all seasons and was preferred for feeding over drier sidehill old-growth (MacHutchon et al. 1993).

1.1.3.1. Reproduction

Grizzly bears are polygamous. Pairing normally occurs only for a short time and is dependent on a male's ability to defend an estrous female against other contenders. Breeding takes place from May to early July, with the peak of activity in early June. The age when successful conception occurs varies between 3.5 and 6.5 years. The average litter size of cub-of-the-year varies from 1.67 to 2.5. Females generally breed and produce cubs every three to four years. During the breeding season bears were observed in all types of terrain, from tussock tundra to talus slopes. (State of Alaska Department of Fish and Game 1986).

The gestation period is between 229 and 266 days (Banfield 1974). One to four cubs, (usually two), are born in the den January to March (BC Environment 1995). At birth the cubs weigh approximately 400 grams and are up to 26 cm in length. The young usually remain with the mother until the age of two.

Breeding occurs along coastal streams or in subalpine meadows (Stevens and Lofts 1988).

1.1.3.2. Feeding

Grizzly bears are omnivores and therefore consume a wide variety of foods throughout the year. They depend heavily on plant foods but are opportunistic and will feed on fish, wildlife and domestic animals when available. Their diet changes seasonally with the relative abundance of various food items. They find areas where food is abundant through wide movements. The feeding habits of the grizzly bear on the west coast of BC can be divided into five main seasons: spring, summer, late summer, fall and late fall (refer to Table 7). Of these seasons late summer, fall and late fall food supplies are the most important as they provide the fat reserves required for overwintering in the den. MacHutchon et al. (1993) identified three seasons of activity of grizzlies in the Kutzeymateen (refer to Table 8).

Availability of food, such as a salmon-spawning stream or other sources of rich protein, can influence local bear densities. Climatic conditions that cause the failure of spring, summer or fall vegetation food sources or an extremely low salmon escapement also appear to influence survival of bears through winter denning and reproductive status the following year (State of Alaska Department of Fish and Game 1986).

Grizzly bears in the Khutzeymateen were observed feeding on the carcasses of black bears, grizzly bears and mountain goats. They were also observed digging for soft-shell clams and consuming various other intertidal animals on mudflats (MacHutchon et al. 1993).

Spring

In the early spring, grizzly bears on the coast feed on the early green vegetation found in the estuaries and seepage sites that become snow-free first. Skunk cabbage (*Lysichiton americanum*) and sedges are the main diet during this period. As the season advances they follow receding snow up the avalanche chutes feeding on emerging vegetation and roots.

MacHutchon et al. (1993) found that sedges were the most frequently eaten food item from late April until early July in the Khutzeymateen study area. Skunk cabbage was eaten throughout the active period, but predominated in the diet during late June and July and again in late September and October.

In southwestern Alaska, newly emerged plant species such as cow parsnip (*Heracleum lanatum* and *H. sphondylium*), sedges (*Carex* spp.), horsetails, hellebore (*Veratrum* spp.), and grasses (*Poaceae* spp.) are widely used in the spring. Lyngby's sedge (*Carex lyngbyaei*) is an important food item in the estuarine areas. Moose calves and scavenged winter kills of moose are also taken at this time depending on availability (State of Alaska Department of Fish and Game 1986). In late spring they eat the emergent green leaves of devil's club found on the floodplains and lower side slopes (Reynolds 1990).

Summer

In the summer, ripe berries in the lower elevations move the bears back down onto the floodplains. During this period, they feed on available berries and the first salmon entering the fish-streams. Coastal grizzly bears require a large amount of fruit to meet their annual forage requirements (Hamilton et al. 1991). Fruit producing shrubs fed on by coastal grizzlies include:

red elderberry (<i>Sambucus racemosa</i>)	Salmonberry (<i>Rubus spectabilis</i>)
red raspberry (<i>Rubus idaeus</i>)	black twinberry (<i>Lonicera involucrata</i>)
thimbleberry (<i>Rubus parviflorus</i>)	red osier dogwood (<i>Cornus sericea</i>)
stink currant (<i>Ribes bracteosum</i>)	Trailing black currant (<i>Ribes laxiflorum</i>)
black raspberry (<i>Rubus leucodermis</i>)	Highbush-cranberry (<i>Viburnum edule</i>)
devil's club (<i>Oplopanax horridus</i>)	Blueberries and huckleberries (<i>Vaccinium</i> spp.)

Most of these shrubs thrive in floodplain and lower sideslope habitats.

Some other food items used during this season include long-awned sedge (*Carex macrochaeta*), the seeds of cow parsnip (*Heracleum sphondylium*), and moose, mountain goat and other bears (State of Alaska Department of Fish and Game 1986).

In addition to the vegetation species previously identified as grizzly bear food, Balfour (1989) listed the following as important forage species for coastal grizzly bears:

kneeling angelica (<i>Angelica genuflexa</i>)	Sweet cicely (<i>Osmorhiza chilensis</i>)
lady fern (<i>Athrium filix-femina</i>)	Bluegrass (<i>Poa</i> spp.)
lupines (<i>Lupinus</i> spp.)	Small-flowered bulrush (<i>Scirpus microcarpus</i>)
Indian hellebore (<i>Veratrum viride</i>)	Twistedstalk (<i>Streptopus</i> spp.)
horsetails (<i>Equisetum</i> spp.)	Sedges (<i>Carex</i> spp.)
Douglas' water hemlock (<i>Cicuta douglasii</i>)	

Late Summer, Fall and Late Fall

In the late summer and fall, with the arrival of anadromous salmonids to the creeks and rivers on the coast, the diet of the grizzly bear changes from that of fruits and herbaceous forage to one which becomes more dependent on salmon. During this period of gorging on salmon, grizzlies will eat large quantities of live and eventually dead salmon. This period of feasting on salmon is extremely important to grizzly bear survival. The fat reserves acquired over this period sustain the bear through the winter (State of Alaska Department of Fish and Game 1986; BC Environment 1995). When the salmon supplies have been depleted, they return to feeding on skunk cabbage and other vegetation until they enter their dens to overwinter.

1.1.3.3. Denning

Denning starts in early November with den emergence in early April (Weaver et al. 1986).

Coastal bears den for 4 to 5 months generally from November to March. Denning occurs in micro-sites with deep soils and adequate snow cover, or in bedrock caves (Luttmerding et al. 1990).

Grizzly bear dens are generally located at high elevations in areas of deep snowfall and relatively low snowmelt. The dens generally consist of a porch (created from the debris of den excavation), entrance tunnel and a den chamber. The bed is often lined with sticks, moss, leaves, and other vegetation. Dens may be located in natural caves, hollows under roots of trees, or they may be excavated into the banks of steep slopes (BCE 1996a).

Dens of coastal grizzlies generally occur in the forested subalpine, often at the CWH/MH transition zone (Stevens and Lofts 1988).

Most dens are excavated although natural cavities are used to some extent when available. Tunnels and chambers are commonly dug under the root systems of trees or shrubs or located beneath boulders or rock strata that provide roof support. Den re-use is rare, although many bears den in the same general area. Terrain slope where

denning has been observed ranges from 0 to 75 degrees, but the majority of dens were between 30 and 45 degrees (State of Alaska Department Fish and Game 1986).

The slopes most favored are leeward of prevailing winter winds. Dens not situated to the leeward of prevailing winds are often found oriented to local topography so that wind eddying provides heavy snow deposition and seals the entrance. Areas where dens commonly occur were characterized by alder-willow thickets and in winter deep snow cover (State of Alaska Department Fish and Game 1986; Simpson 1993).

Grizzly bears prepare dens well in advance of hibernation. Denning dates vary from region to region and from year to year within a region, but initiation of denning usually occurs during late October and November (Reynolds and Hetchel 1980; Nagy and Gunson 1989). Lone females and females with young enter their dens before subadult and adult males (Barrett et al. 1990).

1.1.3.4. Bedding

Hamilton (1987) concluded that floodplain and fan deciduous forests (natural or post-logging in origin) are extremely important bedding and feeding habitats. Habitat selected for bedding is often dictated by weather conditions. During periods of warm weather, grizzlies will dig deep beds in remnant pockets of snow or in cool moist sand, usually under a heavy, shady, shrub cover. In rainy weather, beds will be located in dry areas, often up against the base of a tree. Beds can vary from slight scrapes on the ground to deeply excavated pits (BCE 1996a).

During the summer, coastal bears may cool off in shallow day beds dug in the soft substrates of floodplain seral areas (Stevens and Lofts 1988).

The lower slopes of both types of sidehill old-growth were frequently use for bedding, particularly when adjacent to well-used feeding areas. (MacHutchon et al. 1993).

1.1.3.5. Migration/Movement

Movements of bears are influenced by the juxtaposition or availability of seasonally important food resources or habitat components, breeding activity, reproductive status of individuals, and availability of denning habitat (Reynolds and Hetchel 1980; Nagy and Gunson 1989). Sows with cubs inhabit areas of rugged terrain, presumably for security, while males more frequently occupy valley bottoms and travel on well used trails (Nagy and Gunson 1989).

Subadult females usually establish their home range within or adjacent to the maternal range (Nagy and Gunson 1989). Adult females most likely produce their female replacements, or produce females that stock vacant, adjacent home ranges. Long range dispersals of subadult females have not been reported in the literature (Barrett et al. 1990).

Seasonal density estimates in the Kutzeymateen study area ranged from 4.7 to 14.8 km² per bear (MacHutchon et al. 1993).

1.1.3.6. Home Range

Grizzly bears on the coast have higher populations and smaller home ranges than those of interior grizzlies.

Home ranges vary in size depending on the individual bear and the locality, ranging from less than fifty to hundreds of square kilometers. Coastal bears tend to have smaller home ranges than interior grizzlies, probably because of their richness of diet. Home ranges of males are generally larger than those of females. The lifetime home range of a male grizzly bear can be thousands of square kilometers (BC Environment 1995). Home range estimates for adult female grizzly bears studied in the Kutzeymateen varied from 22.5 to 115.5 km² with a mean of 51.8 km²; and from 56.9 to 220.1 km² for adult males

Grizzly bear densities including young have been estimated for BC on a Management Unit (MU) basis at the 1:600,000 scale using methods described in Fuhr and Demarchi (1990). The estimated densities for the 15 coastal MUs occupied by grizzly bears ranged from 23 to 282 km² per bear with a mean of 75 km² per bear (SD=41.95). Studies in the Kutzeymateen valley estimated seasonal density estimates ranging from 4.7 to 14.8 km² per bear.

1.1.3.7. Cover/Escape

Grizzly bears use a variety of habitat types for feeding, denning, resting, mating, or escape terrain from humans and other male bears (Nagy and Gunson 1989). Optimum habitat includes open areas for feeding with adjacent forest areas for cover (Jonkel 1987).

Grizzly bears rely on cover (forests) rather than terrain for escape habitat (Luttmerding et al. 1990). Forests adjacent to high use feeding habitats are also important for thermal and bedding cover in all seasons (Simpson 1993).

1.1.4. Rating Guide

1.1.4.1. Hierarchy of Critical Factors

- 1) Growing season (late summer, fall, and late fall) feeding
- 2) Early spring (den emergence to late spring) feeding
- 3) Security/thermal cover
- 4) Reproduction/denning/young
- 5) Growing season (summer) feeding
- 6) Bedding

1.1.4.2. Recommended Rating System

A 6-class/2 season rating scheme (1=high; 2=moderately high; 3=moderate; 4=low; 5=very low; 6=nil) was used to rate habitat use by season for grizzly bears within the study area. Ratings were assigned for security/thermal cover (ST), and feeding (FD) during early spring (PE) and the growing (G) seasons. Hibernating (HI) during the winter (W) season was also rated.

These ratings are based on the habitat's potential under optimal conditions to support grizzly bears and reflects grizzly use of the best habitat in the province. The habitat use is evaluated as the expected use and is based on the measure of the number of animals that may use the habitat during a specified time period for a specified area of habitat. For mapping grizzlies at a 1:20,000 scale this will be the number of individuals/day/hectare.

The three seasons which ratings will be applied to are:

- Early spring (den emergence until berries are the major source of food - early April to late May);
- Growing season (berry availability through the salmon spawning season until grizzly bears enter winter dens)
- Winter season (hibernation)

1.1.4.3. Modeling Theme

The area mapped delineates feeding and proximity to mature forest cover (thermal and security cover, denning and bedding areas) during the growing season.

1.1.4.4. Model Assumptions

In preparation of this model for coastal grizzly bears the following assumptions have been made:

- Early spring and fall habitats are considered the most important for grizzly foraging. Spawning salmon streams are critical to the survival of grizzlies on the coast.
- Low elevation south facing slopes which often contain avalanche/riparian/forest complexes provide the best spring range for grizzlies on the coast.
- Most areas on the coast are rich in bear foods therefore the physiological condition of females at the beginning of the denning season is not limiting (i.e. the rate of not implanting embryos is low).
- Present and future impacts from agriculture and ranching are not considered a limiting factor to bear habitat within the Coast and Mountains Ecoprovince (BC Environment 1995).
- Resource based industries such as forestry, fish hatcheries, hydroelectric power, and mining, and the increased access associated with these activities, have direct impacts on grizzly bear habitat in the coastal grizzly bear ecosystems (BC Environment 1995).
- The CWH biogeoclimatic zone contains the most important habitat associations critical to coastal grizzly bear survival.
- The regional field guide (Banner et al. 1993) accurately predicts ecosystem unit characteristics in the study area.

1.1.4.5. Ecosystem Unit Values and Assumptions

The regional field guide (Banner et al. 1993) has been used to predict ecosystem unit characteristics in the study area. The provincial benchmark for grizzly bears is in the NAR and KIR ecosections of the Coast and Mountains ecoprovince.

Ratings were assigned to the ecosystem units within the study area based on habitat attributes and structural stages considered important. Summaries of the important habitat requirements and the attributes measured for grizzly bears in the study area are presented in the following tables.

Table 3: Summary of habitat requirements for grizzly bears in the study area.

Life Requisite	Season	Structural Stage	Requirements
Feeding (FD)	Early spring (PE)	2-3, 6-7	Abundance of early green up vegetation. Skunk cabbage, sedges, horsetails, devil's club, hellebore and grasses are particularly important. Flood plains, valley bottoms and lower snow free side slopes with moist to wet soil moisture regimes and a rich soil nutrient regime support the best spring habitats.
	Growing (G)	3, 6-7	Fruit producing shrub species and herbaceous plants are the main source of food during this season. High use habitats will consist of submesic to hygric sites with a medium to rich soil nutrient regime. Young seral, mature seral and old-growth floodplain habitat units are important feeding sites during the summer season. Later in the growing season bears will congregate at salmon spawning areas. Moist forests with skunk cabbage and berry producing shrubs close to salmon streams are also important feeding areas.
Security/thermal cover (ST)	Early spring (PE)	3, 5-7	Mixed conifer/deciduous mature forest. Shrub cover >50% and canopy closure >66%.
	Growing (G)	6-7	Canopy closure >50% and tree compositions dominated by spruce and hemlock-spruce.

Table 4: Summary of critical grizzly bear habitat requirements measured.

Season/Activity	Measurable Attribute	Habitat Features
Spring feeding (PE_FD)	Herb cover	Percent cover of herbs (see preferred species list)
Summer feeding (G_FD)	Berry abundance	Preferred berry producing shrubs measured as no. of stems and no. of fruit/stem.
	Berry producing quality	Berry producing shrubs below 2.5 m in height
Fall feeding (G_FD)	Salmon spawning stream	Presence of salmon stream in or adjacent to polygon.
Spring thermal cover (PE_TH)	Aspect	South and southwest aspects have lower snow depths and increased outflow wind protection.
	Crown closure	Canopy closure >66% in spruce and spruce/hemlock forest.
	Elevation	Lower elevations will have lower snow levels and higher average temperatures.
Summer/fall thermal cover (G_TH)	Crown closure	Canopy closure >50% in spruce and spruce/hemlock forest.
Security Cover (G_SH)	Distance from mature forest.	Sows with cubs require escape cover from boars within 100 meters of forage areas.
	Shrub cover	Shrubs over 2 meter in height (>50% cover).

1.1.5. Field Sampling Scheme

Methods used to sample habitat attributes important to grizzly bears are outlined in Table 11.

Table 5: Sampling scheme for grizzly bears.

Habitat Attribute	Sample Method
Abundance of grizzly bear food plants	Recorded on ecosystem field form (vegetation data sheet).
Abundance and quality of berries	Recorded in comments on wildlife data form (methodology outlined in Describing Ecosystems in the Field page 119). Methodology developed by T. Hamilton (no. of stems and no. of fruit/stem) will also be employed.

Presence of shrub canopy closure of >50% (security cover)	Recorded on ecosystem field form (vegetation data sheet).
Canopy closure >30% (thermal cover)	Recorded on ecosystem field form (vegetation data sheet).
Evidence of habitat use (scat, diggings, marking)	Recorded on wildlife data sheet.
Presence of dens	Recorded in comments on wildlife data form.
Presence of salmon stream within polygon	Sightings recorded on the wildlife data form. FISS, SISS mapping and DFO/BCE escapement records researched.
Presence of roads and distances from polygons	Recorded in comments on wildlife data form.
Road densities	Recorded in comments on wildlife data form (from FDP maps).

1.1.6. Relative Abundance Studies: Black & Grizzly Bears

In the spring and fall of 1998, fieldwork was conducted in the Upper Kitimat/Davies and Dala watersheds to determine bear use. Helicopter flights were undertaken along the valley bottoms and bear observations and tracks were recorded. The upper limits of salmon spawning within the main river systems (Hoult Creek, Davies Creek, Kitimat River and Dala River) were located.

Overview helicopter flights of the study area combined with ground surveys revealed that suitable black bear and grizzly bear habitat occurs throughout the study area. Summer habitat occurs primarily in the CWH units adjacent to the Kitimat River, Dala River and Davies Creek. Evidence of late summer bear use was significant along the banks of the salmon bearing streams within the study area. Tracks, fecal droppings and sightings of both black and grizzly bears were noted on the sandbars of Davies Creek, the upper Kitimat and Dala River systems extending to the upper limit of salmon passage.

Much of the study area is inaccessible, therefore road densities were not taken into account in the field sampling or data analysis. During helicopter surveys of the study area, four grizzly bears (female and 3 cubs) and numerous black bears were sighted within the study area.

REFERENCES

- Alexander, R.R., and W.D. Sheppard, 1984. Silvicultural characteristics of Engelmann spruce. USDA Forest Service general technical report RM 114. US Dept. of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.
- Amstrup, S.C. and J. Beecham, 1976. Activity patterns of radio collared black bears in Idaho. *Journal of Wildlife Management* 40: 340-348.
- Balfour, P. 1989. Effects of Forest Herbicides on Some Important Wildlife Forage Species. BC Ministry of Forestry, Research Branch, Victoria, BC.

- Banci, V., 1990. The Status of the Grizzly Bear in Canada in 1990. Yukon Government, Dept. of Renewable Resources; Alberta Forestry, Lands and Wildlife Branch, Fish and Wildlife Division; and British Columbia Ministry of Environment, Wildlife Branch, Victoria, BC.
- Banfield, A.W.F., 1974. The Mammals of Canada. University of Toronto Press 438 pp.
- Banks, T., W. Bessie, B. Beck, J. Beck, M. Todd, R. Bonar, and R. Quinlan, 1996. Red Squirrel (*Tamiasciurus hudsonicus*) Winter Food and Cover: Draft Habitat Suitability Index (HSI) Model In: Beck, B et al (eds.), 1996. Habitat suitability index models for 35 wildlife species in the Foothills Model Forest. Draft report. Foothills Model Forest. Hinton, Alberta.
- Banner, A., W. MacKenzie, S. Haeussler, S. Thomson, J. Pojar, and R. Trowbridge, 1993. A Field Guide to Site Identification and Interpretation for the Prince Rupert Forest Region Parts 1 and 2. Land Management Handbook Number 26. Research Branch, BC Ministry of Forests, Victoria, BC.
- Barrett, M.W., J.A. Nagy, A.W. Hawly and J.W. Nolan, 1990. Selection and characteristics of grizzly bear dens in west-central Alberta. Alberta Environmental Centre, Vegreville, Alberta
- BC Environment, 1994. Wildlife Habitat Areas Field Guide: Management Strategies for Specified Wildlife Species. Internal Government Review Draft. Victoria BC.
- BC Environment, 1995. Conservation of grizzly bears in British Columbia: Background report. Ministry of Environment, Lands and Parks, Victoria BC.
- BC Environment, 1996a. Grizzly bear habitat use and diet. From BC Grizzly Page (Internet).
- BC Environment 1996b. Taxonomy and distribution. From BC Grizzly Page (Internet).
- Brink, C., and F.C. Dean, 1966. Spruce seed as a food of red squirrels and flying squirrels in interior Alaska. Journal of Wildlife Management 30(3): 503-512.
- Demarchi, D.A., 1996. An Introduction to the Ecoregions of British Columbia. Wildlife Branch, Ministry of Environment, Lands and Parks, Victoria, British Columbia.
- Demarchi, D.A., L. Bonner, K. Simpson, L. Andrusiak, and M. Lashmar, 1996. Standards for Wildlife Habitat Capability/Suitability Ratings in British Columbia. Review draft. Wildlife Interpretations Subcommittee, Resources Inventory Committee, Victoria, B.C.
- Fancy, S.G., 1980. Nest-tree selection by red squirrels in a boreal forest. Canadian Field Naturalist 94(2):198.

- Fuhr, Brian L. and D.A. Demarchi, 1990. A Methodology for Grizzly Bear Habitat Assessment in British Columbia. B.C. Ministry of Environment, Victoria, B.C.
- Gadd, B., 1995. Handbook of the Canadian Rockies. 2nd Edition. Corax Press. Jasper, Alberta 831 pp.
- Gyug, L. W., 1994. Wildlife use of logging debris piles in clearcuts. Prepared for BC Environment, Penticton, BC.
- Hamilton, A.N., 1987. Classification of coastal grizzly bear habitat for forestry interpretations and the role of food in habitat use by coastal grizzly bears. M.Sc. thesis, University of B.C., Vancouver, B.C.
- Hamilton, A.N., C.A. Bryden and C.J. Clement, 1991. Impacts of Glyphosate Application on Grizzly Bear Forage Production in the Coastal Western Hemlock Zone. FRDA report, ISSN 0835-0752;165. B.C. Ministry of Forests, Victoria, B.C.
- Harper, B., 1996. Red and Blue lists for terrestrial vertebrates. B.C. Ministry of Environment, Lands and Parks, Victoria. Internal memo.
- Hatler, D.F., 1972. Food habits of black bears in interior Alaska. Canadian Field Naturalist 86: 17-31.
- Hatler, D.F., 1967. Some Aspects in the Ecology of Black Bear (*Ursus americanus*) in Interior Alaska. M.Sc. Thesis University of Alaska, College 111pp.
- Interagency Grizzly Bear Committee (IGBC) 1987. Grizzly bear compendium. National Wild. Fed., Washington, D.C. 540 pp.
- Jonkel, Charles J., and I McTaggart Cowan, 1971. The black bear in the spruce-fir forest. Wildlife Monographs 27.
- Jonkel, C., 1978 Black, brown (grizzly) and polar bears. pp. 227-248 in J.L. Schmidt and D.L. Gilbert (eds.) Big Game of North America: Ecology and Management. Stackpole Books 494 pp.
- Jonkel C.J., 1987. Brown bear. In Novak M., J.A. Baker, M.E. Obbard, and B. Malloch (eds.) Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources 1150 pp.
- Knighton, M.D. 1981. Growth response of speckled alder and willow to depth of flooding. Resource Paper NC-198. St. Paul MN: USDA, Forest Service, North Central Forest Experimental Station 6pp.
- Kolenosky, G.B., and S.M. Strathearn, 1987. Black Bear. Pages 443-545 in M. Novak, J.A. Baker, M.E. Obbard and B. Mallock (eds.) Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources. Toronto Ont. 1150 pp.

- LeFranc Jr., M.N., M.B. Moss, K.A. Patnode, and W.C. Sug III. (eds.), 1987. Grizzly bear compendium. Interagency Grizzly Bear Committee, Bozeman, Montana 540p.
- Lindzey, Frederick G., and C. E. Meslow, 1987. Home range and habitat use by black bears in southwestern Washington. *Journal of Wildlife Management*. 41: 413-425.
- Lloyd, K. and S. Fleck, 1977. Some aspects of the Ecology of Black and Grizzly Bears in Southeast British Columbia. Unpublished Report, B.C. Fish and Wildlife Branch., Cranbrook, B.C. 55 pp.
- Lloyd, Kevin, 1979. Aspects of the ecology of the grizzly bear. M.Sc. thesis. University of British Columbia, Vancouver. BC.
- Luttmerding, H.A., D.A. Demarchi, E.C. Lea, D.V. Meidinger, and T. Vold (eds.), 1990. Describing Ecosystems in the Field-Second Edition. MOE Manual 11. Ministry of Environment, Lands and Parks and Ministry of Forests. Victoria, BC.
- MacHutchon, A.G. and B.L. Smith, 1990. Ecology, status and harvest of black bears (*Ursus americanus*) in the Yukon. Yukon Fish and Wildl. Br., Whitehorse. 117pp.
- MacHutchon, A. G., S. Himmer, and C.A. Bryden, 1993. Khutzeymateen Valley Grizzly Bear Study Final Report. Ministry of Environment, Lands, and Parks and Ministry of Forests, Victoria, BC.
- Martin, P. A. 1979. Productivity and taxonomy of the *Vaccinium globulare*, V. membranaceum complex in western Montana. Missoula, MT: University of Montana. 136pp. Thesis.
- McLellan, B.N., 1989. 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.
- Meidinger, D., and J. Pojar (comp). 1991. Ecosystems of British Columbia. BC Ministry of Forests, Victoria, BC.
- Minore, D. 1979. Huckleberry ecology and amangement research in the Pacific Northwest. USDA Forest Forest Service general technical report PNW 93. Dept. of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon
- Modafferi, R.D., 1978. Black bear movements and home range study. Alaska Department of Fish and Game Report 23 pp.
- Nagy J.A., and J.R. Gunson, 1989. Management Plan for Grizzly Bears in Alberta. Forestry Lands and Wildlife, Fish and Wildlife Division, Edmonton, Alberta.
- Nagy, J.A. and A.G. MacHutchon, 1991. Khutzeymateen Valley Grizzly Bear Study annual progress report - Year 1 (1989/90); Annual working plan - Year 2

- (1990/91). B.C. Ministry of Environment Wildlife Working Report No. WR-48 and B.C. Ministry Forests Wildlife Habitat Research Report No. WHR-29. 39p.
- Nagorsen, D., 1990. The mammals of British Columbia: A taxonomic catalogue. Royal British Columbia Museum, Victoria. Memoir No. 4. 140pp.
- Obbard, M.E., 1987. Red Squirrel p264 - 281 in Novak M., J., Baker, M.E. Obbard, and B. Malloch (eds.) Wild Furbearer Management and Conservation in North America. Ontario Trappers Association 1135 pp.
- Pelton, M.R., 1982. Black bear. Pages 504-514 in J.A. Chapman and G.A. Feldhamer (eds.) Wild mammals of North America. John Hopkins University Press., Baltimore 1147 pp.
- Radcliffe, G., B. Bancroft, G. Porter, and C. Cadrin, 1994. Biodiversity of the Prince Rupert Forest Region and Biodiversity and Forest Management in the Prince Rupert Forest Region: A Discussion Paper. BC Ministry of Forests, Victoria. B.C. Resource Inventory Committee, March 31, 1995. Standards for Terrestrial Ecosystems Mapping in British Columbia, Review Draft. Ecosystems Working Group of the Terrestrial Ecosystem Task Force, Victoria, BC
- Reynolds H.V., and J.L. Hetchel, 1980. Big game investigations. Structure, status, reproductive biology, movements, distribution, and habitat utilization of a grizzly bear population. Fed. Aid Wildl. Rest. W-17-11, Job 4.14R, Job Prog. Rep., July 1978 - June 1979. Alaska Department of Fish and Game, Juneau, Alaska 66pp.
- Reynolds H.V., 1990. Population Dynamics of a Hunted Grizzly Bear Population in the North Central Alaska Range. Alaska Department of Fish and Game. Research Progress Report Project W-23-2. 63.
- Rogers, L.L., 1977. Social relationship, movements, and population dynamics of black bears in northeastern Minnesota. Ph.D. thesis, University of Minnesota, Minneapolis. 194 pp.
- Rothwell R., 1979. Nest sites of red squirrels (*Tamiasciurus hudsonicus*) in the Laramie Range of southeastern Wyoming. *Journal of Mammology* 60: 404-405.
- Ruff, R.L., 1982. Dynamics of black bear populations: (low to no human exploitation). Pages 87-103 in F.G. Lindzey, ed. *Procedures Second West Black Bear Workshop*, Logan, Utah 136pp
- Rusch, D.A. and W.G. Reeder, 1978. Population ecology of Alberta red squirrels. *Ecology* 59:400-420.
- Schoen, J. and L. Beier, 1990. Brown bear preferences and brown bear logging and mining relationships in southeast Alaska. Alaska Department of Fish and Game, Fed. Aid. in Wildl. Rest., Research Final Rep. Study 4.17. 90p.

- Servheen, C. 1992 Grizzly Bear Recovery Plan. Second Review Draft. US Fish and Wildlife Service, Missoula, Montana
- Simpson K., 1993. Wildlife Habitat Assessment of the Proposed Volcano Creek Road. Report prepared for Prime Resources Group Inc., Vancouver, B.C.
- Smith, M. C., 1968. Red squirrel responses to spruce cone failure in interior Alaska. *Journal of Wildlife Management* 32(2):305 -317.
- State of Alaska Department of Fish and Game, 1986. Alaska Habitat Management Guide: Life Histories and Habitat Requirements of Fish and Wildlife (ed.). Alaska Department of Fish and Game, Juneau Alaska.
- Stevens, V. and S. Lofts, 1988. Wildlife Habitat Handbooks for the Southern Interior Ecoprovince Vol. 1: Species Notes for Mammals. BC Environment and Ministry of Forests Victoria, BC.
- Stevens, V., 1995. Wildlife Diversity in British Columbia: Distribution and Habitat Use of Amphibians, Reptiles, Birds, and Mammals in Biogeoclimatic Zones. B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks, Victoria, B.C.
- Sullivan, T.P. and R.A. Moses, 1986. Red squirrel populations in natural and managed stands of lodgepole pine. *Journal of Wildlife Management* 50: 595-601.
- Sullivan, T. P., 1987. Red squirrel population dynamics and feeding damage in juvenile stands of lodgepole pine. Ministry of Forests Research Branch, Victoria, BC.
- Unsworth, J.W., J.J. Beecham, and L.R. Irby, 1989. Female black bear habitat use in west-central Idaho. *Journal of Wildlife Management* 53: 668-673.
- USDA Forest Service, 1991. Wildlife and vegetation of unmanaged Douglas-fir forests. Gen. Tech. Rep. PNW-GTR-285, Portland Oregon, 533 pp.
- US Department of the Interior, Fish and Wildlife Service. 1996. Endangered and threatened wildlife and plants. 50 CFR 17.11 & 17.12. Washington, DC (Publisher unknown) 42pp
- Vahle, J.R. and D.R. Patton, 1983. Red squirrel cover requirements in Arizona mixed conifer forests. *Journal of Forestry* 81: 14-15, 22.
- Washington Department of Wildlife. 1994. Species of concern in Washington - state and federal status. Olympia, Washington: Washington Department of Wildlife. 41pp.
- Weaver, J.L., W.R. Archibald, and J.W. Schoen, 1986. Integrated management of timber and coastal grizzly bears. Paper presented at the Habitat Futures Workshop, October 20-24, 1986. Cowichan Lake, BC. Sponsored by BC Ministry of Lands and Forest and US Department of Agriculture Forest Service.

- Young, B.F. and R.L. Ruff, 1982. Population dynamics and movements of black bears in east central Alberta. *Journal of Wildlife Management* 46:845-860.
- Young, B.F., and J. J. Beecham, 1986. Black bear habitat use at Priest Lake, Idaho, In Zager, P., ed. *Bears their biology and management: Proceedings, International conference on bear research and management; February, 1983. Grand Canyon, AZ. International Association for Bear Research and Management: 73-80.*
- Zirul, D.L. and W.A. Fuller, 1971. Winter fluctuations in size of home range of the red squirrel. *Trans. North Amer. Wildlife and Natural Resource Conf.* 35:115-127.