7.0 SPECIES - HABITAT MODEL FOR GRIZZLY BEAR

Common Name:	**Grizzly Bear**
Scientific Name:	*Ursus arctos horribilis*
Species Code:	M-URAR
B.C. Status:	Blue-listed (B.C. MoELP, 1996; B.C. Conservation Data Centre (CDC), 1997)
Identified Wildlife Status:	Yes (B.C. MoELP, 1997)
COSEWIC Status:	Designated as vulnerable in Canada, following a review by Banci (1991) (COSEWIC, 1997).

7.1 Introduction

The information presented in this species-habitat model has been largely extrapolated from other regions as there is little documentation of grizzly bear habitat associations for this part of British Columbia. There have been no specific grizzly bear habitat studies or inventories completed within the Dunedin study area nor in northeastern B.C. (B. Webster, L. Wilkinson, *pers. comms.*). At this time, general habitat ratings for the grizzly bear for the Dunedin study area are predicted to have a low reliability as no model verification has been done. Before more reliable ratings of habitat value can be developed, data is required on the seasonal food habits and habitat selection of grizzly bears in this region.

A grizzly bear study began in May 1998 in Prophet River (to the southeast of the Dunedin study area) and should provide some information on grizzly habitat use in this region (B. Webster, L. Wilkinson, *pers. comms.*).

7.2 Distribution

The traditional range of the grizzly bear throughout most of central and western North America has been dramatically reduced during the last century (Banci, 1991). Presently this species occurs in the western United States (Alaska, Wyoming, Idaho, Montana, and Washington) and in northern and western Canada (Alberta, British Columbia, Northwest Territories, and Yukon Territory) (Lefranc *et al*, 1987).

7.2.1 Provincial Range

Grizzly bears inhabit most of the mainland portion of British Columbia except areas that have been urbanized or intensively farmed or used for ranching (Hamilton, 1989). The latter include the lower mainland, Thompson-Okanagan, Cariboo, and Peace River areas (Fuhr and Demarchi, 1990). The British Columbia population of grizzly bears is estimated at 10,000 to 13,000 bears (B.C. MoELP, 1997; Fuhr and Demarchi, 1990). Fox (1987) estimates that approximately 9,000 or 72% of the provincial grizzly bear population is found throughout the Northern Region: 4,700 in the Skeena, 1,500 in the Omineca, and approximately 2,800 in the Peace sub-region.

The British Columbia grizzly bear population can be described as two distinct ecotypes; coastal and northern interior (Hamilton, 1997). Coastal mountain studies indicate that grizzly bear habitat occurs predominantly below tree line, concentrating on ecosystems associated with important salmon rivers (Banner *et al.*, 1985). The northern interior grizzly bear ecotype occurs where there are no salmon bearing watersheds. These bears use a range of habitat types from forested valleys to alpine and subalpine ecosystems (Banner *et al.*, 1985; Mosquin and Suchal, 1977). An “ecological gap” exists in the Sub-Boreal Interior and Northern Boreal Mountains of British Columbia (Hamilton *et al.*, 1997) and in the Taiga Plains ecoprovince (T. Hamilton, *pers. comm.*) as no studies have examined the habitat use and ecology of grizzly bears in these ecosystems (Hamilton, 1989). At present, a study has just been initiated (Northern Rockies Grizzly Bear Project) to view and understand the ecology and viability of grizzly bears in the Central Rocky Mountains of British Columbia (G. Watts, *pers. comm.*, 1998). Some important findings from coastal studies have been included in this summary, yet the habits of the interior grizzly bear will be the focus of this species account.

On a provincial basis, relative abundance of grizzly bears is rated as moderate over most of the Dunedin study area (1 grizzly per 65 km^2 to 140 km^2) (Fish, Wildlife and Habitat Protection Department, 1994). Grizzlies are found within all of the ecoregions, ecosections, and biogeoclimatic zones found within the Dunedin study area, as summarized in Table 46.

Table 46: Expected Grizzly Bear Occurrence within the 6 Ecosection/BEC Variant Combinations Found within the Dunedin Study Area

Ecoprovinces	**TAIGA PLAINS**		**NORTHERN BOREAL MOUNTAINS**			
Ecoregions	**Muskwa Plateau**		**Northern Canadian Rocky Mountains**			
Ecosections	**MUP**		**MUF**			
BEC Variants	**BWBSmw2**	**BWBSwk3**	**BWBSmw2**	**SWBmk**	**SWBmks**	**AT**
Species						
Grizzly Bear	•	•	•	•	•	•

Legend:
- = occurs in the variant

7.2.2 Elevational Range

Within the study area, grizzly bears are found from the BWBS zone up to the AT zone (approx. 250 m to 2105 m).

7.3 Ecology and Habitat Requirements

The grizzly bear has extensive spatial requirements and uses a diverse range of ecosystem types to meet its life requisites (Hamilton, 1989). As apex predators with conservative reproduction and low resilience to human disturbance (Weaver *et al.,* 1996; Hamilton, 1989), grizzlies are indicators of ecosystem health. The presence of grizzlies indicates that all other trophic levels of the ecosystem are intact (Gibeau *et al.,* 1996; and White *et al.,* 1995). Grizzly bear requirements for large expanses of continuous wilderness containing abundant food make them very susceptible to habitat fragmentation and human encroachment (B.C. MOELP, 1997; Gibeau *et al.,* 1996). Population recovery or resilience is inhibited by a late age of first reproduction, long inter-litter periods, and a low survival rate for cubs (Wielgus, 1986; Miller *et al.,* 1982).

Social interactions between individuals are important factors determining habitat use (B.C. M)ELP, 1997). They are discussed briefly here to further clarify the ecology of the grizzly bear, but they are not included in the ratings tables as they are considered non-habitat features.
Home range size and location is influenced by sex, age, and reproductive status of animals. Size and location of home ranges also vary with population density and habitat quality (Nagy and Gunson, 1990). Adult male grizzly bears are the most mobile of the sex and age groups (Pearson, 1975; Miller *et al.,* 1982), and male home ranges are larger than those of females or sub-adults. Male requirements range from 916 km^2 in Jasper to 24 km^2 in the Karluk Lake area (Lefranc *et al.,* 1987). Male ranges in the northern interior averaged about 287 km^2 (Pearson, 1975), but estimates suggest that home ranges for males in interior ecosystems may range from 1000 km^2 to 2000 km^2 (Gibeau *et al.,* 1996; Russell *et al.,* 1979). Adult females show more fidelity to specific home ranges, and average range sizes for these bears in the Mackenzie Mountains of the Northwest Territories was 265 km^2 (Miller *et al.,* 1982). This range size is larger than that reported by Pearson (1975) who found 86 km^2 in southwestern Yukon and 73 km^2 in northern Yukon for females (Pearson, 1976). Although female ranges do not commonly overlap (excepting between daughter and mother), sub-adult and adult male ranges commonly overlap female ranges.

The sexual segregation among grizzly hears (Weilgus and Bunnell, 1994) forces females to use higher elevations, different aspects, and steeper slopes when males move into female ranges. Compression of male home ranges may indirectly lead to displacement of females from more high quality food sources. It

is suggested that females move into less productive habitat in order to avoid adult males, particularly in the fall when males converge on highly productive berry patches (Weilgus and Bunnell, 1994).

Reproduction rates are low among grizzlies as first age of reproduction ranges from age four upwards, and litter sizes range from one to four (1.4 to 2.5 average) (B.C. MoELP, 1997). Bunnell and Tait (1981) found that litter size was negatively correlated with latitude, and Pearson (1975) suggests that age at first reproduction may vary with latitude and nutritional status. Some studies at more northern latitudes have found relatively larger litter sizes (e.g., Ballard *et al.* (1993) recorded an average litter size of 2.17 cubs per female in north-western Alaska). This higher relative litter size was attributed to an abundance of marine mammal carrion and salmon. Miller *et al.* (1982) found a mean litter size of 1.83 cubs per female in the Mackenzie Mountains, Northwest Territories. Pearson (1975) found a mean of 1.6 young per litter in the Kluane Range.

Cubs remain with the mother from the time of birth in the winter den until they are between 26 to 28 months old (B.C. MoELP, 1997). The average litter interval is three years with a minimum inter-litter period of three years in the Kluane National Park.

7.4 Habitat Use (Life Requisites and Seasons)

Grizzly bear habitat use for the study area is broken into spring, summer, fall, and winter seasons. Life requisites that are rated for the grizzly bear include living, hibernating, feeding, and combined security/thermal, as summarized in Table 47.

Table 47: Summary of Rated Life Requisites and Seasons for Grizzly Bears in the Dunedin Study Area

Rated Life Requisites and Seasons	Code	Months of Use*	Period Covering
Living during the spring season - food Living during the spring season - security/thermal	LI_P_FD LI_P_ST	April to late-May	- Early spring period - Emergence from dens to full leaf flush (season of scarcity - food resources are few and far between, few ecosystems of value and few plants of value)
Living during the summer season - food Living during the summer season - security/thermal	LI_S_FD LI_S_ST	June to mid-August	- Late spring-early summer period - Full leaf flush to berry ripening - Feeding mainly on vegetation
Living during the fall season - food Living during the fall season - security/thermal	LI_F_FD LI_F_ST	Mid-late August to September (until denning)	- Late summer-fall period - First berry ripening to time of denning (season of plenty)
Hibernating	HI	October to late March-April	- General areas of denning - Birth of cubs

*Please note the months of these seasons do not correspond with those suggested for these ecoprovinces in RIC (1998). Rather, they have been modified to more closely reflect the seasonal food habits of the grizzly bear for this region of British Columbia (based upon communication with T. Hamilton, Wildlife Branch, Victoria).

For the species model, differentiation between security and thermal values is not included because security habitat meets most thermal requirements. Rated life requisites are described in detail below. Additional information on reproduction is also included, although this requisite has not been rated. Reproducing (birthing) habitat is assumed to be the same as hibernating habitat as young are born in the winter dens.

7.4.1 Living

Grizzly bears use a variety of habitats in B.C. from coastal estuaries to alpine meadows (RIC, 1997c). In each of these different biomes, the grizzly encounters "grossly varying conditions not only in terms of availability of food but also in terms of denning sites and other physical requirements for its existence and successful reproduction" (Pearson, 1977:35). The grizzly bear requires extensive space (Nietfeld *et al.*, 1985) and uses a diverse range of ecosystem types to meet its life requisites (Hamilton, 1989). As indicated by habitat use, forage patterns follow seasonal food availability. In the early spring, bears follow the phenology of the high-value early herbs and move into the higher elevations with early green-up usually near denning sites. Bears move to lower elevations in the early summer as berries ripen, then gradually move back to higher elevations as the summer progresses using later ripening berries and other foods to put on fat stores required for winter survival.

7.4.2 Feeding

Grizzly bears are omnivorous and have a diverse diet including vegetation, berries, carrion, small and large mammals, fish, and insects. During all seasons, grizzlies will opportunistically take ants, ground squirrels, and young or weak ungulates (Miller *et al.*, 1982). Studies have found that food use varies seasonally (Miller *et al.*, 1982; Pearson, 1975), and season of use varies regionally according to different provincial ecotypes (Fuhr and Demarchi, 1990). Season of use will also vary annually as grizzly food use will follow the phenology of their particular area, and the bears will seek out the highest value food sources according to emergence and maturation of plants (Fuhr and Demarchi, 1990; Miller *et al.*, 1982).

Spring Season

In early spring at den emergence, food is localized and generally scarce. During this time, bears may frequent ungulate wintering grounds feeding on carrion and opportunistically preying on winter-weakened ungulates (Nagy, 1990; Nietfeld *et al.,* 1985). In many areas, hedysarum roots are important in the early spring as are over-wintered berries (crowberries and bearberries), corms of the spring beauty, and corms of glacier lilies (Miller *et al*., 1982; McCrory and Herrero, 1983). As green vegetation emerges, grizzlies will feed on the succulent early growth stages including grasses, horsetails, rushes, and sedges (RIC, 1997c). In late spring, bears will frequent warm aspect avalanche tracks and meadows where the vegetation is first exposed, usually at lower elevations (Gibeau *et al.,* 1996; T. Hamilton, *pers. comm.*; Hamilton, 1989). In Alberta, Kansas and Riddell (1995) found the most important vegetation sites in April are characterised by sub-xeric moisture conditions and coarse-texture soils occurring on south and west facing steep slopes in the lower Montane and lower Subalpine ecosystems. Steep south-facing river slopes with grassy areas are important foraging areas in early spring (T. Hamilton, *pers. comm.*).

Summer Season

Green vegetation (particularly graminoids, horsetails, cow-parsnip, and forbs) form an important part of the late spring and early summer diet. These foods are probably most available in riparian areas and seeps (subhygric and hygric sites) that produce high densities of prime summer vegetation and in run out zones on south facing avalanche chutes (Hamilton, 1989; McCrory and Herrero, 1983). Kansas and Riddell (1995) found that important sites used in May and June occurred on fluvial landforms and alluvial fans on the lower slopes of steep south aspects characterised by aspen and balsam poplar forests, spruce/horsetail forests, and/or wet shrub thickets. On higher elevation avalanche slopes, bears feed on spring beauty, glacier lily, valerian, grasses, and sedges (Eastern Slopes Grizzly Bear Project, 1997; Hamilton, 1989). Grizzly bears will continue to forage on horsetails into late June at lower elevations and will also prey on ungulates on their calving grounds. By about mid-July, soopolallie berries become ripe (Hamilton, 1989) and are thought to be an important early berry food in northeastern B.C. (T. Hamilton, *pers. comm.*).

Fall Season

Berries form a very important component of the bear's diet during late summer and fall. Use of alpine habitat is significantly reduced in late summer and early fall as bears move down into the lower elevations where berry and root production are the highest (Miller *et al.,* 1982). Hamilton (1989) suggests that in the fall bears will be found in a wide diversity of habitats supporting berry and root production. Important fruit producing shrubs include soopolallie, huckleberry (important during August and into September (Hamilton, 1989), high-bush cranberry, Saskatoon, choke cherry, currants, bearberry, and crowberry (Nietfeld *et al.*, 1985).

Grizzly bears were found to depend heavily on soopolallie in Kananaskis Country, Alberta (Wielgus and Bunnell, 1994) to put on fat stores for the winter. Hamilton (1989) found soopolallie to occur in large burns and along active floodplains, and, although these berries were observed in riparian spruce stands, berry production seemed higher in more open canopies. Nine of ten soopolallie sites in the Rocky Mountain front ranges were found in the Montane ecosystem (Kansas and Riddell, 1995). In addition to berries, grizzly bears will return to digging hedysarum roots (common on floodplains) and will feed on ants and wasps (Hamilton, 1989). In years when berry crops fail, bears switch back to green vegetation sites and use of roots intensifies (Pearson, 1975).

7.4.3 Hibernating (Denning)

Denning for pregnant females may begin as early as October 1, while other bears will den in November within the northern interior region of British Columbia (Hamilton, 1989). Grizzlies generally den in higher elevation talus slopes, shrub-fields, krumholtz areas, or timbered subalpine areas with stable, deep, snow packs and relatively slow snow melt (Vroom *et al.,* 1980; Vroom *et al.,* 1977; RIC, 1997c). Dens are often right at the edge of the tree line at the transition to alpine ecosystems (D. Becker, *pers. comm.*). Dens are generally excavated into steep slopes (deeply bedded soils when available that are well drained and cohesive) or they may be in natural caves or hollows under the roots of trees (RIC, 1997c). Often, an initial den site may not be adequate, and bears will try excavating other den sites until a suitable site is found (D. Becker, *pers. comm.*). Den sites are often located on slopes ranging from 25° to 40° with a predominately southeastern orientation (leeward of prevailing winds) (Miller *et al.,* 1982; Nagy, 1990; Pearson, 1975;

Vroom, 1977). Dens in the Banff area generally collapse on an annual basis so are not reusable (Vroom, 1977).

Denning requirements have not been researched for the boreal forest of British Columbia; however, it appears that elevation and adjacency of suitable spring foraging habitats may play a role. Areas of suitable denning may be very restricted within the northern part of the Dunedin study area due to lack of denning sites, which generally comprise high elevation areas on slopes with stable, deep, snow packs (Vroom *et al.*, 1980; Vroom *et al.*, 1977; RIC, 1997c).

No exact den emergence times are available, and grizzly bear emergence may vary annually. Emergence for an adult male in the Mackenzie Mountain area, Northwest Territories, occurred during the first week of May; although females with cubs were not observed until mid-May (Miller *et al.*, 1982). In the Mackenzie area of B.C., Hamilton (1989) suggests that male grizzlies would probably emerge from their dens in early April, females alone or with yearlings and older offspring would probably emerge in late April, and females with cubs would remain in dens until late May. Grizzlies in Banff den sometime in November and emerge about early April (Vroom *et al.*, 1977).

7.4.4 Security Habitat

Understanding of grizzly use of habitat for security is limited, literature references are inconsistent, and no studies have been done specifically testing grizzly reliance on cover in the northern interior ecotype. Nietfeld *et al.* (1985:97) assume that "security cover is most likely not a limiting factor in wilderness areas" with the exception of areas of resource development (dependent upon the amount and type of access – permanent, temporary, or seasonal) such as logging and oil and gas exploration with associated road construction.

Grizzlies use a variety of different cover types for escape cover including vegetation and/or topography having a diameter of at least 91 m and able to hide 90% of a grizzly from view of a person 122 m away (Zager *et al.*, 1980, as cited in Nietfled *et al.*, 1985). Requirements for security cover may vary between hunted versus unhunted populations with open habitats being used more for foraging by the latter while hunted populations may use areas with relatively high cover. Importance of security cover in hunted areas is increased according to Mattson (1993) as cited in Gibeau *et al.* (1996). McLellan (1985) suggests that even if timber is not mapped as grizzly habitat, it should be noted particularly in relation to other selected habitats. Servheen (1981) suggested that bears rely on darkness for cover and will forage and travel under cover of darkness in habitat where security is low. Hamilton (1987) found that bears on the coast (Kimsquit River) preferred to be in cover, possibly to avoid other bears.

Cover use varies with female reproductive status (Lefranc *et al.*, 1987). Females with young often select rugged, isolated habitats and will avoid habitat more commonly used by other conspecifics, particularly males. Pearson (1975) observed sows with cubs to use rock and snow zones as refuge.

7.4.5 Thermal Habitat (Bedding)

Bedding is an important activity throughout the growing season. Grizzly bears will often rest between bouts of feeding particularly to avoid the heat of the day, and daybeds are therefore often in timbered areas near feeding sites. During warmer summer temperatures, bears will often dig beds in patches of remnant snow or in soil under closed canopies provided by forest cover or high shrub.

Thermal cover will be required by bears during warm periods in spring and summer to reduce body temperatures and during periods of heavy rain to remain drier. Methods of cooling include bedding in snow patches and excavated soil beds and bathing in streams and springs. Dry habitat types like older forest patches with closed canopies and rock overhangs will be used to intercept rain (Hamilton, 1989).

7.4.6 Reproduction

Although little information is available on the habitat requirements for mating activities in the northern interior, mating areas in Banff National Park included isolated mountain summits or upper-elevation ridges (Hamer and Herrero, 1990). The copulation period of grizzly bears is from approximately late May until mid-July, and implantation of the fetus is delayed (B.C. MoELP, 1995). In the northern Yukon, Nagy (1990) found the copulation period to be from mid-May to mid-July with the most paired adults observed between late May and late June. The breeding period is from April to June in the Mackenzie Mountains, Northwest Territories, according to Miller *et al.* (1982). Between January and March, cubs are born in the den (B.C. MoELP, 1995). Den characteristics are important to provide favourable conditions for birthing and early survival of cubs.

7.4.7 Seasons of Use

Table 48 summarizes the rated life requisites for grizzly bear for each month of the year.

Table 48: Monthly Rated Life Requisites for Grizzly Bear in the Dunedin Study Area

Month	Season	Rated Life Requisites	Estimated Time Period
January	W	HI	
February	W	HI	
March	W	HI	
April	P	LI-FD, ST or HI	Emerge around April to mid-May
May	P	LI-FD, ST	
June	S	LI-FD, ST	
July	S	LI-FD, ST	
August	S, F	LI-FD, ST	
September	F	LI-FD, ST	
October	F, W	LI-FD, ST or HI	May den as early as October 1 or as late as October 31.
November	W	HI	
December	W	HI	

Legend
W=Winter P=Spring S=Summer F=Fall HI=Hibernating LI=Living FD=Food ST=Security/Thermal

7.5 Habitat Use and Ecosystem Attributes

Table 49 outlines how each rated life requisite relates to specific ecosystem attributes.

Table 49: Terrestrial Ecosystem Mapping (TEM) Relationships for each Life Requisite for Grizzly Bear

Life Requisite	Ecosystem Attribute
Living Habitat (Feeding)	Slope, aspect, elevation, structural stage, % cover of low shrub, herb cover, herb species composition, shrub species composition, soil depth
Living Habitat (Security/Thermal)	% cover trees and shrubs, height of shrubs, microtopography, riparian or water substrate
Hibernation	Availability of secure den sites, elevation, slope, aspect, prevailing winds, bedrock, terrain texture, flooding regime, soil texture and depth, drainage

7.6 Development of the Habitat Ratings

7.6.1 Rating Scheme

A 6-Class rating scheme of high (1), moderately high (2), moderate (3), low (4), very low (5), and nil (6) is employed (as suggested for grizzly bear by RIC, 1998) and requires a substantial knowledge of habitat use (Table 50).

Table 50: Habitat capability and suitability 6-class rating scheme (from RIC, 1998)

% of Provincial Best	Rating	Code
100% - 76%	High	1
75% - 51%	Moderately High	2
50% - 26%	Moderate	3
25% - 6%	Low	4
5% - 1%	Very Low	5
0%	Nil	6

This rating scheme is used when assigning habitat ratings to the ecosystem units present within the Dunedin study area. The habitat ratings express the ability of the units to fulfil habitat requirements for the specific life requisites and seasons rated for the grizzly bear, as previously outlined in Table 47.

7.6.2 Provincial Benchmark

The provincial standard (best in B.C.) for the interior grizzly bear is the BRR ecosection within the Southern Interior Mountains ecoprovince (RIC, 1998). The two ecosections (MUP and MUF) found within the Dunedin study area each have a moderate (26% to 50% of standard) capability compared to the standard (RIC, 1998). Overall, the Dunedin study area is expected to have a moderate capability for grizzly bear.

As a smaller scale reference, the Northeastern British Columbia Biophysical Overview Mapping project has assigned grizzly bear habitat capability ratings for the ecosection/BEC variant combinations found within this region (Table 51) (Habitat Inventory Section, 1994).

Table 51: Ecosection/BEC Variant Combinations for Grizzly Bear
Class values for habitat capability mapping of northeastern B.C.
(Habitat Inventory Section, 1994)

Ecosection	**MUP**		**MUF**		
Variant	**BWBSmw2**	**BWBSwk3**	**BWBSmw2**	**SWBmk**	**AT**
Species					
Grizzly Bear	3	3	2	3	3

Legend
6-class rating scheme: Class 1 - high, Class 2 - moderately high, Class 3 - moderate, Class 4 - low, Class 5 - very low and Class 6 - nil.

The SWBmks was not rated in this study; T. Hamilton speculates that this variant would probably be Class 2 (T. Hamilton, *pers. comm.*).

7.6.3 Ratings Assumptions

Habitat ratings tables for the grizzly bear are presented in Appendix 5. Each combination of ecosystem unit and structural stage was individually assessed for its ability to meet the grizzly bear's seasonal requirements for feeding, security, and hibernation. The expanded legend and field data were used to determine if these combinations provided the necessary ecosystem attributes (as outlined in Table 49) to meet the requirements. The following assumptions have been made:

- Feeding values were assigned on the basis of availability (presence, percent cover) and timing of seasonally important food species as described in the feeding section. In general, structural stage 1 has poor foraging value as it is mainly unvegetated. Stage 2, 3a, and 3b are used throughout the growing season with stage 2 receiving more use in the spring and summer and stage 3a and 3b receiving more use in the summer and fall. Structural stages 6 and 7 are used in early summer through to the fall. Riparian areas and other ecosystems with preferred herbs are rated high in early spring as these areas should provide abundant, new succulent forage. Units with preferred species of herbs are rated highly in the defined summer period, and units with berry-producing shrubs are rated high in the defined fall period. Fire influence will increase berry production.
- Units in the SWBmks and AT have poor foraging values in the spring due to the increased snow depths at these higher elevations. Lower elevations should provide the first available green vegetation; meadows, warm aspect avalanche tracks and slopes where the vegetation is first exposed are very important spring feeding sites, and therefore rated highly, during this season.

- The Tall Jacob's ladder - Bluejoint (JB) unit in all biogeoclimatic zones and the BWBSmw2 Ac - Alder - Horsetail ecosystem unit, "pa" seral association (SH:pa), were given lower food ratings in the spring as they were assumed to have delayed phenology due to spring flooding.
- Understory characteristics including shrub composition, height, and density determine the value of units as security habitat. Units with a very sparse understory generally provide low security cover. Coniferous shrubs provide better visual screening than deciduous shrubs in spring. Larger trees provide better security as will more CWD and structural diversity. Stage 3a units provide moderate security cover if vegetation is tall enough to screen standing grizzlies. Stage 3b forests should generally provide good security cover as will most units with dense shrub understory.
- Security habitat ratings are significantly less important than food ratings throughout the growing season.
- Grizzly bear hibernating requirements are not known within the BWBS biogeoclimatic zone for this area of British Columbia. Grizzlies generally den in higher elevation areas with stable, deep, snow packs and relatively slow snow melt (Vroom *et al.*, 1980; RIC, 1997c) which are not present within this zone. Wet units were given a rating of 6 as they are unlikely to provide suitable denning sites. Mesic units may have some potential for denning, therefore they were given a 4 until more is known about denning requirements.

7.6.4 Rating Adjustment Considerations

Grizzly bear habitat is fragmented by forest harvesting, fire suppression, and increased human development and settlement (B.C. MoELP, 1997). Habitat loss beyond large scale physical loss of habitat was found to include "loss of security, which is being triggered primarily by development, increased human use levels, and a known negative response of grizzly bears to sensory disturbance" in Banff National Park (Gibeau *et al.*, 1996:43). Grizzly bears will avoid using high value habitat near human disturbance, and McLellan and Shackelton (1988) found that even low volumes of traffic on tertiary roads led to displacement of bears. Displacement, habitat loss, and fragmentation are all indirect impacts of development and industry on grizzly bear populations. Direct mortality is attributed to increased hunting pressure (and vehicle collisions) resulting from increased access afforded through road development in the forestry, oil, and gas industries; poaching and illegal trade in body parts; and inadequate garbage management (B.C. MoELP, 1997; Hamilton, 1989). Hamilton (1989:16) states that "access can be viewed as the major impact that resource extraction industries have on wildlife populations".

The different factors affecting grizzly bear populations whether direct mortality resulting from increased human use and access or indirect impacts causing displacement or habitat loss are interactive (Knight and Cole, 1995). There is a cumulative effect of the combined impacts of these factors through time and across the landscape (Weaver *et al.*, 1985). Grizzly bears are known to follow regular travel routes, and any feeding habitats immediately adjacent to their well established trails will have increased value.

Warm aspect units, especially avalanche tracks and meadows, will have increased value in early spring. Habitats adjacent to areas of human disturbance will have decreased value.

7.7 References

Ballard, W. B., L. A. Ayres, D. J. Reed, S. G. Fancy and K. E. Roney. 1993. *Demography of Grizzly Bears in Relation to Hunting and Mining Development in Northwestern Alaska*. US Department of the Interior, National Park Service.

Banci, V. 1991. *The Status of the Grizzly Bear in Canada in 1990.* COSEWIC, Ottawa Ontario.

Banner, A., J. Pojar, R. Trowbridge, and A. Hamilton. 1985. *Grizzly Bear Habitat in the Kimsquit River Valley, Coastal British Columbia: Classification, Description, and Mapping*. Pp 36-49. in Contreras, G.P. and K.E. Evans (eds.*). Proceedings - Grizzly Bear Habitat Symposium*. Intermountain Research Station, Ogden Utah.

B.C. Conservation Data Centre. 1997. *Rare Vertebrate Animal Tracking List (Sorted Phylogenetically Within Each Taxonomic Group).* March 10, 1997.

B.C. Ministry of Environment, Lands and Parks. 1997. Draft. *Managing Identified Wildlife Guidebook*. B.C. Ministry of Environment, Lands and Parks, B.C. Ministry of Forests, Victoria B.C.

B.C. Ministry of Environment, Lands and Parks. 1996. *Vertebrate Red and Blue Lists*. Wildlife Branch, Victoria, B.C.

B.C. Ministry of Environment, Lands and Parks. 1995. *Grizzly bear conservation in British Columbia: A Background Report.* Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, B.C.

Becker, D. Personal communication. 1998. Senior Wildlife Biologist, Madrone Consultants Ltd., Duncan, B.C.

Bunnell, F. L. and D. E. N. Tait. 1981. *Mortality Rates of Bears*. Northwest Territories Wildlife Survey, Yellowknife, Northwest Territories.

COSEWIC. 1997. Can*adian Species at Risk, April 1997*. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario.

Eastern Slopes Grizzly Bear Project General Information. 1997. *The Eating Habits of Grizzlies or Grizzly Cuisine.* Web Address: http://www.canadianrockies.net/Grizzly/diet.htm

Fish, Wildlife and Habitat Protection Department. 1994. *Wildlife Distribution Mapping, Big Game Series*. Ministry of Environment, Lands and Parks, Victoria, B.C. 16 maps, 1:2,000 000.

Fox, R. J. (Ed.) 1987. *The Wildlife of Northern British Columbia: Past Present and Future: Proceedings of a symposium*. Spatsizi Association for Biological Research, Smithers, B.C.

Fuhr, B. and D. A. Demarchi. 1990. *A Methodology for Grizzly Bear Habitat Assessment in British Columbia.* Wildlife Bulletin No. B-67, B.C. Environment, Wildlife Branch, Victoria, B.C.

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*. Committee on Resources and Environment and Faculty of Environmental Design, University of Calgary, Calgary, Alberta.

Habitat Inventory Section. 1994. *Northeastern British Columbia Wildlife Biophysical Project Phase 1 (Overview),* February 1994, Ministry of Environment, Lands and Parks, Wildlife Branch, Habitat Inventory Section, Victoria, B.C.

Hamer, D. and S. Herrero. 1990. *Courtship and Use of Mating Areas by Grizzly Bears in the Front Ranges of Banff National Park, Alberta.* Can. J. Zool. 68: 2695-2697.

Hamilton, T. Personal communication. 1997. Large Carnivore Specialist, Wildlife Branch, Ministry of Environment, Lands and Parks. Victoria, B.C.

Hamilton, T. 1989. *Assessment of Grizzly Bear Ecology in the Ospika Drainage as it Relates to Proposed Timber Harvest*. B.C. Ministry of Environment, Mackenzie, B.C.

Hamilton, T. 1987. *A Study of the Grizzly Bear: Coastal Grizzly Bear Project 1982-1987*. pp:68-81 in*:* Fox, R.J. (Ed.) 1987. *The Wildlife of Northern British Columbia: Past Present and Future: Proceedings of a symposium*. Spatsizi Association for Biological Research, Smithers, B.C.

Hamilton, T., B. McLellan and D. King. 1997. *Integrated Management of Grizzly Bears and Forestry in the Northern Interior if British Columbia*. Website: http://www.res.for.gov.bc.calnews/frbc/proposal/ss_4html.

Kansas, J. and R. Riddell. 1995. *Grizzly Bear Habitat Model for the Four Contiguous Mountain Parks: Second Iteration*. Prepared for Parks Canada, Alberta Region.

Knight, R.L., and D. N. Cole. 1995. *Wildlife responses to recreationists*. pp 51-70. *In*: Knight, R. L. and K. J. Gutzwiller (Eds.) Wildlife and Recreationists: Coexistence Through Management and Research. Island Press, Washington, DC.

Lefranc, M. N. Jr., M. B. Moss, K. A. Patnode, and W. L. Suggell. (eds.). 1987. *Grizzly Bear Compendium*. Sponsored by the Interagency Grizzly Bear Committee. 540pp.

Mattson, D. S. 1993. *Changing Mortality of Yellowstone Grizzly Bears*. International Conference Bear Research and Management 10.

McLellan, B. N. 1985. *Use-availability Analysis and Timber Selection by Grizzly Bears*. pp. 163-166. in: Contreras, G. P. and K. E. Evans (eds.*). Proceedings - Grizzly Bear Habitat Symposium.* Intermountain Research Station, Ogden Utah.

McLellan, B. N. and D. M. Shackelton. 1988. *Grizzly Bears and Resource-Extraction Industiras: Effects of Roads on Behaviour, Habitat Use and Demography*. J. Applied Ecology. 25:451-460.

McCrory, W. and S. Herrero. 1983. *The Capability and Use of Grizzly Bear Habitats in the Kananskis and Spray Lakes Valleys and Areas from Canmore to Mount Allan. 1982*. BIOS Environmental Research and Planning Associated. Calgary, Alberta. 20pp.

Miller, S. D., N. Barichello, and D. Tait. 1982. *The Grizzly Bears of the Mackenzie Mountains, Northwest Territories*. Completion Report no. 3. Northwest Territories Wildlife Service, Yellowknife, Northwest Territories. 118pp.

Mosquin, T. and C. Suchal (eds.). 1977. Proceeding of the Symposium on Canada's Threatened Species and Habitats. Canadian Nature Federation, Ottawa, Canada.

Nagy, J. A. 1990. *Biology and Management of Grizzly Bear on the Yukon North Slope.* Yukon Fish and Wildlife Branch, Whitehorse, Yukon.

Nagy, J. A. and J. R. Gunson. 1990. *Management Plan for Grizzly Bears in Alberta.* Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division. Wildlife Management Planning Series, Number 2.

Nietfeld, M., J. Wilk, K. Woolnough, and B. Hoskin. 1985. *Wildlife Habitat Requirement Summaries for Selected Wildlife Species in Alberta.* Wildlife Resource Inventory Unit. Alberta Forestry, Lands and Wildlife, Fish and Wildlife Division. Edmonton, Alberta.

Pearson, A. M. 1977. *Habitat Management and the Future of Canada's Grizzly Bears*. In*:* Mosquin, T. and C. Suchal (eds.). *Proceeding of the Symposium on Canada's Threatened Species and Habitats*. Canadian Nature Federation, Ottawa, Ontario.

Pearson, A. M. 1976. *Population characteristics of the Arctic Mountain grizzly bear*. Int. Conf. Bear. Res. and Manage. 3:247-259.

Pearson, A. M. 1975. *The Northern Interior Grizzly Bear (Ursus arctos L.).* Canadian Wildlife Service Report, Serial No. 34, Ottawa, Ontario. 86pp.

Resources Inventory Committee. 1998. *British Columbia Wildlife Habitat Rating Standards.* Review Draft, April, 1998. Wildlife Interpretations Subcommittee, Wildlife Branch, Ministry of Environment Lands and Parks, Victoria, B.C.

Resources Inventory Committee. 1997a. *Standards for Wildlife Habitat Capability/suitability Ratings in British Columbia*. Review Draft, May 18, 1997. Wildlife Interpretations Subcommittee, Wildlife Branch, Ministry of Environment Lands and Parks, Victoria, B.C.

Resources Inventory Committee. 1997b. *Procedures for Wildlife Habitat Capability and Suitability Mapping.* Partial Draft, August 1, 1997. Wildlife Interpretations Subcommittee, Wildlife Branch, Ministry of Environment Lands and Parks, Victoria, B.C.

Resources Inventory Committee. 1997c. *Standardized Inventory Methodologies for Components of British Columbia's Biodiversity: Large Terrestrial Carnivores - Black Bears and Grizzly Bears.* Draft. Wildlife Branch, Ministry of Environment, Lands and Parks, Victoria, B.C.

Russell, R. H., J W. Nolan, N. G. Woody and G. H. Anderson. 1979. *A study of the grizzly bear in Jasper National Park, 1975 to 1978*. Can. Wildl. Serv., Edmonton, 136pp.

Servheen, C. 1981. Grizzly bear ecology and management in the Mission Mountains, Montana. Ph.D. Diss. Univ. of Montana, Missoula.

Vroom, G. W., S. Herrero, and R. T. Olgivie. 1980. *The Ecology of Winter Den Sites of Grizzly Bears in Banff National Park, Alberta*. Pages 321-330 in C. J. Martinka and K. L. McArthur (eds.). *Fourth International Conference on Bear Research and Management*. Bear Biology Associations publishers.

Vroom, G. W., S. Herrero, and R. T. Ogilvie. 1977. *The Ecology of Winter Den Sites of Grizzly Bears in Banff National Park, Alberta*. pp 321-330 In: M. R. Pelton, J. W. Lentfer, and G. E. Folk, eds. *Bears - Their Biology and Management*. I.U.C.N. New Series. Morges.

Watts, G. Personal communication. 1998. Wildlife Biologist, Ministry of Environment, Lands and Parks, Fish and Wildlife Branch, Prince George, B.C.

Weaver, J. L., P. C. Paquet, and L. F. Ruggiero. 1996. *Resilience and conservation of large carnivores in the Rocky Mountains*. Cons. Biol. 10:964-947.

Weaver, J., R. Escano, D. Mattson. T. Puchlerz and D. Despain. 1985. *A cumulative effects model for grizzly bear management in the Yellowstone Ecosystem*. pp:234-236 in Contreras, G. P. and K. E. Evans (Eds.) Proceedings-Grizzly Bear Habitat Symposium. Intermountain Research Station, Missoula, MT.

Webster, B. Personal communication. 1998. Senior Wildlife Biologist, Ministry of Environment, Lands and Parks, Fort St. John, B.C.

White, C., D. Gillbridge, M. Scott-Brown, C. Stewart. 1995. *Atlas of the Central Rockies Ecosystem: Towards an ecologically Sustainable Landscape*. A Status Report to the Central Rockies Ecosystem Interagency Liaison Group. Komex International Ltd., Calgary, AB. *49pp.*

Wielgus, R. B. 1986. *Habitat and Ecology of the Grizzly Bear in the Southern Rocky Mountains of Canada.* Masters Thesis, University of Idaho, Moscow, ID. 136pp.

Wielgus, R. B. and F. L. Bunnell. 1994. *Sexual Segregation and Female Grizzly Bear Avoidance of Males*. J. Wildlife Manage. 58(3):404-413.

Wilkinson, L. Personal communication. 1998. Wildlife/Habitat/Inventory Specialist, Ministry of Environment, Lands and Parks, Fort St. John, B.C.

Zager, P., C. Jonkel, and R. Mace. 1980. *Grizzly Bear Habitat Terminology*. BGP Spec. Rpt. No. 41. 10pp.