GRIZZLY BEAR POPULATION

TREND MONITORING DESIGN USING DNA METHODS

FOR THE

QUESNEL HIGHLANDS (TFL 52) PROJECT

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Submitted to:

The Ministry of Water, Land and Air Protection
and
The Ministry of Sustainable Resource Management
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Submitted by

Stefan Himmer
Arctos Wildlife Services
PO Box 562
Hagensborg, British Columbia, VOT 1HO
Shimmer@laketown.net

John Boulanger
Integrated Ecological Research
924 Innes Street
Nelson, British Columbia, V1L 5T2
Boulange@ecological.bc.ca
www.ecological.bc.ca

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1. INTRODUCTION

1.1. Objectives

The main objective of this document is to outline optimal population monitoring design strategies for the Quesnel Highlands (TFL 52) Grizzly Bear DNA project. The first part of this document summarizes a field reconnaissance survey to determine the potential of fall DNA sampling in the TFL52 project area. The second section introduces and reviews mark-recapture methods and discusses optimal design strategies. The third section presents a workplan for spring sampling for the TFL 52 project.

Grizzly bear management objectives for the TFL52 project area are to:

1. Establish baseline grizzly bear population data which can be used for population monitoring in the long term, to ensure that proposed land development, forest harvesting and access will not have negative impacts on grizzly bears in the area.

2. Develop population objectives. Once a precise population trend is determined, this information will be used by the wildlife branch for management purposes.

1.2. Background

Grizzly Bears are a blue-listed species and are identified wildlife under the Forest Practices Code. Historically over the past 500 years their range has diminished by half in North America. Baseline data on grizzly population size, trend and distribution are non-existent in the Quesnel Highlands area. It is a provincial and regional priority to monitor grizzly bear population trends in order to implement conservation and management measures, which will ensure the historic pattern of habitat loss, does not continue. This year a consultant was contracted through FRBC funding to recommend, in consultation with Ministry staff, the best methods of proceeding with this project. The area of study is the result of a balance between sampling the entire population unit, which would be excessively expensive, and concentrating on an area which has high and increasing pressure from multiple resource users, and is believed to include enough habitat to enable sufficient sample opportunities. This report outlines what is required to ensue a five-year monitoring design across the study area beginning in the spring of 2002. It entails three years of intense systematic hair collection using baited barbed wire sites placed within each cell of a grid across the area. Following successful completion of this level of sampling, a preliminary trend would be established and two more years of sampling at a lower intensity would ensue to determine a precise population trend. A dataset containing “DNA fingerprints” of individual grizzly bears would be established which could be used for future monitoring.

Grizzly bear populations and habitat in the Quesnel Highlands are under increased pressure due to conflicting natural resource use by an increasing human population. Regionally, this area is among the highest priority to study due to relatively high and diverse resource use. Commercial timber harvesting has been occurring in this general area for many years. Mining has been active intermittently since before the turn of the century. The study area is in relatively close proximity to numerous communities and has high recreation use including both motorized and non-motorized backcountry recreation. Resource use must be managed in a way that allows for grizzly populations to be sustained through time. It is vital to monitor the population and collect baseline data in order to determine higher-level plan population objectives. Provincially, this project supports the grizzly bear strategy by contributing to the effort of completing a province-wide inventory of the species. There is concern that proposed land development, forest harvesting and access will have an impact on grizzly bears in the area if planning does not account for maintaining a stable population.

1.3. Summary of project

Traditionally, mark–recapture estimates of bear population abundance have required that bears be captured so they could be physically marked in some way (Manning et al. 1994). Recent developments in DNA fingerprinting techniques now allow use of a bear's DNA identification as the mark. Both mitochondrial DNA (mtDNA) and nuclear DNA can be extracted from hair follicles. As a result, DNA samples can be obtained by 'capturing' some hair. The main benefit of the DNA mark–recapture technique is that bears do not have to be captured to be marked, therefore, the bears are not handled or disturbed and the cost of doing population estimates is reduced.

A major objective of this report is to establish a design for the monitoring of long-term population trends in grizzly bear populations in the Quesnel Highlands area. This objective is different from previous DNA projects which have attempted to estimate grizzly bear population size and density, and involves newer scaled down field methodologies and analysis methods. It is assumed that this project will sample for subsequent years to allow enough data points to estimate population trends. This approach requires a longer term perspective to bear management given that more than one year of sampling is needed to determine population trend.

One immediate issue is that little information is known about the abundance and distribution of bears in the Quesnel Highlands area. Therefore, it is difficult to refine and optimize the sampling design. We suggest that an adaptive monitoring scheme is employed in which information gathered in the first year is used to refine the design in subsequent years. Systematic spring sampling will be used to gain more information about distribution and relative abundance of bears in spring habitats. Spring sampling will establish a relative estimate of bears that traverse the study area and surrounding area. Subsequent years will be used to establish population trend information in the area.

One fundamental monitoring design strategy, which will be emphasized in this report, is that it is optimal to initially sample more intensively to gain information about bears and the study area and then reduce sampling later rather than change sampling design (i.e. areas sampled) in later years. The mark-recapture monitoring models can incorporate varying yearly effort as long as it is consistent across the study area and the study area does not change once monitoring has begun.

1.4. Study area

The Ministry of Environment, Lands, and Parks staff initially delineated the study area for the Quesnel Highlands Grizzly Bear project in 2001. The original boundary included all of TFL 52 and the Weldwood License Area within TFL 52. The study area has since been expanded and is 4414 km^2 in area and centered 60 km east of Quesnel (Figure 1). It encompasses roughly half of the Quesnel Lake North Grizzly Bear Population Unit, sharing much of the west and north boundaries of the population unit. The study area is bounded to the east by Bowron Lake Park and to the south by the inclusion of most of the Cariboo River watershed. Other significant drainages within the study area include: Cunningham Creek, Antler Creek, Willow River, Cottonwood River, Swift Creek, and Victoria Creek. There is road access across much of the area by the network of logging roads.

The drainages listed above are surveyed annually by DFO and have known chinook salmon escapements, which are of potential fall foraging value to bears. Also of key importance to bears are habitats with abundant and diverse berry production and early spring green-up of important forage species. Half of the study area is comprised of the ESSF biogeoclimatic zone (subzones wc3 and wk1). Approximately 40% is SBS (subzones mw and wk1), just less than 10% is made up of ICH (subzones wk4 and mk3), and a small proportion of the study area is AT. Terrestrial Ecosystem mapping has been completed for part of the study area, including grizzly bear habitat suitability mapping for multiple seasons of use. There are numerous ecosystem units within the above listed subzones which are considered potentially high or moderately high value to grizzly bears for spring and summer forage (Keystone 2000).

A study was conducted during the fall of 2001 by Region 7, which was centered on the Bowron River area (G. Mowat pers. Comm.). The study area boundaries of the TFL52 project do not include the Bowron River, which minimizes overlap between studies. However, this study will be sampling Antler Creek, which is a tributary of the Bowron River and therefore might provide useful data for comparison with the Region 7 study.

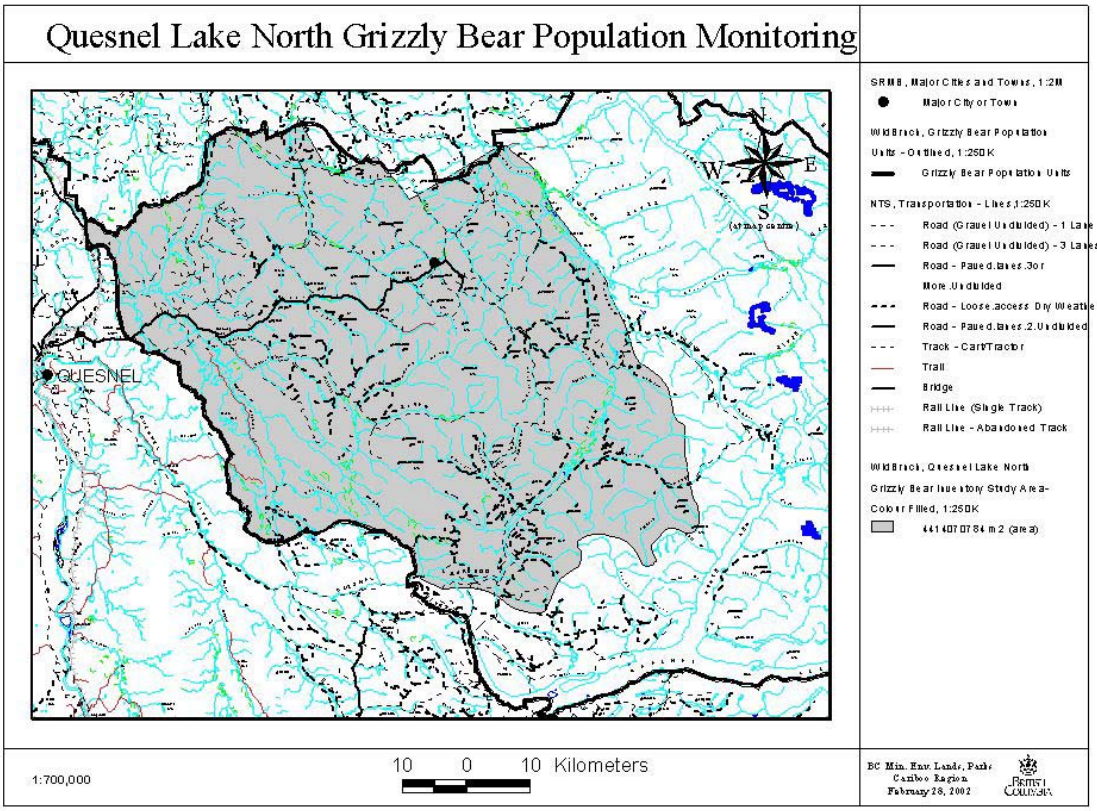

Figure 1: Quesnel Highlands (TFL 52) study area.

2. FALL 2001 RECONAISANCE SURVEYS

Fall DNA hair collection was not conducted in 2001 due to lower than expected funding for the TFL52 grizzly bear project. However, it was still felt to be important to determine if fall sampling would be viable for future consideration in the grizzly bear population trend monitoring for the TFL52 study area. Eight days of field reconnaissance sampling were undertaken from September 02 to 09, 2001. This consisted of three helicopter surveys and ground based transect surveys. For two days Stefan Himmer accompanied DFO personnel on chinook escapement counts on Willow / Wansa Rivers (Region 7) on Sept 2nd and Bowron / Antler / Indian Point Rivers (Region 5&7) on Sept 4th. A final early morning helicopter (R22) survey of all salmon streams in the TFL52 was conducted on Sept 9th. On other days the TFL52 area was traversed by truck, mountain bike, on foot and by kayak. Grizzly bear sign, grizzly bear habitat suitability and access within the

study area was assessed by Stefan Himmer and Kirk Safford. Information on bear activity and access information was also obtained in discussion with local residents.

2.1. Helicopter Surveys

Stefan Himmer accompanied Bruce Whitehead (DFO Kamloops) during helicopter surveys to count chinook salmon on the Willow and Wansa Rivers on September 02, 2001. This provided an opportunity to assess potential for grizzly bear population along salmon streams. Flights were conducted at low level and slow speed. The only grizzly bears seen were a female and 2 yearlings on the Wansa River near Wansa Lake in Region 7 outside of the TFL52 study area. Fewer bear tracks than expected were seen given the relatively high number of salmon carcasses on riverbanks. On September 04, Stefan Himmer accompanied Dale Michie (DFO Kamloops) during helicopter surveys to count chinook salmon on the Bowron, Antler and Indian Point rivers (Region 5&7). Again very few bear tracks were seen. It is possible that because of the slow speed bears may have been scared off the river before sightings were possible. However, Dale Michie indicated that grizzly bears are rarely seen by DFO personnel on most rivers in the TFL52 area, except for the Bowron River near Bowron Lake.

On September 09, an early morning flight was conducted with an R22 helicopter using sighting methods similar to those described in Himmer and Boulanger (2001). The following rivers and creeks were surveyed: Cariboo River, Cunningham Cr., Little River, Antler River, upper Bowron River, Indian Point River, Lightning River, Swift River, Victoria Creek and lower Quesnel River. No grizzly or black bears were observed although at least one set of bear tracks were seen on all rivers surveyed. In comparison to areas surveyed during the fall on the Midcoast, very few tracks were seen in relation to the availability of salmon to bears.

2.2. Ground Surveys

Road, river and habitat transect surveys were conducted from September 03-08, 2001 in the following areas:

- Swift River (from the falls near Newell Hill and Sovereign Cr.)
- Cariboo River (between Kimbal Cr. and Little R.)
- Cunningham Creek (lower 2 km)
- Little River (from Clair Cr. to the Cariboo R.)
- 4x4x roads in the Roundtop Mtn, Yanks Peak and Twins Sisters Peak ESSF areas

- Antler River area (1600 Rd., 2900 Rd., and 2600 Rd)
- Ghost Lake (Cariboo Mtns Park)
- Upper Willow River (near Wells)

No grizzly bears or black bears were observed during field reconnaissance work. We were also surprised at the low level of grizzly bear and black bear sign we encountered in the areas surveyed (see field notes in Appendix 1) compared to other areas we have visited in BC. Very few bear scats (old or new) or tracks were encountered on roads even in the ICH & ESSF zones. This was at a time when berry production was judged to be good in several areas surveyed. This was also reported by Keystone (2000) who, during 20 days of TEM fieldwork for the TFL52 area in August and September 2000, only encountered grizzly bears or grizzly bear sign on five separate occasions: one sighting of two subadult grizzlies, two different spring scats, one ground squirrel dig, and only one grizzly bear track. They also reported not seeing an abundance of black bear sign in the area.

Based on our reconnaissance surveys, we felt that good grizzly bear spring and summer habitats had a patchy distribution with only minor concentrations in the ICH and ESSF zones. This was also reported by Keystone (2000) who found that the overall grizzly bear habitat values appear to be low in the TFL52 area. They indicate that very little high suitability spring habitat exists with less than 355 ha identified mainly in the Antler and Bowron landscape units. However, moderately high and moderate rated spring habitats are well distributed throughout most of the TFL52 area (Keystone 2000). No high value summer berry-feeding habitats were mapped by Keystone and the majority of moderately high rated berry producing habitats were found in the ESSF zone.

We also found lower numbers of bear trails and mark trees along salmon streams than expected given the salmon availability. Only three mark trees showing a high amount of use were found along salmon streams.

Discussions with several Wells residents indicated that grizzlies and black bears were only occasionally seen around the dump and some Wells homesteads but fewer were seen in other areas. Many people interviewed felt that if there were bears in the area that they were probably highly nocturnal avoiding people.

2.3. Potential for Fall DNA sampling

Based on ground and aerial reconnaissance surveys it would appear that fall based DNA grizzly bear population monitoring would not be feasible especially as a stand-alone option. Even in conjunction with spring based sampling it is questionable if much

additional information would be collected given the inherent problems of low fall DNA quality and cost as described in Himmer and Boulanger (2001).

Reasons for this conclusion are: low numbers of grizzly bears appear to be using salmon streams; salmon bearing streams in the TFL52 study area are quite spread out; the majority of streams are chinook spawning streams with significant differences in the timing of runs; and most salmon streams have relatively low escapement numbers and timing of escapement may vary considerably between years (Dale Michie, DFO Pers. Comm.). Some, but not all, streams may also have sockeye and pink salmon spawning, however, with little or no overlap with chinook spawning. This means it would be difficult to determine the peak of salmon availability to bears and therefore sampling may have to be spread out over a longer period. As well if, during some years, berry production is good then some bears may be feeding on berries and not utilizing salmon to full potential and would therefore not be sampled unless baited sites were used. Therefore, in terms of timing, effort and cost we recommend spring based sampling over fall sampling.

3. OVERVIEW OF MONITORING STRATEGY

One of the first steps in designing an estimation project is consideration of how the data will be analyzed and assumptions of analysis methods. This section provides a review of monitoring analysis strategy with an emphasis on model assumptions and how these assumptions relate to optimal study design.

3.1. The difference between monitoring and estimation of population size and density.

The main emphasis in estimation of population size and density designs are to sample intensively in a shorter period of time to meet the assumption of population closure while providing enough data for the use of mark-recapture models which are robust to heterogeneity and other forms of capture probability variation detected in bear populations in previous studies (Boulanger et al. 2001a; Boulanger et al. 2001b). To accomplish this, an area is sampled intensively usually with helicopter access to sites, and the grid is situated in an area, which is topographically closed. For example, the results of British Columbia projects suggest that smaller grid cells (of 8x8 km or less) need to be sampled for at least 4 sampling sessions (Boulanger et al. 2001a) to use estimators, which are robust to unequal capture probabilities in bear populations. Unless an area is topographically closed, the resulting population estimate will correspond to the bears in the sampling area and surrounding area. The main challenge has been attempting to scale the superpopulation (unbounded population) estimate into an estimate, which corresponds to the average number of bears on the sampling grid. Various methods have been proposed to scale estimates (Boulanger and McLellan 2001; Poole et al. 2001), however,

each of these make strong assumptions about the geographic distribution of bears in the study area. Another alternative is to radio collar a segment of the population, which will allow a direct estimate of the violation of closure (White and Shenk 2001), however, this approach is costly to implement.

The main emphasis of population monitoring is to estimate the relative change in population size rather than population size itself. This approach is reasonably robust to issues with closure violation as long as it can be assumed that the degree of closure violation is consistent among years. As discussed further in Appendix 1 it is also reasonably robust to heterogeneity of capture probabilities given the assumption that the degree of heterogeneity is consistent for each year of the study (Schwarz 2001). Because of this robustness, it is possible to scale down sampling efforts and therefore the yearly cost of monitoring efforts will be less than projects, which estimate population size. For example, much of the TFL 52 area is roaded and therefore it may be possible to do most of the spring sampling using road access. If experienced bear biologists are used, it is possible to efficiently conduct road based sampling at a much reduced cost (Mike Proctor, per. Comm.).

The main disadvantage of monitoring is that it requires a longer term approach to bear management. It takes at least 3 annual surveys to get an initial estimate of population trend, and will take more bi-annual surveys to obtain estimates with suitable levels of precision. However, once this initial effort is completed it will be possible to obtain estimates of trend at a much reduced cost. The reason for this is that the cumulative sample size of bears increases each year an area is sampled. As sample size increases the precision of estimates will increase also and therefore estimates of trend and potentially population (of bears in the grid and surrounding area) will be possible at a much reduced annual or bi-annual cost (McDonald 2001). It is the current research objective of John Boulanger to adapt new mark-recapture models to bears populations. This work, which is funded by a separate FRBC research grant, will be completed in the spring of 2002 and will provide further guidelines for monitoring bear populations using DNA methods.

3.2. Mark-recapture methods

There has been a great deal of advancement in mark-recapture methods for population monitoring in the last five years due to the arrival of advanced software packages, such as program MARK (White and Burnham 1999), to analyze field data. This advancement is also due to newer methods of optimizing the fit of mark-recapture models to data, therefore, increasing the degree of estimate precision compared to past, less flexible, methods (Burnham and Anderson 1992; Burnham and Anderson 1998; Armstrup et al. 2001). It is suggested that readers consult Section 5 for details on mark-recapture models to be used for this project. It is important that biologists who will be conducting sampling understand the assumptions and data.

3.3. Optimal monitoring design

The following section outlines the most critical design strategies for the design of a mark-recapture monitoring project. While the main emphasis of this work plan is the first year of sampling, it is important to understand how this first year will fit into hypothetical future years of sampling.

3.3.1. Sample intensively initially and towards the end of the project

The fundamental objective or measurement of mark-recapture models is the fate of marked bears through time. To maximize the amount of information that goes into the mark-recapture model, as many bears should be identified in the initial years of monitoring as possible. This will provide a rich history of individual bears through time and enhance estimate precision (Figure 2). Sampling intensively towards the end of the project maximizes the chance of recapturing bears, which also enhances apparent survival estimates (Arnason et al. 1998).

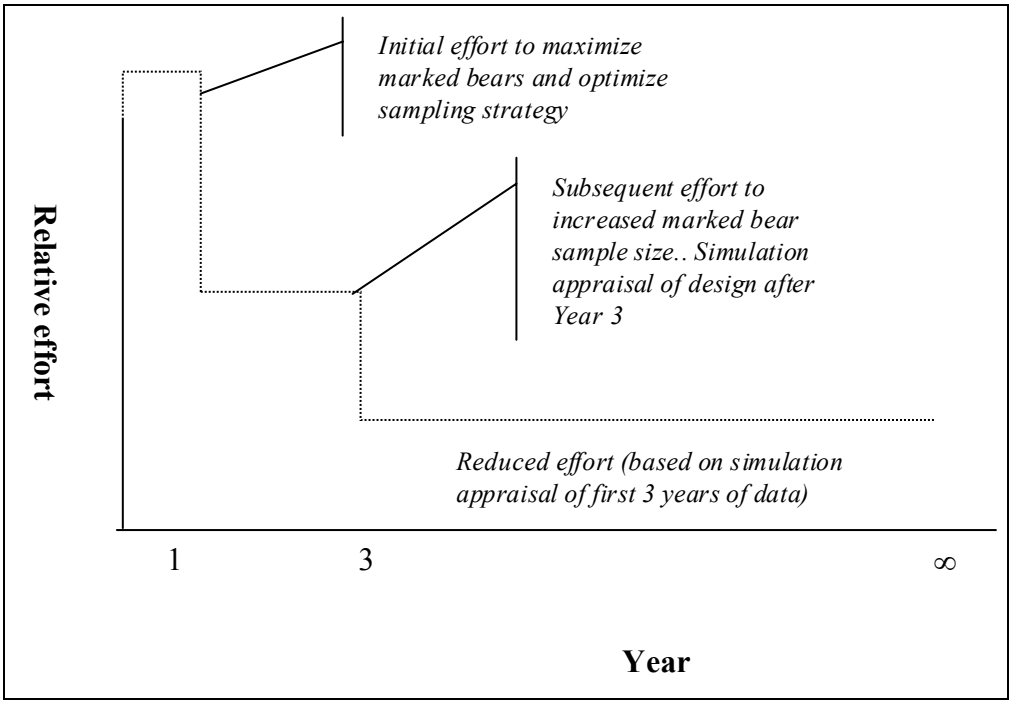

Figure 2: Hypothetical allocation of effort and timeline of project events.

The other advantage to enhancing initial efforts is that a more intensive spring survey will allow an unbounded superpopulation estimate for the Quesnel area. If spring bait sites are checked for more than 1 session it may be possible to get an estimate of bears, which traverse the Quesnel Highlands and surrounding area. This will be an unbounded

estimate due to the fact that topographic closure cannot be accommodated in the Quesnel Highlands area, and therefore density estimates will not be possible.

Much of the strategy in Years 2 and 3 would depend on the success of snagging hair in Year 1. The following questions should be asked from the year 1 data:

1. Did spring sampling identify a substantial number of bears? How efficient was spring sampling?

2. What was the recapture rate of bears per sampling session? By pairing sessions it is possible to estimate efficiency of sets at identifying individual bears. Based on this data, an optimal number of sessions and optimal number of sites can be deduced therefore optimizing effort in subsequent years. A simple analysis of the number of new bears per bears captured should give an indication of the efficiency in which the population is being sampled.

Based upon these analyses, the sampling sessions in following years can be optimized. Regardless of analysis results, it is recommended that sampling in years 2 and 3 be higher than subsequent years to maximize the number of bears identified and marked genetically and provide maximum resolution for simulation efforts in year 3.

Once three years of data is collected it will be possible to get estimates of apparent survival, rates of additions, and rates of population change. The precision of these estimates will not be high, however, they will allow a general idea of the success of sampling, and the general values of estimated parameters. This information can then be used in a Monte Carlo simulation model to fine tune sampling procedures. The approach is to fit the simulation parameters to the first three years of data and then simulate varying future levels of effort. Analysis of simulated data will then allow an estimate of precision of final parameter estimates as a function of effort and design. Simulations can be fine tuned for post and pre impact appraisal and other management concerns. The sampling strategy for the following years will then be appraised. A lessened sampling plan (i.e. sampling every other year) would be the focus of efforts after year 3. Note that this simulation work while being technically challenging is not difficult and would use pre-existing software. Therefore, the cost of this work compared to fieldwork would be very inexpensive.

3.3.2. Standardize sampling

Sampling should be standardized so that the area being surveyed is similar for each year, and the approximate amount of effort in terms of sites employed is similar. Effort can be increased yearly by adding more sampling sessions or site checks each year. Most importantly, the area being surveyed *should not* be expanded over the course of the study. This basic constraint further supports the strategy of sampling intensively initially to

identify optimal sampling areas rather than expanding sampling throughout the monitoring program. It is possible to post stratify or eliminate data from the initial year (based upon lack of success at sites) without compromising estimates.

3.3.3. Use experienced bear biologists to set up initial sites

The optimal placement of barbed wire sets in spring habitats can have large effects on sampling bears and the ultimate success of projects. The general monitoring design involves using the same sites over time. Therefore, ***key initial site placement is essential*** and experienced bear biologists should be used to select and set up initial sites**.** Less experienced personnel can check sites once they are selected and set up. Each site setup should be photographed and marked permanently (i.e. metal tree tags) so that setup is standardized on a yearly basis. Barbed wire should be taken down or unattached at one end when not being used for sampling to avoid long term avoidance of bears to sets.

4. METHODS

The work plan for spring sampling will now be detailed.

4.1. Spring sampling

The initial year of spring sampling will involve a systematic sampling grid over the entire study area. This will allow all likely areas to be sampled evenly and provide the best chance of marking as many bears as possible as discussed in Section 2. Unlike fall sampling, scent baits will have to be used to draw bears into the barbed wire bait sites as discussed in Woods et al. (1999) and Mowat and Strobeck (2000). Systematic sampling is optimal given that there is little information available to stratify sampling efforts, and therefore a systematic approach will give the most information about bear distribution.

The results from the year 1 effort will be used to further focus subsequent years of sampling. In particular, the results of spring sampling in year 1 will allow a general idea of the distribution of bears within the study area, which could be the basis for stratification of sampling in future years. The actual methodology in terms of grid cell spacing for the use of monitoring is the focus of another ongoing research project by John Boulanger. During the winter of 2001/2 results from past DNA methodologies will be used to parameterize simulation tests of the Pradel and Cormack Jolly Seber models (as discussed in Section 5) under varying sampling regimes. The results of these simulation studies will be used to finalize the design for spring sampling. In addition, more detailed information about potential densities of bears based upon Fuhr-Demarchi methods will be used to optimize sampling.

Much of the TFL 52 area is roaded and therefore it may be possible for helicopter costs to be minimized in accessing sites therefore providing a sampling plan at a much-reduced cost.

4.1.1. Grid Cell Selection and Site Setup

4.1.1.1. Divide study area into 8 km x 8 km grid cells.

As soon is practicable in spring set a barbed wire, baited site in each grid. Cell placement within the mark–recapture study area will be determined by overlaying a grid of 8 x 8 km (64 km^2) cells on a 1:50,000 scale NTS map. The grid will be fit to the study areas to maximize the number of cells that are within the study area boundary. All cells will be sampled regardless of habitat type and topography.

4.1.1.2. Sampling Interval for collecting hair sample.

Choosing an appropriate sampling interval for trend monitoring of bear populations requires a trade-off between maximizing capture success and the effectiveness of baits at capture sites. A sampling interval of 5-7 days was chosen for the first year of population estimation in the study area. The effectiveness of this sampling interval will be evaluated with the first year's data.

Studies have shown that DNA degrades when hair is wet and therefore checking of sites should occur more frequently if there is a lot of precipitation during sampling. The actual duration can be adjusted after initial checks to determine the number of samples at sites. If sites are saturated with hair then checks should occur more frequently. Checks should occur during the mid-day to minimize encounters with bears. Samples should be collected in individual sample envelopes, which should be labelled, by site number and the barb number on the site. Barb numbers allow extra inference to determine if double snags have occurred. Barb numbering is simply the number of the barb from the observers right to left as the observer is facing the barbed wire.

4.1.1.3. Hair Capture Site Set-up.

Human scent at hair capture sites and on site equipment will be kept to a minimum. Barbed wire will be used to capture hair samples at each site. The wire will be tightly stretched and stapled to the outside of trees so that it forms a perimeter approximately 5 m from a central scent. The barbed wire will be strung approximately 50 cm off the ground. Understory vegetation within and adjacent to the barbed wire perimeter will be removed. A scent lure, consisting of the best available bait (blood, meat, fish and scents) will be hung between 2 trees such that it is centred in the barb wire perimeter. The bait will be hung in such a manner that bears cannot get at the bait and will not receive a food reward. This will be achieved by hanging burlap sacks containing the scent lure approximately 5-6 m off the ground and at least 5 m from each tree (Woods et al. 1996).

The Universal Transverse Mercator (UTM) co-ordinates, slope, aspect, elevation, habitat type, cell number and date of set-up of each hair capture site will be recorded. In addition, the UTM coordinates of the road, trail, and boat or helicopter access point will be recorded. All sites will be marked with permanent tree markers so that the same sites can be used in subsequent years.

4.1.1.4. Hair Collection and Rebaiting.

After 5-7 days, each hair capture site will be revisited to collect the hair samples. The hair capture sites will be moved to new locations between capture sessions, preferably 1 km away from previous site locations. Moving sites is a measure intended to ensure grizzly bears do not lose interest in or habituate to traps thereby introducing behaviour variation to capture probabilities. Sites should be checked for at least 4 sessions.

4.1.2. General barb wire sampling techniques

Barbed wire will be checked carefully to ensure that all hairs are collected. A sheet of white reflective plastic can be run under the wire so that the hairs are more visible. Each hair sample (i.e., from 1 to multiple hairs) will be placed in a separate envelope, which will be marked with the probable species (e.g., grizzly bear, wolverine, wolf), and site sample number. Site sample details will be recorded in a log book and a copy will be put in an envelope with all the hair sample envelopes from the site.

4.1.2.1. Dry all samples immediately and store in silica gel to minimize degradation of DNA.

Recent studies have shown that the degree of degradation of DNA in hair is related to how the sample is dried. This is especially applicable to coastal areas, which exhibit high humidity (Murphy et al. 2001). Therefore, proper drying of samples is essential to ensure genotyping success. In addition, sites should be checked more often (i.e. about every 3-5 days) during times of rainfall. If possible, barbed wire sites should be placed in partially sheltered areas to avoid saturation of hair samples.

4.1.2.2. Collect all hair samples and use optimal extraction procedures.

Bears are shedding hair in the spring and therefore the percentage samples of hair should not be a problem. However, all hair, including underfur should be collected. Species identification will be done during field collection. All glossy black hairs will be assumed to be from black bears. All other hairs will be analyzed. A random sample of black glossy hairs will also be analysed to determine the accuracy of species identification by hair colour. Geneticists with experience with hair genotyping such as David Paetkau (Wildlife Genetics International, dpaetkau@wildlifegenetics.ca) should be contracted to do genotyping of samples. Quiagen should be used for extraction for it exhibits far superior results to Chelex extraction methods (Boulanger and Himmer 2000). Issues such as allelic dropout (Taberlet et al. 1999) due to sparse DNA in samples can confound

results and therefore it is ***essential*** that experienced personnel be employed for genotyping.

4.1.2.3. Numbering hair snag samples

The location of snags should be recorded by numbering barbs on barbed wire from left to right. This allows further appraisal of whether a double snag has occurred. Finally, an experienced geneticist, who can usually identify double snag genotypes, should be employed for genotyping.

4.1.2.4. Minimizing age specific sampling bias

One potential issue with spring based DNA sampling is that the height of the barbed wire mainly targets adult bears (Woods et al. 1999) which causes young bears to be under sampled. To avoid this problem, the height of barbed wire snags should be varied, and when possible, double barbed wire sets should be used. Ideally, a tall spring set would be placed along a trail followed by a lower set a few meters away to avoid potential aversion to double barbed wire sets.

5. DISCUSSION OF MARK RECAPTURE MODELS

There are two mark-recapture models, which should be considered for use in the TFL 52 project. For these models the data for each year is pooled into one data set for each year. Therefore, a sampling session is the combination of all hair collections in any given year. These models have recently been applied to a variety of species including polar bears (Armstrup et al. 2001). Boulanger et al. (2001a) provides a more detailed discussion about these models and the design of long-term monitoring projects.

5.1. The Cormack Jolly Seber model

The Cormack Jolly Seber model (Seber 1986) basically tracks the fate of marked animals in the population through time (Anderson et al. 1995). Consider a bear which is identified using DNA methods in the first year of the study. In subsequent years this bear will either be caught again, die, or leave the area as indexed by whether it is captured again. The probability that the animal is within the target sampling area for each year surveyed is estimated by the Cormack Jolly Seber model as apparent survival. One minus apparent survival is the probability that it left the area or died. Apparent survival is a biologically useful quantity in terms of determining potential impacts of development on bear populations. The principal issues are whether bears show fidelity to an area, or die or abandon the target area due to development or other reasons. Monitoring of trends in apparent survival through time provides indices of these quantities.

One critical point is that the Cormack Jolly Seber model only considers the marked segment of the population in estimating apparent survival. No inference is given towards

bears never captured. This avoids many of the issues which plague models, which estimate population size such as whether the capture probabilities of marked bears equal the capture probabilities of unmarked bears. The result is that the estimate of apparent survival is robust, or minimally affected by unequal capture probabilities between bears (Pollock et al. 1990; Lebreton et al. 1992). In addition, a higher degree of precision (tighter confidence intervals of estimates) is possible from the Cormack Jolly Seber model in terms of trend when compared with models, which estimate population size. The Cormack Jolly Seber model has been applied to a variety of bird and mammal species in which estimates of population size are not possible (Lebreton and North 1993).

The Cormack Jolly Seber model assumes that individuals within the population are similar in terms of apparent survival rates but need not have equal capture probabilities. Differences in sexes in survival rate can be partially accounted for by modeling each sex separately for apparent survival estimates. Yearly differences in recapture rates of bears can be accounted for by the Cormack Jolly Seber model by the estimation of recapture rate for each year of the study. Ideally, yearly recapture rates will be similar which would allow a less complex estimation model resulting in enhanced precision of population estimates. Or, if yearly rates differ due to a measurable covariate (i.e. escapement levels), then this covariate can be incorporated into the analysis in program MARK.

Unlike closed models used for population estimation, the Cormack Jolly Seber does not assume that the population being sampled is closed. However, the degree of geographic closure in the population influences how much the estimate of apparent survival reflects true survival (mortality) or emigration from the study area. Fundamental to interpretation of estimates is the definition of a "target population" in which the analysis will apply to. In the case of this project, the target population would be bears, which utilize the TFL 52 study area and surrounding area during the fall and spring season.

A less rigorous sampling regime can be used to collect data for the Cormack Jolly Seber model (compared to closed models for population estimates) due to the robustness of the apparent survival estimator to most forms of capture probability variation. However, standardization of methods (i.e. similar times of yearly collection, similar number of sites), as discussed later, will improve the precision and reliability of estimates.

5.2. The Pradel (1996) enhancement to the Cormack Jolly Seber model

Pradel (1996) provided a further refinement to the Cormack Jolly Seber model, which allowed estimates of rate of recruitment, and population rate of change (λ), in addition to apparent survival and recapture rate (Franklin 2001). The estimate of λ provides an

index of whether the overall population is increasing ($\lambda>1$) or decreasing ($\lambda<1$) or stable ($\lambda=1$) over time.

The cost of the more complex Pradel model formulation is the need for increased sample sizes, and potential bias in λ caused by behavioural response of the bears to trapping, changes in trapping procedure (i.e. change in study area size) and heterogeneity of capture probabilities of bears. Of these, the most serious bias would be caused by behavioural response of bears to trapping caused by avoidance of sites after initial snagging. In addition, if sampling was expanded to cover a larger area than the initial project, then λ may increase also since a larger population is being sampled Initial simulations conducted for spotted owl populations suggest that the degree of bias due to heterogeneity is not large (Nichols and Hines 1999), however, further simulation specific to bears should be carried out to verify this finding.

In conclusion, the Pradel model provides useful estimates of population rate of change, and rate of additions. However, it also needs higher sample sizes to achieve reasonable estimate precision, and requires a highly standardized sampling design. An ongoing research objective of John Boulanger is simulation testing of the Pradel model for use in monitoring grizzly bear populations.

5.3. Count based methods.

An alternative to mark-recapture methods is regression analysis of minimum yearly counts of bears at spawning areas. This is not an optimal strategy for the following reasons:

1. *Trend estimates are biased if bears exhibit year specific differences in recapture rates*. A fundamental assumption of count indices is that bear will exhibit the same attraction and recapture rate at sampling areas. If this assumption is violated, then trend indices will exhibit an unknown bias. Mark-recapture models account for this problem by estimating bear recapture rate (Pollock et al. 1990).

2. *Count based indices are inefficient in that they do not utilize all the available information in the data*. DNA mark-recapture identifies individuals each year the areas are sampled. Whether an individual identified each year is new, or a recapture from previous years is ignored by count indices. The result is that count indices are less reliable than mark-recapture methods.

Therefore, mark-recapture models should be given primary consideration both in terms of the design of this project, and subsequent analysis.

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7. APPENDIX 1 - FIELD NOTES FOR FALL 2001 RECONAISANCE SURVEYS

Sept. 3/01-Yanks Peak Road and Roundtop Mtn

Sunny with scattered cloud
bear (unknown species) scat with elderberry, grasses, Vaccinium on road.
WPT#10 614459 5863277 (lower peak south of Roundtop, 2032 meters,
- 4X4 road to Roundtop – chewed up by ATV's, 4X4's and off road bikes (closed area), see photo 1563.
- Alpine and sub-alpine habitat, rich and moist: Veratrum viride, Heracleum lanatum, Valeriana sitchensis, sedge, Ribes lacustre.
- Drier site have: Phyllodoce empetriformis, Artemisia norvegica, Abies with some Picea engelmannii, no Vaccinium in alpine.
- lots of Anemone (Prairie smoke)
- Photo 1564 – Looking towards Sandy Lake from GPS 10
- Photo 1565 – Looking south from GPS 10
- Access in ESSF very good, hiking to sites or ATV use very feasible, mountain bikes, 4X4, some helicopter.
- Photo 1566 – north from minor peak of round trip
- Photo 1567 – northeast from minor peak towards Bowron Lake.
- 2 videos (1568, 1569) from minor peak in 360 degree, starting from Roundtop Mountain going clockwise.
- Good AV slopes on northeast side of Roundtop, see video
- Very little barrier to movement anywhere in study area.
- Not heavily logged in this corner of study area more towards Bowron Park, but mining roads up every drainage.
- Further west lower more rolling and SBS
- photo 1570 Anemone meadows in sub-alpine on west facing slope 1905 meters. Mule deer in velvet with drop point antler
- Took transect down Penny Creek. Saw mule deer took photos then photo 1575 - ---- Photo of rich sub-alpine meadows at 1850 meters.
-Photo 1576, Vaccinium membranaceum under subalpine fir canopy.
- 1700 meters with Streptopus roseus, Rubus pedatus, Tiarella sp., very few berries on Vaccinium membranaceum.
- Out at road at 1500 meters, lots of Valeriana sitchensis, Heracleum lanatum, Equisetum arvense, Epilobium angustifolium, clover, some Angelica genuflexa on road side.
- No bear sign seen, very little scat on the road. Talked to several ATVers, have seen little bear sign, scat or visuals.
- Off road vehicles everywhere, little enforcement of closure – see photo of sign. May 15/2001 in effect.
- Pickup stuck in Alpine with lots of stuff in box, no plates.

- Newer white 4X4 Ford in alpine: 6017 AB Blue pick-up, older 4X4 driving in alpine on Yanks Peak, got information from them. (2 men 1 woman)
- Moose tracks seen
- Gary Hedberg, Rec Officer, Quesnel FD, 250 992 4445 or Robin Webb Rec Officer, Horsefly 250 620 3261, make complaint.
-1240 meters: Shepherdia Canadensis, Sambucus racemosa, Vaccinium ovalifolium with berries, Streptopus amplexifolius with very large berries along road.

Scat-Yanks Pk Road. Sambucus racemosa berries and grasses.

Hike up to Round Top Mtn

-1.25 hr hike

-recent 4WD activity in alpine in off limits area; photo KS01-02, 03

-the drive up took us through most of ESSF, then hiked through sub-alpine parkland and alpine to southern 'peak' on Roundtop ridge.

Terrain - Rolling mountains with broad, flat alpine and subalpine regions. Little exposed rock. On the Roundtop Mtn ridge, steep avalanche chutes are found on the northeast side of the ridge. The Yanks peak ridge to the west did not appear to have any avalanche chutes or steep relief from our vantage point. Farther to the west, the lower elevation ridge tops are forested. To the east, the more rugged terrain of the Columbia Mtns. forms steeper alpine and subalpine terrain with greater avalanche chutes, and exposed rock at higher elevations. (photos KS01-04-looking ENE toward Bowron from Roundtop ridge; 05- looking SE from Roundtop ridge).

Along the Yanks Peak Road, the upper Cunningham Creek forms a steep V-shaped valley (compared with the area around Wells and other valleys in the area where the valleys have been filled with glacial debris, resulting in wetlands and meandering creeks).

Habitat

ESSF-

Rich forested habitat with dense patches of shrub, and herb growth.

Forest-Abies lasiocarpa, spruce. Patches of open canopy, increasing with increasing elevation. Dense shrub and herb production.

Shrubs-Vaccmem, Vaccova, Sorbus, Sambrac (minor component), Rhodalb.

Herbs-Anemocc, Veravir, aster, Valesit, Senetri, *Castilleja*, Heralan

Disturbed Habitat (road edges, mining development): Herbs-willow, Epilang, Equiarv, Geummac, grasses, Trifolium.

SUBALPINE PARKLAND-

Patchy forested areas, herb layer increasingly dominant. Forest-Abielas

Shrubs-willow (in wetlands), Rhodoalb

Herbs- Anemocc, Veravir,Aster, Valesit, Senetri, castilleja,

Lazupar, grasses, sedge, Trolllax, Thalocc.

Alpine

- Drier, windswept ridge top, shrub layer dominated by subalpine fir krummholz.
- Shrubs-Abieslas, Heather (Cassiope or Phyllodoce sp.), Siliaca (moss campion), castilleja, platanthera (bog orchid), cottongrass (in wetlands), sedge sp., grasses, Lazupar.

Seasonal Bear Use

Greatest forage value seen along hike and on road was in forbs, with berry production limited to the ESSF. ESSF forests have berry production (Vaccmem, Vaccova, Sorbus, Sambrac) and herb layer provides spring, summer forbs. Subalpine habitat has minimal berry production and extensive rich herb layer production. Alpine habitat is restricted to grasses and sedge for food.

Seasonal use is dependent on snowpack levels and spring melt. Forested areas in ESSF and subalpine, and rolling flat terrain at higher elevations are not conducive to early spring melt (although patches may be exposed on wind swept alpine ridges). Steeper, midslope terrain in ESSF occur below 1600 metres on this ridge, and south facing slopes are on the end of the ridge. In early June 2001, the snowpack line was approx. 1200-1300 metres elevation on a south facing slope after a low snowfall year (Bowron Park), good forb production was at a much lower elevation.

Caribou numbers are presently quite low (35-50?) in the Quesnel highlands, winter killed caribou are probably infrequent.

Yanks Peak Road provides 4WD access to upper Cunningham Creek, Roundtop Ridge, Yanks Peak, and Keithley Creek. The road continues through to Likely, as long as there aren't any logs on the road.

Bird Species- Roundtop Mtn.

CHSP-Chipping Sparrow

GRJA- Gray Jay
RTHA-Red-tailed Hawk
AMKE- American Kestrel
SSHA- Sharp-shinned Hawk
PISI-Pine Siskin
BOCH- Boreal Chickadee

Flight with Dale Michie, DFO Sept.04/01
Bowron River, Chinook count
10:17 take off from Prince George
Sunny and scattered cloud

WPT #11 – willow River area, looking northeast, southwest, F (w river) photo 1580
WPT #12 – photo of Narrow Lake, looking northeast. photo 1581-1583
WPT #13 – burn N northeast photo 1584
WPT #14 – Sender Lake, photo 1585, 1586 Bowron cutblock
WPT #15 – looking northeast, photo 1587
WPT #16 – looking W southwest, photo 1588
- Antler bridge, photo 1589
WPT # 17 + 18 – end Bowron, start Indian Point Creek
WPT #19 – Single grizzly bear seen by PWH, pilot from Prince George, Ken on road 10u 599327 / 5921922
WPT #20 – end Bowron

Dale Michie, Chinook salmon discussion

Early summer run:	**Start**	**Peak**	**End**
Quesnel system	begin August,	September 12-20	October 2
Spring:			
Bowron system	August 28	September 5	August 15
Willow system	July	August 15	August 25
Wansa	September 5	August 15	August 30

Coho counts will be starting this year. Enter river October 5 – 15; begin spawning November 10 – 20. Late fish only.
- Pinks Quesnel River found only to lower reaches to Beaver Creek?
- Bowron see very few grizzly bear if any in river systems this year.
- Other years lots in park above Bowron Lake.
- Hagen to Tsus 2 grizzly bear, August 23/01.
- 3 – 4 seen upstream of Hagen on other years.
- No Black bears seen on river.
- KSP 465 BC Green jeep Cherokee at Cunningham Creek – panning for gold in creek.

Sept. 4/01 Antler Creek, Atan Lake, Chisel Lake
Antler Creek +2900 Rd crossing SBSwk1
High overcast – STJA, EUST in town
GPS mark 088T 10U 6 054 059 58 950 59 UTM Location

Elev. 3250 ft.

Spoke to Norm and his wife who are camping in area for the last few days, have seen no sign of wildlife of any kind.
Old mining activity, creek dredging near bridge
Road edge: Ribes lacustre with berries
Sambucus racemosa loaded with berries
Trifolium pratense
Rubus idaeus with berries
Rubus parviflorus with berries

Steep slope forest above creek (no flood plain)
Tree species primarily spruce, Amabilis Fir (balsam)

Shrub – alder, Cornus stolonerifera, Amabilis Fir (balsam), Ribes lacustre, Viburnum edule (berries), Vaccinium ovalifolium (berries), Oplopanax horridus - see page sites (berries), Lonicera involucrata (berries), Rubus parviflorus.

Herbs – Cornus stolonerifera, Gymnocarpium dryopteris, Rubus pedatus, Equisetum sp., Smilacina, Dryopteris expansa, Aralia nudicaulis, Aruncus dioicus, Streptopus amplexifolius, with berries, Actea rubra, Streptopus roseus (with berries) Tiarella trifoliata, Tiarella unifoliata

Minimal floodplain consisting of willow, alder and similar shrubs as forest; Low/medium spring value.
Photo: KS106- forest along Antler Cr
Photo: KS107- Antler Cr 200 m upstream from bridge, no salmon so far. Shows floodplain and steep side slopes
So far no salmon, creek is in steep draw canyon like, small medium bench, floodplains with thick spruce, Amabilis Fir (balsam), willow, alder regeneration; creek not prime spawning gravel.

WIWR – Winter Wren
Sign of moose winter browse.

GPS 605748 / 5894371 Old floodplain along short stretch (200 meters) of creek: spruce, Amabilis Fir forest.

Lonicera involucrata, Oplopanax horridus (berries), Cornus stolonerifera, Ribes lacustre, Rubus idaeus (berries), Rubus parviflorus, alder, Viburnum edule (berries) Streptopus roseus (berries), Gymnocarpium dryopteris, Dryopteris expansa, Cornus canadensis, Rubus pedatus, Tiarella trifoliata, Bedstraw, Equisetum

Spring forage – Equisetum, Gymnocarpium dryopteris, Dryopteris expansa, Rubus
Occasional steep rock bluff and slide area. Juniperus, Cornus stolonerifera, Fragaria sp., Rannunculus, Aruncus dioicus,

2 WIWR – Winter Wrens
- Left creek at GPS 605714 / 5894115
- No salmon, little spawning habitat
- Creek confined to canyon, minimal, medium and high bench floodplain.
Spruce dominated forest, rich, good berry production for forest habitat.

Steep slope up to ridge, including pine, more open understory: spruce/pine/balsam;
- Shepherdia canadensis, Linnaea borealis, Viburnum edule, Rubus pubescens, Ribes lacustre, Rosa sp., Cornus stolonerifera, Vaccinium membranaceum (no berries), alder, Smilacina racemosa, Cornus canadensis, Epilobium angustifolium, Gymnocarpium dryopteris.

Several sets of tracks in moss up slope, probably moose, and faint game trail at the ridge top.

GPS 605808 / 5894208. Elevation: 3570 ft.
Mark tree + 2 (rub tree) berry scats, 1 week old, both primarily Vaccinium.
Habitat – trail along the edge of gully to Antler Creek; clearcut approximately 100 meters away.
Forest – pine/spruce/aspen
Shrub: Lonicera involucrata, Amabilis Fir (balsam), alder, Viburnum edule, Spiraea sp., Vaccinium membranaceum (no berries),
Mesic / dry site; gently rolling terrain.
Herbs: Streptopus roseus (berries), Cornus canadensis (berries), Rubus pedatus (berries), Clintonia uniflora, Smilacina racemosa (berries), Streptopus amplexifolius (berries).

KS01 – hair sample collected off rub tree.
Poor spring habitat improved by the adjacent clearcut?
Moderate late summer / fall berry habitat, improved by clear cut.
Older scat nearby, tough to identify, looks like soil with some greens.
Another older scat, similar to previous: greens and vegetation.

Photo KS09- Looking across Antler Creek gully westward.

AMKE –American Kestral in clear cut
GPS 60906 / 594261
Elevation 3540 ft.

Adjacent to clear cut
Habitat: shrub stage regeneration
Photo: KS10- clearcut looking northeast.
Berry production good in clearcut but berry shrubs are not densely stocked.

Berry producing shrubs: Rosa, Amelanchier alnifolia, Vaccinium membranaceum, Viburnum edule, Sorbus sitchensis, Ribes lacustre, Rubus idaeus, Cornus canadensis, Ribes laxiflorum, Smilacina racemosa, Lonicera involucrata, Vaccinium ovalifolium, Sambucus racemosa.
Berry production is better here than in forest, but not dramatically better – surprising?

Indicator species: Clintonia uniflora, Linnaea borealis, Epilobium angustifolium, Rubus pedatus.
Easy travel in clearcut, good berry season habitat,
little spring value (young shoots)
limited summer (pre-berry) some herbs, forest has greater value.

Road access to this clear cut (and for Antler Creek gully), water barred (not large enough)
Old moose pellets and deer tracks in mud along road.

Photo KS11: wetland along road from clearcut.
- The creek is a tributary of Antler Creek
- Sambucus racemosa, alder, Athyrium filix-femina, Equisetum, grasses, sedge, Oplopanax horridus.
- Spring value in equisetum, ferns and grasses.

Old scat along old road paralleling the new road, herbaceous material. Lots of Equisetum.
GPS: 606288 / 5895081
BOCH – Boreal Chickadees in large group

Atan Creek – slow meandering through willow and Sb swamp land
No salmon spawning habitat at road crossing of Atan Creek.
Fresh moose sign
willow, hardhack, Lonicera involucrata dominate. Some Rosa, Cornus stolonifera, Rubus idaeus. No GPS coverage.
Only did a brief look, however bear values appear low – possible spring value in Equisetum and grasses. Could check further; no salmon, few berries.

Atan Lake GPS: 607969 / 5894802 (more accurate mark – 089T/ 090T)
Photo KS17 – Faint trail along lake – human used.

spruce, Amabilis Fir (balsam) wet forest along lake. alder, Equisetum and some grasses are main spring food. 09 site series.
Cornus stolonifera, Rubus pedatus, Tiarella trifoliata, Lonicera involucrata, Ledum groenlandicum, Gymnocarpium dryopteris, Vaccinium membranaceum, clubmoss.
Forms thin band around lake, not extensive.

2 BBWO or TTWO (D,C)

Photo KS12 – rich spruce forest above chisel Lake, Viburnum edule, Sambucus racemosa, Rubus parviflorus, Cornus stolonifera, Dryopteris expansa, Gymnocarpium dryopteris, Athyrium filix-femina, Rubus pedatus, Streptopus amplexifolius, Aruncus dioicus.
GPS 609582 / 5893282
1 week old scat on the road composed 1 of Oplopanax horridus berries and some Viburnum edule.

Photo KS13 in pine/spruce 20 year old regenerated forest on road past Chisel Lake. Poor bear habitat low spring, summer and fall values.
- Not in ICH yet
- Mostly clear cuts past Chisel Lake
- Have biked since Chisel Lake but 2WD truck could make it this far, providing it is dry.
- GPS 610965 5891434 mark 091T (on road)

Past 2nd creek crossing 100 meters east of road spruce/balsam/pine forest
spruce dominant.
Gentle terrain; primarily Hw trees

Shrubs: Spiraea betulifolia, Vaccinium membranaceum, Amabilis Fir (balsam), Cornus stolonifera, Viburnum edule, Ribes lacustre.

Herbs: Epilobium angustifolium, Streptopus roseus (berries), Cornus stolonifera, Gymnocarpium dryopteris, Streptopus amplexifolius (berries), Rubus pedatus (berries), Listera sp. Poa sp., Linnaea borealis, Arnica cordata, arctic coltsfoot, mosses clubmoss, Hylocomium splendens, plume moss.

Photo KS14 - Close up of herb layer in above forest.
Photo KS15 - forest understory.

Generally poor spring habitat, no aspect snow remains late; some herb forage – summer, Streptopus amplexifolius, Poa sp.
More forage in adjacent clearcut and road edge.
Poor berry coverage though a rich site.

No GPS coverage, GPS on road 612163 / 5889931 mark 092T
Four beaver at the junction with McKenna Rd.

5:40 turned around. Saw scat s while biking, mostly old grass, spring and summer. GPS at turn around point: 613373 / 5887003 mark 093T
Confusing area – road map don't agree. I appear to be on the 1600 road – but still heading towards the mountains (around 1620).
Fresh deer tracks on return.

High point on road – stopped on return. Site series 01?
Adjacent forest spruce / balsam; Vaccinium membranaceum, Smilacina racemosa, Rubus parviflorus, Cornus canadensis, Rubus pedatus, Sorbus sitchensis, white-flowered rhododendron, Streptopus roseus.
GPS: 611232 / 5892443
Elevation: 3740 ft.
Rolling terrain, no dramatic change in forested habitat; except as in clear cut and along creeks.
Photo KS16: forest at high point on bike route.

Stopped at Atan Lake on return
Photo KS18 – Herbs at lake edge facing east.

Logistics –
Whole route today could be done in a 2 WD truck possibly, 4 WD is a safe bet.
Stations could be set up in spruce old growth patches, or possibly in regenerated (young forest) of 20 years on some spots.
The area biked is primarily clearcut.

On the whole most habitat seen today was low or medium value.
Rolling terrain all SBS, no ICH; no alpine, sub-alpine habitat.
Spruce forests have good herb production (spring and summer), and good patches of berry shrubs, which may attract transit use; Clear cuts lots of young forest on bike route.
Generally diverse habitat was lacking; no strong floodplain habitat – Antler Creek was in a canyon; wetlands primarily moose habitat – willow, grasses not prime bear habitat.

Sept. 5/01 Nolaka Creek, Cunningham Creek, Confluence with Cariboo River, Hike up Cariboo River
Frost overnight in Wells,
Sunny with a few clouds
Cunningham Creek road up to

- Scat with devil's club berries and herbs (clover and grass?) on road, N 2-3 days old.

- Further on, Vaccinium, DC, elderberry scat on road, 1-2 days, however not a lot of scat on road, expected more given the habitat quality.
- # 24 GPS on Nolaka Creek 4660 ft., ESSF wk1 above ICH wk4.

- Logging road hydro seeded with clover and Calamagrostis Canadensis of lower elevation and with Timothy in ESSF – good road construction, bridges etc.

4700 ft. 40% slope, northeast facing, site series 03,
- spruce, Ba, with heavy Rhododendron, Gymnocarpium dryopteris, DRYOASS, Valeriana sitchensis understory, Veratrum viride lots of Alectoria on trees class 3 / mossy.
- Oval leaved blueberry has good but sour berries, found big scat: grasses, ferns? Cornus Canadensis.
- Moose tracks in area, brose on Ribes lacustre, Ba.

- photo 1591, photo 1592 at GPS 25 photos of hydro-seed Timothy.
- photo 1593, photo 1594 near 25 Vaccinium membranaceum.
- photo 1595 Streptopus amplexifolius.

GPS #26 : AV3, Photo 1596, 1185 meters, ICHwk4
- Sambucus racemosa, DC, alder, willow, Veratrum viride, Rubus parviflorus, Maple, Athyrium filix-femina, Cornus stolonifera bordered by Ba, Cedar, spruce, Heracleum lanatum, Epilobium angustifolium, Calamagrostis Canadensis, Smilacina racemosa (1598, 1597 – void), Urtica dioica, Equisetum arvense class one summer, class 2 spring.

GPS # 27: photo 1599 – photo 1600 clover
1601 DC site 07, in ICHwk4, class 3 summer, class 4 spring.
- Bear foods: DC Veratrum viride, Athyrium filix-femina, Vaccinium ovalifolium moderate Berries.

GPS #28 Clearcut in ICHwk4 at 1082 meters, GO cabin?
- At edge of block, 6 year old cut. Moderate berry production. Shrubs, edge hydro seeded.
- Black bear track on cabin, deer tracks.
- Class 2 summer, class 2 spring.

Cunningham Creek walk from bridge at
1 at the creek mouth
Good spawning gravel (class 2-3) but short
- 2 post spawning Chinook < 1 km below the bridge plus 1 carcass, Saw* one spawn out at mouth too.
- 1 female with COY, 6.5 cm – grizzly bear

- 1 female with yearlings – grizzly bear
    - Small Black bear too
- 17.5 cm grizzly bear tracks, GPS #30
- 16.5 cm grizzly bear tracks

balsam marked tree with very deep rutted trail beside Cunningham Creek river left, Kirk collected hairs KS04, good location for fall session site and if accessible for spring session, photo 1608.

Highbench floodplain
- Hiked to Cariboo River which is very glacial no fish counting in this river.
- Wolf tracks on sand bar, and hunting camp at mouth, photo 1609
- Saw young bull moose upstream.
- Not a lot of bear sign along creek most movement was from beavers and moose
- Looks like grizzly bears travel up and down once looking for sparse fish and then leave.
- Travelled upstream from Cunningham Creek to just below bridge crossing along moose / bear trail, found approximately 10 marked trees with some recent use no marked trails; also found one freshly consumed Chinook carcass, Kirk collected several hair samples from marked trees with waypoints.
- Most of the way was high-bench floodplain with well used trail. Good site for wire in spring and fall. Would be good to have zodiac and jet motor for Cariboo system.

WPT #36 photo 1613, Victoria Creek from bridge, not paddleable too much wood, beaver dams, low gradient.

Swift River falls photo 1622, impassable to salmon, very steep trail to falls. Site series 04. Douglas fir, Ba, spruce, pine, Cornus stolonifera, Viburnum edule, DC, Ribes laxiflorum, Sorbus scopulina, alder, moss.
- Another access point to area below falls old camp and truck camper.
- No Chinook seen in this section.

WPT #38 Swift River put in.
- Saw one live spawned out Chinook.

Kayak down Swift River just below falls
- 1 chinook at put in and
- 1 chinook 500 meters downstream,
- 2 carcasses to WPT 039.

photo 1627 & 1628 of Kirk in Kayak over redd.
- Several redds here
- Found 2 scratched trees 200 meters upstream on river right
- Moose / bear trail along both sides of river.

- Water level very low. Would be good in spring, not too many sweepers, looks like spawning is over.
- Marked Tree 150 meters downstream of WPT 039, river right, not recently used, no hair no tracks on sand bars to here, except for moose and deer.
- 2 live Chinook and 1 Chinook carcass between WPT 39 and 41 (40 used as take out).
    - 20 redds in this section.

WPT #042
- Wide gravel bar and good spawning, 13 dead Chinook, 2 live Chinook since 41, of these 2 dead Chinook fed on by grizzly bear, FPW 15 cm. approximately one week old, adjacent to good spring habitat of ephemeral wetland on river right.
- Pool 200 meters downstream, 4 carcasses.
- Marked tree and 4 carcasses on gravel bar, river right 200 meters downstream again, mostly Black bear hair on marked tree, some grizzly bear hair.

WPT #43
- 12 carcasses
- Walked in on river right and found old GO trail (cut trees and blazes).
- (Need moose prevention bars across trail sets)

- 9 dead Chinook, 2 live Chinook to pull out at WPT 40

- 4 dead Chinook from 040 to 044
- One set of 15 cm Grizzle bear tracks at 044
- Lots of deer tracks on bar.

- 4 live Chinook, 3 dead Chinook at 45
- Good spawning area above very high bank on river left, fresher 15 cm grizzly track.

- Most of good spawning area ends below 45,
- Saw 15 cm grizzly track again
- 1 dead Chinook

WPT 46, old cabin on river right last used in ’95 according to calendar.
- 1 carcass across river.
- Cabin open with food on shelves and no bear activity! Means something about bear density.
- 8 carcasses on gravel bar beside pool 500 meters downstream, some spawning potential below pool.
- 15 cm grizzly bear track at 047 and 3 carcasses
- Picked up Kirk at Sovereign Creek / Swift River junction at 19:36, good pullout.

- Total: 66 dead Chinook, 13 live Chinook from falls to Sovereign Creek pullout.
- Kirk had some on his drift not recorded in my notes.
- 16 km drift altogether
- 22.5 km to Lightning junction
- Approximately 30 km to bridge (Cottonwood)

2 NOFL; RTHA – 3100 rd STJA
Cunningham Rd – past Nolaka Creek, scat, ICH wk 4,Oplopanax horridus, clover, grasses, <1 week old.
Scat, fresh: Oplopanax horridus, Sambucus racemosa, Vaccinium sp.

Road goes up Nolaka Creek to 4634 ft., 2 wheel drive access. Transition to ESSFwk1 at 1250 feet.
Road seeded with Calamagrostis canadensis and clover at lower elevation; above 1200 meters road seeded with Timothy.

50 meters up from the road in spruce /balsam forest, scat fairly fresh – grasses (Timothy?) a few Oplopanax horridus berries. GRJA
Moose tracks and browse sign
20 degree slope north east facing – mid slope

Shrubs:
Rhododendron albiflorum dense & patchy, Vaccinium ovalifolium, Menziesia ferruginea, Ribes lacustre(browsed by moose).

Herbs:
Rubus pedatus, Dryopteris expansa, Sitka valerian, three-leaved foamflower, Gymnocarpium dryopteris, Cornus canadensis, Streptopus roseus, Veratrum viride, Arnica cordifolia.

Site series 03
Habitat – spring, some herb forage (Sitka valerian, Indian hellebore) but north facing, late snow melt summer, same herbs
Fall, Vaccinium ovalifolium berries, low density.
Low to medium habitat, nothing adjacent to improve values.
Heavy Oplopanax horridus below road – 05 site series lower slope – few berries seen.

Landing approximately 200 meters below landing where plot was done. spruce, balsam, Hw, Hm, Cw. Dry upper slope to bench (landing).

Vaccinium membranaceum berries, Cornus canadensis heavily berried and dense; Clintonia uniflora berries, Streptopus roseus, Smilacina racemosa, Viburnum edule, Gymnocarpium dryopteris.

2. 1185 meters elevation road crosses bottom of ICH week 4/ avalanche track, east facing – alder, Sambucus racemosa, Veratrum viride, Cornus stolonifera, willow, Athyrium filix-femina, Rubus parviflorus, Smilacina racemosa, Aruncus dioicus, Heracleum lanatum, Epilobium angustifolium, Equisetum arvense, Urtica dioica,

cedar, spruce, Ba, Hw forest – Off of the road (pullout) in ICHwk4; Site series 08 transition to site series 07 in adjacent forest. GPS: 0619365 / 5863964
Flat bench on overall east facing slope. No slope or aspect in plot. (Nolaka?) hummocky habitat along creek: Oplopanax horridus berries, Vaccinium ovalifolium berries, Vaccinium membranaceum berries, Lonicera involucrata, alder, Menziesia ferruginea, Rubus parviflorus.

Herbs: Rubus pedatus, Cornus canadensis, Equisetum arvense, Gymnocarpium dryopteris, Athyrium filix-femina, Streptopus amplexifolius, Viola sp., Heracleum lanatum.

Site series 07
Spring and summer forage forbs (Athyrium filix-femina, Equisetum, Heracleum lanatum) a wet rich site, moderately good spring summer values through habitat along creek is not extensive – still over 3500 feet so snowpack moderately late? Spring
Adjacent habitat in rich CwHw forest understory, gentle east facing slope dominated by Oplopanax horridus (few berries), Gymnocarpium dryopteris, Dryopteris expansa, Streptopus amplexifolius, Rubus parviflorus, Vaccinium ovalifolium, Rhododendron albiflorum, Veratrum viride, Rubus pedatus.

RBNU
Pulled into a side road that leads to a clear cut with a guide outfitters camp (very new) Black bear paw prints on cabin.
Road edge into clear cut in loaded with grasses, clover and Sambucus racemosa – high berry density.
The clear cut beyond road edge doesn't have strong berry shrub growth.
The clear cut – 6 year spruce, balsam, pine regeneration: Veratrum viride, Sambucus racemosa, Gymnocarpium dryopteris, Rubus parviflorus, Epilobium angustifolium, Dryopteris expansa. Same spring value in clear cut but better along road.
Gentle terrain with a gully through the clear cut. Minimal aspect except in gully and on slope in the lower clear cut, east facing.
Deer tracks on the road.

Cunningham Creek hike:
Osprey
AMDI
Chinook – 1

KS02, KS03: 2 hair samples taken off marked tree in spruce stand adjacent to the creek, trail leads to the creek edge.
1 black bear; 2 grizzly bear (Female & 1 COY) at least one cub.
RUGR,
AMKE – American Kestral
- 17.5 cm grizzly bear track
- Faint trail through spruce flood plain (on lower slope).
- Rich forest, spruce dominant: Cornus stolonifera, Oplopanax horridus, Urtica dioica, Rubus parviflorus, Equisetum arvense, Viola, Smilacina racemosa, - Lonicera involucrate, grasses.
- Ungulate trails through the forest.

KS04 – GPS 225/652, off of mark tree - bleached out hair
balsam – river left; on well used trail.
- spruce, balsam forest, flat, rich, good spring and fall habitat : Rubus parviflorus, Smilacina racemosa, Oplopanax horridus, berries and fish.
- Very braided area, good spawning habitat
- Site series 06.
- At least one set of wolf tracks near confluence with the Cariboo River.

Confluence with the Cariboo River:

- 1 young bull moose up stream on Cariboo River
- 2 KIFI
- 1 BAEA (J); CORA
- Old track, adult grizzly bear on river right on entrance to trail downstream of confluence.
- Cunningham Creek is not paddlable.

Photo KS 19 – Cunningham Creek confluence with the Cariboo River.
Cunningham Creek (below the bridge) has:
rich lower slope,
good spring habitat,
very braided, lots of good spawning ground but few fish (3) (+1 spawned out in Cariboo)
little bear sign, infrequently travelled.

Hike up from Cunningham along Cariboo River:

16.5 cm grizzly bear upstream from Cunningham Creek, 500 meters from the Cariboo River.

hair samples KS05, KS06, KS07 – GPS mark 031 (2D), off of 2 marked trees along Cariboo river1 km up from Cunningham Creek along a well used trail,
both marked trees are balsam
habitat high bench floodplains/site series (06?)
- Fairly fresh salmon feeding.

Another marked tree approximately 50 from last large balsam
- hair sample, KS08 – big clump grizzly bear
- 2 BAFA
- Old moose carcass
- Another marked tree, grizzly bear tracks coming up from river edge.
- Fresh 14 cm grizzly track on gravel bar where hill begins.
- Mark 032

SPSA
- Trail follows edge of the Cariboo River, disappears in sections, very rough going with lots of Oplopanax horridus, Lonicera involucrate, Rubus parviflorus, Cornus stolonifera, alder and willow.
- Thick understory
- About 3 more marked trees seen, trail well used in sections.
- Richest habitat seen so far.
- Steep slope above floodplain toward road, less Oplopanax horridus, drier habitat.
- Photo KS20: Cariboo River from bridge, looking upstream.

Sept. 6/01 Victoria Creek, Swift Falls, Swift River

Rainy and overcast
3 river otters in Jack of Clubs Lake
300 Rd. – DEJU, RUHU, 3600 Rd. to Swift River Falls

Victoria Creek
- Swampy, silt substrate, lots of CWD in Creek
- No spawning gravels
- Spring bear habitat

037 – farthest 2WD to Swift Falls

Swift Falls

- SBSmw, 963 meters, site series 06?
- Steep canyon to water level
- Douglas fir, spruce, balsam on steep rocky ground down to river
- Rubus parviflorus, Aruncus dioicus, Oplopanax horridus (berries), Rubus idaeus, Cornus stolonifera, Ribes lacustre, alder.
- No fish up this far
- Not good access for boats

On ridge top: site series 04
- spruce, Douglas fir - Cornus Canadensis, Vaccinium membranaceum, Cornus stolonifera (berries)
- Bear values – a few berries in fall, no salmon in canyon, little spring value.
- 6 year clear cut adjacent has grasses and clover, along old roads, main clear cut is dominated by Epilobium angustifolium.

RTHA

Approximately 200 meters downstream from falls turnoff a spur road in clear cut ends near river – an old placer mine operation.
Saw 1 Chinook, post spawn,
pine, spruce, Douglas fir forest

Swift River Drift
- Chinook – 1 live at put-in (seen earlier)
- 1 live Chinook 200 meters downstream (same as above?)
- 1 dead Chinook, mark 39 – good spawning gravel, large redds.
- Trails on both sides of river – no recent activity along river so far.

Habitat:
- River edge: alder, sedge, aster, small amounts of Equisetum arvense, grasses, Vaccinium, Rosa, Rubus parviflorus, Heracleum lanatum.
- Some forested high bench floodplain within canyon.
- spruce, balsam forest.
- Spring value along river, but not extensive.

1 Chinook near mark 39
Moose and mule deer tracks on gravel bar downstream.
Equisetum arvense, Viburnum edule (lots of berries), Heracleum lanatum, willow, alder along shore 200 meters downstream from mark 39
High moose activity
Marked tree: 13

Mark 41
1 Chinook, 300 meters downstream from 039 area of high spawning activity, lots of redds (6-8)
SOVI
2 Chinook, 1 dead Chinook

Mark 42 - river left
- 7 dead Chinook on shore, on beach
- 1 fed on by grizzly bear
- 2-3 CORA; BAEA (adult)
- Area of dense redds just upstream
- 1 grizzly bear track along beach
- Holes in the bank on river right, bank swallow? KIFI?
- Marked tree (old bleached hairs) and trail along bank.
- 5 dead Chinook, one fed on by bear, grizzly bear tracks 15 cm
- Wetland up on bench, moose activity and tracks

150 meters downstream: 4 dead Chinook in pool
250 meters downstream: 4 dead Chinook on gravel bar river right, fed on.
trails, 1 marked tree, mostly black bear hair, a little grizzly bear
Mark 43
300 meters downstream: 1 set of wolf
8 dead Chinook
15 cm grizzly bear track
good trail
BCCH
9 dead Chinook, 2 live Chinook
3:35 pm reached take out.
1 berry scat in clear cut on bike out, lots of grass in clear cut, pine - 10 year regeneration.
Lots of deer sign around.

Spur road just west of Victoria Creek crossing:
Trimble GPS 66 – 563787 / 5863970, Mark 094T
COYE, BCCH
Road ends close to Mark 095T, 564039 / 5864348

1st Sovereign Cr. north	70500 – loop road
2nd Cabin	68100
3rd	71500

Downstream from Victoria Creek, redds still seen.
Mark 048 – 5 dead Chinook

5 COME
1 BAEA (J)
Mark 49 – impassable log jam
- Photo KS21 – log jam.
2 dead Chinook above mark 50, 6:53 pm,
1 dead Chinook just below mark 50
Mark 51 – 1 dead Chinook, 7:00 pm
Mark 52 – 1 dead Chinook
1 BAEA (adult)

Reached Sovereign Creek at 7:45 pm, class 3 drop at junction in higher water.
- No large game seen at all during paddle!
-heard 1 large animal (moose?) move away from creek at one point.
- No bear sign, but didn't spend any time walking along shore.
- Some deer and moose tracks – areas of cattle activity.
- Although Chinook numbers are low, one would expect more bear activity, fishing was easy in shallow bits.
- Redds seen until just before Sovereign Creek.

Are there any Coho in these systems?
Little sign seen so far, why so few bears? Should have seen more black bear sign.
habitat should support higher numbers
good berry season: Oplopanax horridus, Vaccinium, Sambucus racemosa, Cornus Canadensis, Cornus stolonifera (some), Streptopus roseus, Smilacina racemosa,
Lack of sign due to low numbers?
Better habitat nearby in Bowron River salmon run, Cariboo River, Quesnel River salmon runs?
Low numbers due to past human activity? Placer miners have been everywhere.

Totals: dead Chinook - 49 + (Stefan's count) 20 = 69
Live Chinook - 8 + (Stefan's count) 4 = 12

Swift River paddle from falls to Sovereign Creek = 16 km.
falls to Lightning = 22.5 km.
falls to bridge = 30 km.

Sept. 7/01 Cariboo River, Nolaka Creek
Sept. 07/01
Sunny and clear (few clouds), frost overhead, snow in alpine
Drove Likely road, dropped Kirk off on Cariboo River to kayak down to J road off 8400 road.

WPT #054 Photo of southeast facing cutblock.
- Photos 1631 and 1632, red in photo is fireweed – winter logged because stumps very tall, poor regeneration.
- 1635 towards Ghost Lake (M+ Mathew on for left in Bowron PP for WPT 54.

- Ghost Lake falls are incredible berries, see photos: Vaccinium membranaceum, Vaccinium ovalifolium, Amelanchier alnifolia, Sorbus sitchensis, Viburnum edule very, very vigorous berry production

- Clearcut at WPT 55 is not very productive, see photo 1656 with Lowes falls in background.
- 1657 is Likely – Wells road (from WPT 55) looking southwest.
- Only 2 berry scats on road up from Ghost falls to 055.
- Notice indicates Glyphosate (vision) to be used on cutblock by September 30 (none to date) (off 8421.5 road).
- J road not an option because over 1 km.
- 2 photos of Cariboo River towards lake photo 1658 & photo 1659 across valley from WPT 058.
- 8 fresh or newer scats on road mostly Vaccinium and Saskatoon.
- Black bear track,
- No the tracks identifiable.
- Walked Little River from WPT059 to 060
- At upstream branch where meets the Cariboo River (also female with COY) found on way back.
- Found one grizzly track of 16.5 cm male and female with 2 yearlings, also 14 cm SUB (before yesterdays rain).
- Didn't see any spawning salmon but saw Chinook fry in the river and found old roe - bags on beach at the junction.
- Fresh wolf tracks x3, deer and moose on sand bars.
- River is very badly choked with wood at some points and would be impossible to paddle – wading no problem.
- Otter scat at mouth
- Very good spawning gravel (Sockeye?) no Chinook redds seen, may be they spawn in
- Cariboo main river at junction. Didn't see any sign or small of carcasses on Little River (see below)*
- Good berry, moderate on floodplain: Cornus stolonifera, Vaccinium ovalifolium,
- Viburnum edule, Lonicera involucrate, Ribes laxiflorum, DC
- spruce, Ba, forest with small Cw component.
- 4 live Chinook seen on way back up with Kirk and is Kayak.

Doug Meritt – Black Chev truck, short canopy – local access knowledge

Clear skies, sunny
GERF?, AMRE
Cariboo Rd. J Rd pickup approximately – 5860 / 06213
COSN last night at Sovereign Creek

Cariboo River staring point
Mark 097T, E 228 / N 676
RBNU
River left close to Cunningham Creek is very steep, no sign of trails
Chinook Live =
Total dead Chinook = 8
Dead = 1 downstream from bridge
2 river left (island)
2
11:30 1 below Cunningham Creek
1 Nolaka Creek (confluence)
1 Nolaka island

(21422 / 59270)

Gravel bar near first island
No bear tracks, all moose
willow, fescue, sedge, Rushes, alder, Cottonwood regeneration
COYE, RYKI
Spring grasses, not rich, sandy soil (beach like), no berries
Good section of spawning gravel through here. Photo KS22

2 BAEA

Nolaka Creek

- 6 PISI
- Confluence is swampland, sedge and willow
- Water is slow moving in Nolaka, beaver dam activity, unlikely that fish get through
- Photo KS23
- One dead Chinook hauled up on log, fed on by BAEA, no bear sign.

old 13 cm tracks grizzly bear on island off of Nolaka Creek, confluence.
Mark 098T, 622495 / 5863440
Wolf tracks
Moose tracks on island as well

12:00 noon, have traveled approximately 4 km as the crow flies.

River left, approximately 500 meters downstream from Nolaka Creek:
- Site series 06 / 08 transition
- hummocky site, lower slope, flat, not really floodplain more swampy.
- Faint trail, moose, no bear sign, <100 meters to steep slope
- Vegetation: Cornus stolonifera, Lonicera involucrate, Oplopanax horridus, Rubus parviflorus, Rosaceae, Ribes lacustre, Viburnum edule (berries), Equisetum arvense, Athyrium filix-femina, Gymnocarpium dryopteris, Tiarella trifoliate, Viola, grasses (minor), Aster, Geranium? Heracleum lanatum minor),
- Trees: cedar, spruce, balsam, paper birch
- Rich site, few berries
- Good spring habitat

Chinook dead = 8 (5 @ Mark 099T)

Mark 099T Photo KS23, looking west, KS24 looking east.
- Wolf tracks
- 15.0 cm grizzly bear, also 13 cm grizzly bear
- Good spawning grounds here
- Active area – 3 fed on fish
- Log jam on river left
- Heard something move off log jam may have been a fishing bear – no visual.

SPSA
KIFI

Photo KS25 – back channel just above Sixbee Creek.
- No salmon in any tributaries so far.

Island just below Sixbee Creek
15 cm grizzly track, before last rain
13.5 cm grizzly track and 9.5 cm – female and yearling (probably from this morning)
1 carcass fed on by young bear (it dug a hole into the sand)
Also an 8cm grizzly track (fresh) – COY?

13 cm fresh grizzly track, heading upstream on river right across from 2nd large island below Sixbee Creek
muddy substrate, spawning gravel upstream
Photo KS26, looking upstream
Bottom of 2nd island:
13.5 and 8.5 cm grizzly track, female and yearling, recent but pre-rain.

Photo KS27 – tracks facing downstream
Photo KS28 – facing upstream, island on right.

Mark 100T, river right – across from tributary where Stefan was going to pick me up (J road – does not get close enough)
- Same grizzly female and cub from island upstream, moving up and down stream, before rain.
- Also moose and fresh deer tracks (small deer)
- Berry scat – primarily Vaccinium, lots of Vaccinium leaves, some green grass, no sign of salmon.
- Wolf tracks

Habitat off of downstream end of gravel bar, river right, trail, Photo KS29
Trees: spruce, paper birch, balsam
Shrubs: Viburnum edule (lots of berries), Cornus stolonifera (few berries), Amelanchier alnifolia (berries), Rubus parviflorus (berries), Rosaceae, Rosa, Spiraea douglasii, Heracleum lanatum, Lonicera involucrate.
Herbs: Equisetum arvense, Aster, Smilacina racemosa (berries), Clintonia uniflora, grasses, Sasparilla, Marigold? Athyrium filix-femina. Thick shrub layer, good berry production (especially Viburnum edule).
Good spring values –Equisetum, Ribes, young growth grasses.

River left approximately 200 meters from end of island
berry scat all Vaccinium membranaceum, lots of leaves, 2nd scat just downstream, very large also containing Vaccinium.
Faint grizzly bear tracks in gravel
Steep bank up to forest, faint trail follows bank edge
Forest is on flat bench, trees: spruce, balsam, cedar
Shrubs: Rubus parviflorus, Amelanchier alnifolia, Vaccinium membranaceum lots of berries), Vaccinium ovalifolium, Viburnum edule berries), Cornus stolonifera
Herbs: Cornus Canadensis (berries), twinflower, Sarsaparilla, Streptopus roseus, Smilacina racemosa (berries),
Drier forest, not as rich as floodplain, still good berry production, spring values not as high.

Fresh tracks river left on the 180 degree turn, pre-rain.

Fresh tracks river right at exit to turn, pre-rain.

Multiple sets of tracks on gravel bar.
1 scat, primarily Vaccinium, some grass (fescue).

Just below small confluence with creek, old tracks in the mud.
- River is slow moving now, no good spawning gravels since #7

Old grizzly bear tracks (pre-rain).
CAGO staging area, approximately 22

grizzly bear tracks
no gravel bars since #10, all mud banks and bars, still seeing grizzly bear sign though no fish have been seen in a while. No spawning grounds.

River right, grizzly bear tracks in mud bank, scrambling up and down bank.
Photo KS30 – looking upstream, bank with tracks is on left.

6:00 pm, Little River
- 1 hour to truck dragging boat
- Saw 1 COY, 7.5 cm tracks among adult and yearling grizzly bear tracks.
- 4 live Chinook, 1 still paired
- MERL
- GHOW, below Cariboo Lake
- Lots of snowshoe hare along road.

Summary
Fall sampling would work here; the best areas are from Cunningham Creek to #10, though lots of activity farther downstream, although there is little spawning habitat. Little River also had lots of activity, also good for fall sampling, lots of potential sites in both areas. It's a long paddle from the bridge to the lake, a full day. It's feasible, but time on the shore setting / checking stations or habitat work would be limited. A long and tiring trip. The river is very slow below the halfway mark, a jet boat may be best.

Mike at the gas station has an inboard and jet boat, maybe for hire?

Sept.8/01

Morning overcast
10+ AMPI
Fran MacPherson 994-3337, local knowledge

Photo KS31 – Antler Creek where Bowron Rd crosses
Photo KS32 – Antler Creek looking downstream back channel
Photo KS33 – Antler Creek off bridge looking upstream
Photo KS34 – Antler Creek off bridge looking downstream

Antler Creek upstream bridge approximately 200 meters,
River left mixed dead conifer stand
Trees: spruce, balsam, alder, Cottonwood regeneration SBSwk1, site series 09
Shrubs: Lonicera involucrate, Rosa.
Herbs: Gymnocarpium dryopteris, Equisetum arvense (good cover), grasses (good cover), Heracleum lanatum, sweet coltsfoot, Cornus Canadensis, Streptopus roseus, Sanguisorba Canadensis.
Photo KS35 – ground cover
Photo KS36 – forest
Good spring habitat - Equisetum arvense, grasses primarily
No berries
No salmon so far

2 dead Chinook (very old), Mark 101T on gravel bar
Adjacent low bench willow / sedge floodplain
Adjacent to highbench floodplain – 09 site series, no berries, good spring forage.
Photo KS37 – Low floodplain (end of role).

KS02 Photo KS38 – test – low bench floodplain
Photo KS39 – Antler Creek looking at stream 50 meters above mark 101T.
Very old grizzly bear track, 15.5 cm
deer tracks
14.0 cm grizzly tracks upstream, fresher than previous.
Good fishing in this section, braided channels.
2 dead Chinook, 1 dying Chinook
2 live Chinook (in good shape), one still redd building (mark 102T)
Photo KS40 river right, river bank foliage, mark 102T
2 dead Chinook, fairly fresh feeding sign (this morning?)
14.0 cm tracks, fairly fresh
1 dead Chinook caught in log jam

Total dead Chinook = 5
Total live Chinook = 3

Mark 103T, farthest point attained – canyon starts.
Photo KS41, looking upstream
Less braiding upstream in canyon
Just downstream of Mark 103T river forks, 1 branch traveling through forest.
Good rearing habitat.

On return downstream
Between Mark 102T and 103T, Photo KS42 and KS43 herb layer, lower slope / toe forest

primarily spruce, balsam, mature stand
Shrubs: Lonicera involucrate, low cover shrub
Herbs: Cornus Canadensis (few berries), wintergreen, Smilacina racemosa, Streptopus amplexifolius,
Few berries, thick moss layer
Low cover of grasses
Approximately 50% canopy closure, dense spruce forest.
Photo KS44 Amanitas
Section between mark 101T and 103T is prime fishing habitat, lots of braids and log jams.

Downstream access to Antler Creek
- Mark 104T – off side road, just inside park (see map in original notes)
- House nearby
- Bait station for Region 7 DNA bear inventory on river left, wire is up, no bait.

1 live Chinook
- Mark 105T, ICH, several redds
- Photo KS45, looking upstream
- Photo KS46 looking downstream
- Photo KS47, mark 105T cottonwood forest / floodplain, good spring habitat.
- More of a Sockeye creek, slow moving, shallow, finer gravels, easy fishing.
- 3 live Chinook (1 half dead)
- 1 dead Chinook
- BCCH

Mark 106T turn around point
- No bear sign, lots of deer tracks
- Photo KS48 river right high bank with pine, spruce forest
- Photo KS49 river left willow / cottonwood flats
some Sambucus racemosa with berries
seems to be opening up toward Bowron River, less spawning gravels.

Mark 106T
- Photo KS50 pine, spruce forest on flats approximately 2 meter elevation above creek
- Marked tree, faint trail
- Hair sample KS04, Blackbear
- Habitat: - minimal shrub and herb layer: Linnaea borealis, Cornus Canadensis,
Low spring and fall grizzly bear value, not rich, not productive, across creek is productive.

Mark108T Approximately 200 meters from creek on high flats (approximately 20 meters elevation above creek)
- Trees: pine, spruce, aspen, balsam mature forest
- Shrubs: Vaccinium membranaceum, Sorbus sitchensis, Vaccinium myrtilloides
- Herbs: Cornus Canadensis (a few berries), Rubus parviflorus, Lycopodium sp., Streptopus roseus, Clintonia uniflora, Gymnocarpium dryopteris, - birch-leaved spirea, sweet coltsfoot, Smilacina racemosa,
- Gently rolling terrain; hummocky site
- Photos KS51 and KS52 site series 03 understory.
- Low spring, summer and fall values, no spring foods, low berry production
    - Some Vaccinium myrtilloides in clearings (road edges, lots etc.), still ripening in places, very tasty.

Clear in morning, sunny with clouds in afternoon / evening
- Logistics day to sort out R22 flight
- Kirk to Antler then got a hole in radiator and went to Quesnel at 16:00
- Met Bill and Claire at gallery talked about grizzly bears in area.
- Marie Nagel (mayor), good contact for locals – editor of paper.
- Hagan – PFO BC Parks Bowron
- Judy Campbell – Ecotourism business, naturalist
- Peter Kushman GO and German GO
- Becker's Lodge
- Dave and Cheryl Jorgenson
- Verna and Rick – snowmobile tours

- Drove to Yanks Peak road

WPT 62, large Vaccinium membranaceum scat on road since rain, lots of leaves and stems (no tracks), 2 photos same vantage, grizzly bear scat 1.62 km south on Yank Park road 13 cm grizzly track.

- Placer mine photos 1670-1675 at 063.

- Vaccinium membranaceum scat at 064 road junction.

Yanks Park area WPT 065
- 6280 ft. photos 1677-1680 taken from Roundtop and area to southeast and east (Cariboo River?)

WPT 66
- Photos 1685-1687 Roundtop and area to east.

Table 1. TFL52 Summary of Bear Sign and Salmon Counts Along Streams.

Stream	Sign	Salmon (Totals)
Upper Swift River	**Sept.6/01**	
	Swift Falls impassable to salmon	
GPS reference	Grizzly Bear sign:	
Mark 042	15 cm grizzly bear track	Live: 8
	Marked tree; FS	Dead: 39
Mark 043	15 cm grizzly bear track	
Lower Swift River from Victoria Creek to Sovereign Cr.		
GPS reference	Grizzly Bear sign:	
Garmin mark 048, 049 (photo 21), 50, 51, 52		Live: 12
		Dead: 69
Cariboo River	**Sept.7/01**	
Kimball Bridge to Little River		
GPS reference	Grizzly Bear sign:	
Trimble mark 098T	13 cm grizzly bear track	Live: 2
Trimble mark 099T	15 cm grizzly bear track	Dead: 21
	13 cm grizzly bear track	
	(may be the same as above)	
Sixbee Creek Island	15 cm grizzly bear track (older)	
	grizzly female & 2yearlings? –13.5 cm tracks	
	9.5 cm grizzly bear track 8.0 cm grizzly bear track (COY?)	
2nd Island below Sixbee Creek	grizzly female & 1 yearling – 13.5 cm, 8.5 cm	
Mark 100T	13 cm grizzly bear track	
	Berry scat, Vaccinium	
	#7. – 2 berry scat, primarily Vaccinium	
	grizzly tracks	
Little River	**Sept.7/01**	
	grizzly bear COY tracks (7.5cm)	Live: 4
	Adult and yearling grizzly bear	

Stream	Sign	Salmon (Totals)
	Chinook fry in river	4 live Chinook, post spawners
Lower Antler Creek	Sept.8/01	
	Grizzly Bear sign	
	15.5 cm grizzly bear (old)	Live: 3
	14.0 cm grizzly bear (fresh)	Dead: 7
	FS (fresh)	
In Bowron Park		
	Marked tree – hair sample, KS04 (black bear)	Live: 5
		Dead: 1
Upper Antler Creek	**Sept4/01**	
	Marked tree – 2 berry scat	Live: 0
	Hair sample KS01	Dead: 0
Atan Creek		
Chisel Lake	Near Atan Lake, at road crossing	Live: 0
		Dead: 0
Cunningham Creek	**Sept.5/01**	
	2 berry scat on Cunningham Creek road	Live: 3
	1 grass/berry scat at road end	
	Black bear prints on guide cabin	
	Along creek, marked tree hair samples:	
	KS02, KS03	
	grizzly bear tracks (female & 1 COY)	
	17.5 cm grizzly bear track	
	marked tree hair sample KS04	
Cariboo River	Sept.5/01	
	Adult grizzly bear track at confluence	Live: 1
	16.5 cm grizzly bear track	Dead: 1
	2 marked trees, hair sample KS 05, 06, 07; FS	
	Marked tree hair sample KS08	
	Marked tree, grizzly tracks	
	14 cm grizzly track	

Table 2. TFL 52 Salmon Availability Ratings (Sept 2001)

Location	Reach	Rating
Cariboo River	Bridge – 1	5
	1 – 2	5
	2 – 3	5
	3 (spawning grounds log jam)	4
	4 – 5	4 – 5 (carcasses available)
	5 – 6	4 - 5 (around island)
	6 – 7	5
	7 – 10	5 - 6
		Possible carcasses available in backwater, though none seen
	10 – Little River	5 - 6
		River slow, deep, mud banks, no gravel bar, no spawning habitat, possible carcass along shore.
Lower Antler Creek	Trimble mark 101T-103T	2 – 3(easy fishing, few salmon)
Lower Antler Creek (in Bowron Park)	Trimble mark 104T-106T	2 – 3 (easy fishing few salmon)
Upper Antler Creek (above 2nd bridge)	Trimble GPS mark 088T – 3 -	6 no salmon
Atan Creek	Mark 089T	6 no salmon
Cunningham Creek	Bridge – confluence	5 – 6 Good fishing grounds few salmon
Swift River	Falls – mark 039	4 - 5
	Mark 039 – mark 043	3– 4 Good spawning grounds, carcasses available
	Mark 043 – Victoria Creek	good Chinook spawning class 2 salmon availability
	Victoria Creek – Sovereign Creek	4 – Good spawning and fishing grounds, few fish
Little River	Good spawning sections but lots of wood choked sections and cascades.	class 2-3 annual salmon availability

Salmon availability (to bears) ratings scheme used in Table 2 is based on the habitat suitability rating scheme from Wildlife Habitat Assessment:

% of best	rating	number code
100 - 76%	High	1
75 - 51%	Mod. High	2
50 - 26%	Moderate	3
25 - 6%	Low	4
5 - 1%	Very Low	5
0%	Nil	6

The following criteria was used to decide on rating for each river or river reach in a given year:

1. annual salmon escapement
2. length of river with salmon spawning
3. bank and gravel bar characteristics
4. # of spawning reaches
5. distribution and numbers of salmon species

The ratings assume that the Bella Coola/Atnarko River system is class 1 (one of the best in the province). This is because:

- The Bella Coola/Atnarko has high annual escapement > 1 million for all species combined in most years
- salmon spawn throughout the system from mouth to headwaters
- water levels during spawning are low, especially in Atnarko, making fish availability high
- has all 6 major salmon species (however, Steelhead very low)
- salmon runs have been stable for a long time.

Table 3. Habitat Types Surveyed for TFL52 Reconnaissance

Location	Subzone Variant	Site series	Forest	Potential Bear Foods
Round top mountain	ESSF		balsam	Late spring, summer forbs
Antler Creek (upper)	SBS wk1	Rich toe slope	spruce, balsam	Spring forbs, summer, fall berries
	SBS wk1	Rich toe slope	spruce, balsam	Spring forbs, summer, fall berries
	SBS wk1	Flat-dry to mesic	pine, spruce, Ac	Summer and fall berries
	SBS wk1		Shrubs stage C.C.	Summer forbs, berries
Atan Creek	SBS wk1	Marsh	willow / Sb	Spring grasses
Atan Lake		09	spruce, balsam	Spring Equisetum
Chisel Lake	SBS wk1			Forbes, berries
	SBS wk1		20 yr. pine regeneration	minimal
	SBS wk1	05	spruce, balsam, pine	Dew berries, dew forbs, late snow
	SBSwk1	01	spruce, balsam	Berries, late snow, forbs
Nolaka Creek	ESSFwk1	Rich	spruce, balsam	Late spring forbs, few berries,
	ICHwk4	Avalanche, slide alder	alder, willow	High values, spring and fall berries
	ICHwk4	08/07 transition	cedar, spruce, balsam, Hw	Berries / forbs (Herlan)
	ICHwk4	07	Forest adjacent to above	Few berries, Oplohor shrub layer
Cabin C.C.	ICHwk4		Shrub regeneration	Road edge, grasses, berries
Cunningham Creek	ICHwk4	Rich lower slope - 06	spruce, balsam	Spring grasses, forbs, fall berries, good habitat
Cunningham	ICHwk4	Rich, high	spruce,	Good spring berry

Creek / Cariboo River		bench floodplain	balsam	production
Swift River				
Falls	SBSmw	06?	Douglas fir, spruce, balsam	A few berries, minimal
Ridge top at falls	SBSmw,	04	spruce, Douglas fir	A few berries
	C.C.		Shrub stage	Grasses and clover along road
Along the river		Rich	spruce, balsam	High spring forbs, some berries
Cariboo River	ICHwk4	Low bench floodplain	willow	Spring grasses no berries
below Nolaka Creek	ICHwk4	06 / 08 transition	cedar, spruce, balsam, paper birch	Good spring forbs, few berries
	ICHwk4	Rich lower slope	spruce, paper birch, balsam	Good berry production in the fall
	ICHwk4	06	spruce, balsam, cedar	Good berry production
Antler Creek				
- Lower	SBSwk1		spruce, balsam, alder	Spring grasses
Mark 102T	SBSwk1	Lower slope	spruce, balsam	Few berries, few forbs, low
Mark 108T	SBSwk1	03	pine, spruce, balsam, Ac	Few berries, few forbs

Table 4. Waypoint List for TFL52 Grizzly Reconnaissance Survey, September 2001.

WPT#	Date	Time	UTM Zone		UTME	UTMN	Photo #
005	01-Sep-01	19:32	10	U	525970	5922837	
006	02-Sep-01	9:15	10	U	558134	5957555	
007	02-Sep-01	11:04	10	U	555536	5962645	
008	02-Sep-01	11:06	10	U	556461	5961891	
009	03-Sep-01	9:27	10	U	555246	5878394	
010	03-Sep-01	15:52	10	U	614460	5863276	1563-1565
011	04-Sep-01	9:35	10	U	555120	5939786	1580
012	04-Sep-01	9:41	10	U	568541	5930337	1581-1583
013	04-Sep-01	9:45	10	U	581077	5921851	1584
014	04-Sep-01	9:51	10	U	594500	5911164	1585,1586
015	04-Sep-01	9:51	10	U	594620	5911064	1587
016	04-Sep-01	9:54	10	U	602422	5902034	1588,1589
017	04-Sep-01	11:46	10	U	598674	5921600	
018	04-Sep-01	11:50	10	U	606726	5914787	
019	04-Sep-01	12:18	10	U	599327	5921921	
020	04-Sep-01	13:53	10	U	574420	5962409	
021	05-Sep-01	8:51	10	U	619033	5872101	
022	05-Sep-01	8:59	10	U	621848	5867009	
023	05-Sep-01	9:04	10	U	621442	5865753	
024	05-Sep-01	9:44	10	U	617071	5864766	
025	05-Sep-01	10:37	10	U	617302	5864713	1591-1595
026	05-Sep-01	10:56	10	U	619184	5863120	1596
027	05-Sep-01	11:16	10	U	619370	5863963	1599,1600
028	05-Sep-01	12:01	10	U	619781	5864448	
029	05-Sep-01	13:13	10	U	622021	5865513	
030	05-Sep-01	13:55	10	U	622499	5865195	1608
031	05-Sep-01	15:25	10	U	623059	5865964	
032	05-Sep-01	15:44	10	U	622835	5866292	
033	06-Sep-01	16:57	10	U	622852	5867582	
034	06-Sep-01	9:13	10	U	552241	5873230	
035	06-Sep-01	9:29	10	U	561281	5866688	
036	06-Sep-01	9:37	10	U	564769	5863315	1613
037	06-Sep-01	9:51	10	U	568922	5861792	
038	06-Sep-01	10:42	10	U	568422	5862102	

WPT#	Date	Time	UTM Zone		UTME	UTMN	Photo #
039	06-Sep-01	13:09	10	U	567521	5862221	1627,1628
040	06-Sep-01	13:09	10	U	566644	5862908	
041	06-Sep-01	13:32	10	U	567636	5862660	
042	06-Sep-01	13:37	10	U	567534	5862908	
043	06-Sep-01	14:24	10	U	567166	5862881	
044	06-Sep-01	15:09	10	U	566210	5864015	
045	06-Sep-01	15:31	10	U	565472	5864651	
046	06-Sep-01	16:08	10	U	565295	5865356	
047	06-Sep-01	16:34	10	U	564179	5865745	
048	06-Sep-01	17:06	10	U	563674	5865825	
049	06-Sep-01	17:31	10	U	562874	5867082	KS21
050	06-Sep-01	17:52	10	U	562785	5868155	
051	06-Sep-01	18:17	10	U	563169	5868597	
052	06-Sep-01	18:24	10	U	563119	5869678	
053	07-Sep-01	9:34	10	U	622868	5867571	
054	07-Sep-01	9:58	10	U	638227	5862838	1631-1635
055	07-Sep-01	11:36	10	U	640306	5867019	1656,1657
056	07-Sep-01	12:45	10	U	621089	5853058	
057	07-Sep-01	13:47	10	U	621421	5859267	
058	07-Sep-01	14:09	10	U	621814	5857889	1658,1659
059	07-Sep-01	15:00	10	U	621215	5853364	
060	07-Sep-01	16:30	10	U	617398	5854225	
061	08-Sep-01	11:53	10	U	603802	5894001	
062	08-Sep-01	16:30	10	U	608218	5873775	
063	08-Sep-01	16:47	10	U	610081	5870890	1670-1675
064	08-Sep-01	16:59	10	U	611180	5863730	
065	08-Sep-01	17:45	10	U	609217	5858223	1677-1680
066	08-Sep-01	18:03	10	U	609437	5858584	1685-1687
067	08-Sep-01	20:50	10	U	605740	5854619	
068	09-Sep-01	5:15	10	U	573533	5772672	
069	09-Sep-01	5:56	10	U	604766	5840739	
070	09-Sep-01	6:09	10	U	608334	5845524	
071	09-Sep-01	6:13	10	U	615029	5851381	
072	09-Sep-01	6:17	10	U	619370	5853305	
073	09-Sep-01	6:20	10	U	624128	5852820	
074	09-Sep-01	6:23	10	U	628815	5851456	
075	09-Sep-01	6:26	10	U	630763	5848756	1773

WPT#	Date	Time	UTM Zone		UTME	UTMN	Photo #
076	09-Sep-01	6:37	10	U	617486	5853953	
077	09-Sep-01	6:39	10	U	618698	5855029	
078	09-Sep-01	6:45	10	U	621457	5860684	
079	09-Sep-01	6:54	10	U	613217	5877498	1776,1777
080	09-Sep-01	6:58	10	U	609397	5886937	1778
081	09-Sep-01	7:00	10	U	606711	5892841	
082	09-Sep-01	7:07	10	U	603809	5902020	1779
083	09-Sep-01	7:09	10	U	604556	5902632	
084	09-Sep-01	7:10	10	U	606147	5901995	
085	09-Sep-01	7:12	10	U	604302	5903073	
086	09-Sep-01	7:15	10	U	602400	5905239	
087	09-Sep-01	7:25	10	U	595341	5922416	
088	09-Sep-01	7:30	10	U	602255	5920532	
089	09-Sep-01	7:31	10	U	603277	5919276	
090	09-Sep-01	7:34	10	U	607045	5914648	
091	09-Sep-01	7:39	10	U	603938	5918780	
092	09-Sep-01	7:42	10	U	601724	5913775	1782
093	09-Sep-01	7:45	10	U	600244	5905226	
094	09-Sep-01	7:53	10	U	596659	5897110	1787-1791
095	09-Sep-01	8:32	10	U	586755	5877964	
096	09-Sep-01	8:40	10	U	576453	5880215	
097	09-Sep-01	8:49	10	U	565104	5875161	
098	09-Sep-01	8:53	10	U	559429	5874215	
099	09-Sep-01	9:02	10	U	564275	5864749	
100	09-Sep-01	9:12	10	U	569544	5851670	
101	09-Sep-01	9:15	10	U	569221	5857553	1796
102	09-Sep-01	9:17	10	U	568521	5862102	
103	09-Sep-01	9:19	10	U	567110	5862928	
104	09-Sep-01	9:24	10	U	562990	5866878	
105	09-Sep-01	9:37	10	U	533157	5875104	
106	09-Sep-01	10:12	10	U	552386	5854649	1797
107	09-Sep-01	10:49	10	U	573539	5772667	
ANTSTA	START-ANTLER		10	U	606118	5894577	
CWBH	03-Sep-01	9:35	10	U	555397	5878494	
CWDMP	04-Sep-01	7:28	10	U	560416	5875710	
LITEND	MAEFORD01	0:03	10	U	560465	5774861	
SWFTFA	06-Sep-01	7:11	10	U	568401	5862124	

WPT#	Date	Time	UTM Zone		UTME	UTMN	Photo #
	Trimble GPS						
088T	04-Sep-01	9:57	10	U	605621	5894917	
089T	04-Sep-01	14:05	10	U	607956	5894874	
090T	04-Sep-01	14:06	10	U	607969	5894802	
091T	04-Sep-01	15:37	10	U	610965	5891434	
092T	04-Sep-01	16:41	10	U	612163	5889931	
093T	04-Sep-01	17:40	10	U	613373	5887003	
094T	06-Sep-01	17:10	10	U	563787	5863970	
095T	06-Sep-01	17:25	10	U	564038	5864348	
096T	06-Sep-01	19:24	10	U	562140	5870439	
097T	07-Sep-01	10:26	10	U	622859	5867591	
098T	07-Sep-01	12:13	10	U	622495	5863441	
099T	07-Sep-01	13:15	10	U	622405	5862501	KS23,KS24
100T	07-Sep-01	14:45	10	U	621342	5860316	KS29
101T	08-Sep-01	11:33	10	U	605518	5898076	KS37-KS39
102T	08-Sep-01	12:09	10	U	605706	5897955	KS40
103T	08-Sep-01	12:25	10	U	605913	5897827	KS41-KS43
104T	08-Sep-01	13:47	10	U	604998	5901127	
105T	08-Sep-01	14:05	10	U	605165	5901293	KS45-KS47
106T	08-Sep-01	14:19	10	U	605491	5901504	KS48-KS50
107T	08-Sep-01	14:31	10	U	605337	5901303	
108T	08-Sep-01	14:56	10	U	605122	5901060	KS51,KS52
109T	08-Sep-01	15:16	10	U	605113	5900866	
110T	08-Sep-01	15:17	10	U	605113	5900866	

Field methods. To collect grizzly bear DNA, we used barbed wire snares to capture hair samples. Hair snares consisted of a single ~30 m strand encircling three to six trees at a height of ~50 cm, baited with scent lure (Woods et al. 1999, Kendall et al.Â Longer time series of salmon availability and bear population trend data are critical to better understand these dynamics on the temporal scale at which they most strongly interact.Â Utilization of mark-recapture for the study of recruitment and population growth rate. Biometrics 52:703-709. http://dx.doi.org/10.2307/2532908. Price, K., A. Roburn, and A. MacKinnon. 2009. Ecosystem-based management in the Great Bear Rainforest.