Ecological relationships between grizzly bears and forest management in the Coast-Interior transition of southern British Columbia

Summary for 2005 Season

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Executive Summary

This project has been designed to evaluate existing grizzly bear/forestry "best management" practices in the coast-interior transition of southern BC through scientific investigation of local grizzly bear ecology. The project will examine several hypotheses related to the impacts of forest practices including forest road access, influence of harvesting and silviculture on forage supply, and bear use of habitats. Objectives will be met through a combination of capture, radio-collaring and monitoring of a representative sample of resident grizzly bears, and the creation of a predictive model of habitat value based on spatially-explicit resource selection functions.

In 2005, five Lotek GPS-Argos collars were placed on 3 female and 2 male grizzly bears in the Cayoosh corridor. Although the satellite-linked collar technology was unstable on grizzly bears, and the collars failed progressively over the summer, a total of 1343 telemetry locations were obtained. Detailed site investigations were then conducted at 53 sites to examine habitat use. Inferences are currently limited given only one year of data, but plans for the 2006 field season include replacing the defective collars with a more reliable and previously tested up-loadable GPS version and adding 6 more collared bears into the study in a second location. Project results will be used to revise forest management practices and create habitat restoration plans where applicable.

Issue

Effective management of grizzly bears requires accurate information on their density and distribution, habitat use, and population trends. However, this baseline ecological information is lacking for bears in the transition zone between coastal and interior habitats. Grizzly bears are rare in the study area. Increasing the knowledge and information available on grizzly bear populations and habitats is key to creating better resource management decisions for all forest resource users and residents, including the St'at'imc Nation. Because forest harvesting activities can greatly alter habitat availability, it is critical to gain an understanding of how current practices,including roads, timber harvesting, silviculture and range management practices, are impacting bear habitat. However, it is also important to understand how the hydro-electric generation facilities influence current and historic bear habitat availability and movements. All of these factors can be addressed through telemetry studies on the bear population.

The information derived from this research project will improve sustainable forest management by: (1) collecting detailed information on the ecology of grizzly bears in the coast/interior transition zone, (2) using that information to objectively evaluate, and where needed revise, the current "best management" practices for forest planners and practitioners, and (3) identify critical bear habitat for the development of restoration and conservation strategies, including provincial Recovery Plans for the Stein-Nahatalatch, South Chilcotin and Squamish-Lillooet Grizzly Bear Population Units, and the St'at'imc Land Use Plan (Nxekmenlhkálha Iti tmícwa) grizzly bear protected areas. Full project objectives are provided in Appendix 1.

Study Area

The study area is within the St'at'imc Nation territory and falls within the Lillooet Timber Supply Area (TSA) of the Cascades Forest District. The habitats represent a coastal to interior transition and vary from very dry Interior Douglas Fir Valley Bottoms (e.g. IDFdk2) through the higher elevation montane and subalpine Englemann Spruce Subalpine Fir forests and parkland areas (e.g. ESSFdk2) to the alpine tundra of the mountain tops. Wetter habitats include productive, non-forested wetlands in the west half of the area and avalanche chutes at higher elevations. The extreme topographic and climatic diversity of the area contribute to its productivity for grizzly bears. Spring captures for grizzly bear collaring were focused exclusively in the Cayoosh Corridor and targeted to the Stein-Nahatlatch bear population unit.

Progress in 2005

Collars

In 2005, six Lotek GPS grizzly bear collars were upgraded to GPS- Argos satellite linked technology. These collars had redundant systems to ensure that collared bears could be relocated including a conventional VHF beacon, a GPS beacon/data chip that could be downloaded from the air, and an Argos satellite link system. Through Service Argos, the satellite system automatically tries to locate the collar every 4 to 6 hours. The cumulative results of these attempts were then e-mailed directly to researchers every 96 hours. This new technology was expected to minimize the need for aircraft in monitoring the collared bears and to increase the security of the data by providing regular updates.

Spring Capture

Because the ground-based capture approach used in 2004 was unsuccessful in the study area, a shift to helicopter-supported trapping and aerial darting was made. The first capture session was held from May 9-16th, 2005. Four grizzly bears were collared, all darted directly from the helicopter (Bighorn Helicopters, Hughes 500D aircraft). These included an adult female with two, two-years-old cubs (GF-01), a second adult female with two cubs of the year (GF-02), a subadult female (GF-03) and an adult male (GM-01). One additional adult female with yearlings was sighted during this session, but was not captured because she was in a heavily forested area. No other grizzly bears were seen. The second capture session was held from May 23-26$^{th.}$ During this session a second adult male (GM-02) was darted from the helicopter and then collared. Although twelve ground-based trap sites were established in excellent bear habitat within the study area, no grizzlies were trapped in the spring for a second year in a row. Ground-based spring trapping is ineffective in this area. Capture efforts were suspended at the end of May because the budget for collaring was spent and each of the three grizzlies seen while searching the study area during the second session had been collared in the first session.

Summer Monitoring

Initially all 5 GPS-satellite linked collars functioned properly. Data from each collar was e-mailed directly to the researchers on a pre-set schedule through the satellite linked transmission services provided by Service Argos. This data was converted, cleaned, sorted, and had duplicates removed to provide a usable data set that was then loaded onto hand-held GPS units for the field crew.

Unfortunately, the collars began failing in June, with the last successful transmission for male GM-01's collar on June 12th and GM-02's on June 19th (Table 1). Similarly, GF-01's collar appeared to fail August 29th and GF-03's collar by Sept 19th. Transmissions from GF-02's collar were received until Oct 12th, and suggests she had entered a den, rather than collar failure. Collars varied in their success rates and the lower success rate for the male bears' collars may reflect selection of habitats with greater tree cover in the spring.

TABLE 1: Number of locations and success of collars. Success refers to the percent of possible locations obtained during the functional period of the collars, not including the time after GPS failure.

	GF-01	**GF-02**	**GF-03**	**GM-01**	**GM-02**
Locations	293	516	443	48	43
Success	44%	56%	53%	28%	27%

Despite the technological problems encountered, 1343 telemetry locations were obtained during the field season. It was not possible to investigate every location obtained on the bears due to budget and time constraints. Therefore, priorities were given to clusters of locations, indicating an area of substantial use, and then to areas which had not yet be sampled to provide a better representation of habitats used by bears. Data collection protocols and forms are provided in Appendix 1.

A total of 53 site investigations were conducted in the Cayoosh corridor spanning most of the area used by the three collared female grizzlies between August and October, 2005. Due to the sequential clusters of many locations and that bears often returned to the same sites weeks later, site investigations could often be expanded to account for the microsite and bear-use features of more than one location. Table 2 describes the number of telemetry locations accounted for by site investigations where the telemetry location was within 100m of the plot centre and the bear's behaviour noted at this location was the same as that described in the site investigation. In Table 3, only locations less than two weeks old with associated site evidence that matched the appropriate time period are documented. An exception were 12 locations of GF-02 where we are certain that she was digging *Claytonia* bulbs and access was so poor that more timely investigation was not possible.

Table 2: Site investigations completed by bear and month of activity.

	August	September	October	TOTAL
GF-01	8	3	0	11
GF-02	4*	13	4	21
GF-03	9	12	0	21
TOTAL	21	28	4	53

* Bear location/date is assumed to be August for plot 0501

Table 3: Locations accounted for by site investigations.

	August	September	October	TOTAL
F1	21	3	0	24
F2	10*	36**	7	53
F3	12	16	0	28
TOTAL	43	55	7	105**

* Bear location/date is assumed to be August for plot 0501

** 12 locations between 14 and 30 days old.

The habitat types used by the three females are shown in Figure 2. Habitat selection was not consistent among the female bears. GF-01's home range includes extensive recent logging and, with the exception of one location for GF-03, GF-01 was the only bear to use regenerating clear cuts. She fed extensively on *Vaccinium mebranaceum* berries in low elevation 5-10 year old clearcuts (Figure 3). Although GF-01's collar malfunctioned in late August, she was successfully relocated with VHF radio telemetry several times. She fed on berries for much of September and continued to use areas with regenerating cut blocks. GF-01 either killed or scavenged an adult Mountain Goat in late September and used a subalpine meadow area when feeding on this carcass. She bedded in old growth forest.

GF-02 and GF-03 primarily used high elevation areas including parkland forest, alpine tundra and avalanche slopes (Figure 2). Most of the bear use of riparian areas represented in Figure 2 is high elevation open valley bottom where GF-02 was digging for *Claytonia* bulbs. GF-03 regularly fed on high elevation *Vaccinium ceaspetosum* which was generally highly productive throughout the eastern part of the study area. Both GF-02 and GF-03 regularly dug for Hoary marmots, particularly after the first snow falls. Fifteen sites where the bears were bedding were investigated, three of which were associated with feeding on carrion. The bears preferred to use sites with some cover when available (Table 4). In areas where the bears were in open habitats such as alpine parkland or avalanche chutes feeding on berries, bulbs or marmots they bedded in the adjacent forest. Some beds in the alpine were not associated with forest cover**.**

Figure 2: The number of telemetry locations represented by plots in the various bear habitat types

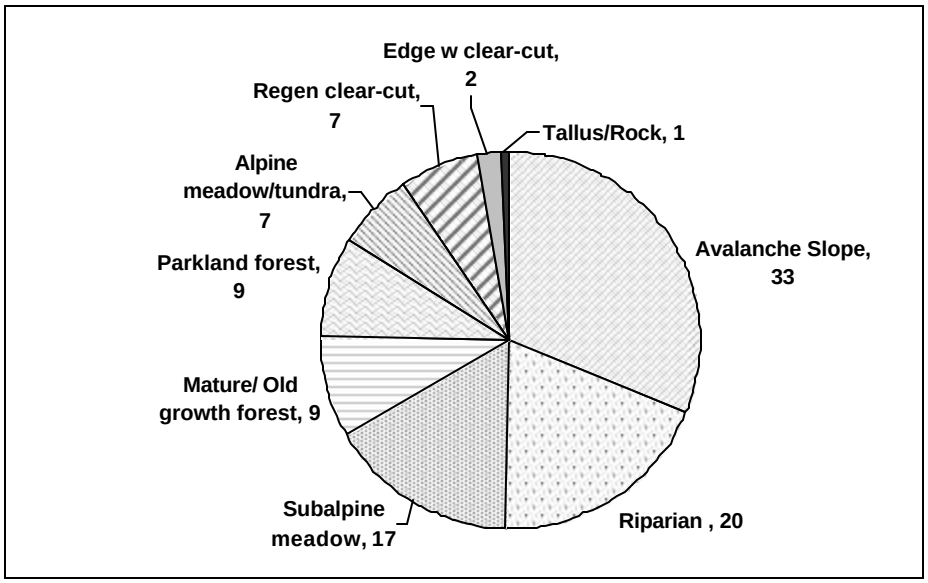

Figure 3: The number of locations represented by site investigation a) Bear Activity b) Species excavated while digging.

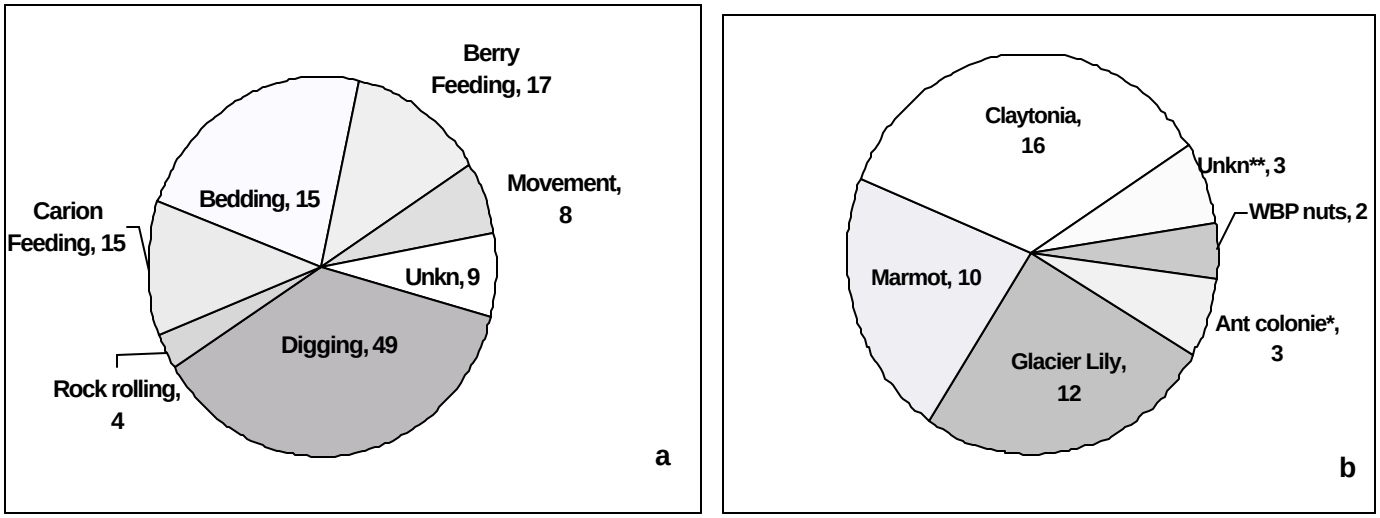

Table 4: Overhead cover for bed locations

Number of Beds	Percent Cover
7	>75%
5	25%-50%
2	<10%
3	0%

Collared Bears on the DNA Grid

As a result of the spring captures, 5 collared bears were on the DNA sample grid established by the companion project "Grizzly Bear Population Density and Distribution in the Southern Coast Ranges" lead by Clayton Apps. Four of the five collared bears were detected by the DNA grid system, the exception being GF-02. Only GM-01 was detected north of Hwy 99. This information will help researchers to better understand the successes and limitations of the DNA grid approach. Plans to have collared bears on a DNA grid system in a second study area are underway for 2006.

Further Habitat Analysis

To create better resource management practices that support the grizzly bear population in the coastal-interior transition zone, an understanding of grizzly bear habitat and food use in relation to the habitats and foods available needs to be developed. Initial computer mapping (GIS) support for the research has been provided by the Integrated Land Management Bureau (ILMB) under their Lillooet Land and Resources Management Planning (LRMP) Implementation funding. ILMB GIS staff have gathered all relevant map layers including roads, forest cover, a digital elevation model, and the current Predictive Ecosystem Mapping (PEM) and have conducted some simple "test" analyses using initial collared bear location data. Plans to update both the forest cover and road map layers for recent forest harvesting activities have also been proposed. The preliminary interpretation of the existing PEM map will be examined in relation to the 2005 collared bear locations. Our goal, ultimately, is to describe and predict grizzly bear distribution based on meaningful variation among habitat variables at different scales.

Plans for the 2006 Season

The first priority for the 2006 field season will be to replace the malfunctioning collars on all previously collared bears if their VHF beacons are working and they can be located and immobilized safely. Collars purchased for this purpose have been downgraded to a combination of a conventional VHF beacon and a GPS beacon/data chip that can be downloaded from an aircraft. The decision to step back from the satellite link technology for 2006 was made due to the high cost of these collars and the limited return of data experienced in 2005. The second priority will be to establish a second study area to the north west of the Cayoosh area to expand the habitat representation being considered.

Experience has shown that helicopter-based captures are necessary in this study area. Therefore, as during the 2005 capturing sessions, bears seen in suitable locations in May will be immobilized from the helicopter. Captured bears will be immobilized and processed using methods that meet standards of the Canadian Council of Animal Care. All collared animals will be located from a fixed wing aircraft approximately once each week from the date of capture to the 30th of November or until they hibernate. GPS location data will be downloaded from these collars when desired. In addition to aerial locations, focal animals will be located from the ground when in areas of intense human activity (recreation, settlement, active forestry, transportation corridors) or in or near cut blocks. Site investigations will be conducted according to the protocols identified and revised during the 2005 field season (Appendix 2).

Habitat selection will be analyzed using spatially explicit resource selection functions following methods currently established in the scientific literature. This will involve the incorporation of available vegetative (PEM), LANDSAT-derived terrain, and human use variables over several spatial scales and multivariate analysis to describe and predict grizzly bear distribution.

To gain an understanding of grizzly bear carrying capacity and to set useful recovery targets, an assessment of the pre-dam habitat available for grizzly bears will also be undertaken in 2006. This assessment will utilize existing information on habitats (i.e. through pre-dam photographs), salmon escapements, bear numbers (i.e. hunting & population records), and historic forest cover. Capability, suitability and effectiveness of habitat will be compared pre and post hydro-electric dam development.

Extension and Communications

Our extension plan is comprehensive with four general clients groups: 1) operational forest managers and planners, 2) the executive of provincial government 3) interested resource user groups and the public, and, eventually 4) the international scientific and conservation community.

The diversity of the project steering committee ensures that day-to-day interactions with government executives, operational staff, licensees, First Nations, municipal government, the general public, and resource users continue to occur and continue to bring grizzly bear management issues to the forefront of planning decisions. Fundamental to our extension plan is that this is a community based research and extension program. The Project Coordinator and Lillooet Tribal Council both ensure that the results are provided to the local community members by maintaining a visible public link to the project and by continuing the pattern of public involvement established through previous projects. Information continues to be provided to the public through local newspaper updates, advertisement of workshops, and summary reports. Three public presentations were provided in 2005 including presentations to the Sustainable Forest Management Public Advisory Committee for Ainsworth's Sustainable Forest Management Plan, to the Lillooet TSA Association which includes major forest licensees and a First Nations representative-Liaison, and to the Annual General Meeting of the Federation of the BC Naturalists held in Lillooet. These presentations focused on objectives, methods, results to date and plans for the future.

Project Monitoring

To meet the project objectives listed specifically in Appendix 1, this project will identify grizzly bear critical habitat and movement behaviors that are necessary for the development of effective, science-based habitat restoration and conservation strategies. Efforts to involve the community are ongoing through continued sighting record collection, outreach, and regular updates.

Success will be measured by the number of radio collared bears captured, the application of research results to grizzly bear conservation and management in the Lillooet area and similar ecosystems, and the passage of products from this work through peer-review publication. The ultimate measure of success will be the recovery of grizzly bear populations in the area for the enjoyment and use of all British Columbians.

Funding Support

This project has received funding from the following organizations and agencies (Table 5):

- Provincial Government of British Columbia
- BC Hydro Fish & Wildlife Bridge Coastal Restoration Program (BCRP)
- Lillooet Timber Supply Area Association (TSA Assoc)
- Habitat Conservation Trust Fund (HCTF)
- Fraser Basin Council (FBC)

Table 5: Summary of funding allocations.

Funding Source	2005/06 Allocations	2006/07 – Funding requests
FBC	(carryover) $4,500	(carryover) $4,500
HCTF	($19,000 carryover; $10, 000 new) $29,000	$40,000
BCRP	(carryover) $22,000	$115,000
Provincial funding	$60,000	$60,000
TSA Assoc	$10,000	$20,000
FII	Rejected again	No application
Total:	$125,500	$239,500

In-kind contributions were generously provided by the following:
Upper St'at'imc Language, Cultural, and Education Society
Lillooet Tribal Council
Bridge River Lillooet News
Lillooet Conservation Officer Service
Buy Low Foods

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Appendix 1 : Project Objectives

Objective 1:

The primary objective is to provide an empirical basis for evaluating current grizzly bear/forestry guidelines. This necessitates the identification of critical bear habitats and movement behaviors that are also of interest to the restoration activities related to the hydro-electric facilities in the Lillooet area. The data will enhance the quality of resource decisions related to grizzly bears and will empower decision-makers to employ practical adaptive management approaches (e.g. by applying and monitoring special silvicultural practices to maintain grizzly bear forage supply at a landscape level). The end result will be greater certainty in planning and decision making for results-based forest management, and healthier grizzly bear populations.

Objective 2:

The project will promote more effective and efficient use of forest resources by ensuring that timber netdowns for grizzly bear habitat are applied only where necessary to meet population-wide or site-specific objectives. In fact, this objective evaluation of current access restrictions and timber netdowns has the potential to increase available timber volume.

Objective 3:

The project will improve forest practices as they pertain to grizzly bear conservation, thus potentially increasing market acceptability and market share through provision of a successful model of multiple-use. The planning, management, and monitoring of sustainable forest practices will be improved through empirical information specific to current best management practices and appropriate population and habitat targets that will be monitored. This will enable certification by demonstrating sound species conservation and science-based management practices in a sustainable, adaptive management framework.

Objective 4:

Although the project is centred in the Lillooet area, inferences and products will have broader utility throughout the coastal-interior transition in southern BC. Results will be made available to a wide range of users through continued multi-stakeholder involvement in project oversight, and development of products directed by a comprehensive extension plan that includes guidelines, public presentations and peer-reviewed publication.

Appendix 2: 2005 Data Collection

Data collection protocols

Five grizzly bears, two adult males, two adult females, and one subadult female were collared with GPS/Argos upload collars. These collars were programmed record six telemetry locations per day and then upload the locations via Argos satellites every four days. These locations were then e-mailed to the field crew who processed and mapped the locations for each bear individually.

It was not possible to investigate all locations that the GPS collars provided therefore we developed a protocol fro prioritizing location for investigations. Our priorities were to minimize possible sampling bias while considering efficiency and ensuring that heavy use areas were investigated. Maps of bear locations revealed an uneven distribution of locations. Some locations were isolated, while many were in clusters. We used clusters of locations as the top priority for site investigation. After clusters of locations, we focused on areas where we had not previously sampled. This protocol sometimes resulted in sacrificing more investigations in relatively accessible areas for fewer investigations in less heavily sampled areas that were often more difficult to access. In general, the time required to conduct a site investigation was about $1/10^{th}$ the time it took to access a site therefore we would often conduct multiple site investigations in one part of a drainage. Multiple sites were investigated either if the microsite was different or the bear showed sign of using the area for a variety of activities.

The microsite where the site investigation was conducted was selected by finding the exact telemetry location by GPS then searching the surrounding area for bear sign. We would move the centre up to 35m from a '3D' location and 70m from a '2D' location to bear sign that matched the age of the location and represented feeding or bedding behaviour. These distances are based on an estimation of twice the average error in obtaining a GPS telemetry location.

A 20x20 meter square plot was centred on the bear sign. The site information was collected on the forms in Appendix 1. BEC Zone/Subzone/Variant and site series were determined according to the 1990 version of the Kamloops Region Site Identification and Interpretation Guide and the 2004 Lillooet TSA Predictive Ecosystem Mapping Final Report. Vegetation cover and description was described by the protocols outlined in the 1998 Land Management Handbook # 25. Circular plots were conducted over either a $100m^2$ or $200m^2$ area in which all trees over 2m tall were counted and measured for 'diameter at breast height' (1.3m) and general vigour was assessed. Canopy cover was visually estimated on site and a digital photo was taken directly upward from the centre of the plot at 1m height. The photo was later overlaid with a 10x10 grid to estimate the canopy cover over the plot centre.

2005 Data Collection Forms

LOCATION DESCRIPTION

Plot ID:
Location ID:
Lat:
Long:
Plot Size:

Date:
Recorders:

SITE DESCRIPTION

Ecosection (GIS):
Zone/Subzone/Varient (GIS):

Elevation (m):
Slope (%):
Aspect (°):

Site Series:
Logging History:
Structural Stage:
Bear Habitat Type:
Canopy Closure (%): **Visual:** **Photo#:**

Percent Cover (%)
Tall Shrub (2-10m):
Low Shrub (<2m):
Herb :
Moss/Lichcen:

Cover Value (m)	**Cover Provided by**
N	
E	
S	
W	

BEAR USE DESCRIPTION

Bear Activity(s):
Verification of Use:
Food Species Eaten:

Distance to Opening (m):
Distance to Security Cover (m):
Bed Size (LxWxH)
Mark Tree Species
Mark Tree DBH (cm)
Mark Trail Length (m)

Sample Number:
Hair:
Scat:
Other:

Photo #s:

Comments/Diagram:

2005

Plot ID:	
Location ID:	
Date:	

Vegetation						
Species	**cov**	**dist**	**veg**	**gen**	**ste**	**abn**
(Bear Food)						

(Other)		
Grass/Sedge		
Moss		
Rock		
Bare/Dirt		

Prism #	
Species	**Number**

Circular Plot size:		
Species	**Vig.**	**DBH cm**
Stocking (sph):		

- cov = %cover, dist = distribution #, veg = vegetative #, gen = generative #, ste = % stems with berries, abn = abundance of berries (low, med, high)
- 1=Alive 2=Declining 3=Tight bark snag 4=Loose bark snag 5=Broken top snag

2006 Data Collection – Proposed Forms

LOCATION DESCRIPTION

Plot ID:
Location ID:
UTM:
Plot Size:

Date:
Recorders:

SITE DESCRIPTION

Elevation (m):
Slope (%):
Aspect (°):

Ecosection (GIS):
Zone/Subzone/Varient (GIS):

Site Series:
Logging History:
Structural Stage:
Bear Habitat Type:
Canopy Closure (%):
Visual: **Photo#:**

Percent Cover (%)
Tree (>10m):
Tall Shrub (2-10m):
Low Shrub (<2m):
Herb :
Grass:
Moss/Lichen:
CWD:

Cover Value (m)	**Cover Provided by**
N	
E	
S	
W	

BEAR USE DESCRIPTION

Bear Activity(s):
Food Species Eaten:
Other Mammals activity:

Distance to Opening (m):
Distance to Security Cover (m):
Bed Size 1 (LxWxH):
Bed Size 2 (LxWxH):
Dig Area (LxWxH):
Mark Tree Sp/DBH:

Presence/Sample Number:
Hair:
Scat:
Other:
Photo #s:

Comments/Diagram:

2006

Plot ID:	
Location ID:	
Date:	

Vegetation

Species	cov	dist	veg	gen	ste	abn
(Bear Food)						

TREES		
SHRUBS		
FORBS		
Other Forbs		
ROCK		
DIRT (no dig)		

Prism #

Species	Number

Circular Plot size:

Species	Vig.	DBH cm

Stocking (sph):

- cov = %cover, dist = distribution #, veg = vegetative #, gen = generative #, ste = % stems with berries, abn = abundance of berries (low, med, high)
- Vigour: 1=Alive 2=Declining 3=Tight bark snag 4=Loose bark snag 5=Broken top snag