

**Grizzly Bears and the Montanore Mine Project:  
Analysis of Bear Scat Monitoring, Agency Data, and Literature**

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## *Summary*

A grizzly bear scat survey was conducted during 2009 in the area of the Montanore Mine Project in the Cabinet Mountains in northwest Montana. The results demonstrated the effectiveness of the method and provided baseline data that can be used to modify the method for the purpose of documenting impacts of the Project. Mitigation could then be modified to reflect actual impacts. The proposed grizzly bear mitigation requirements that are described in the Draft Environmental Impact Statement for the Project are based on predicted impacts. The level of conservativeness in these predictions and the extent of the proposed mitigation are heightened by a lack of confidence in the predictions and a belief that the grizzly bear population in the Cabinet Mountains is small and declining. Based on a review of the Draft Environmental Impact Statement, available data, technical literature, and the results of the 2009 bear scat survey, it appears possible that:

- Grizzly bear abundance in the Cabinet Mountains may be considerably greater than the current minimum population estimate;
- Predicted impacts of the Project may be overly conservative.

## ***Introduction***

The Montanore Mine Project is a proposed underground silver and copper mine located in the Cabinet Mountains, along the eastern boundary of the Cabinet-Yaak Ecosystem (CYE, Map 1). The CYE is one of six recovery zones for grizzly bears in the U.S. It is a 2,600 mi<sup>2</sup> region lying mainly in the northwest corner of Montana and supports a population of grizzly bears that is listed as Threatened under the Endangered Species Act. The 1,500 mi<sup>2</sup> Cabinet Mountains portion of the CYE is separated from the Yaak River portion by U.S. Highway 2, the Kootenai River, and a major railroad. No grizzly bear movement has been documented between these two areas (Kasworm *et al.* 2009).

Implementation of a large scale natural resource development project on public land requires a thorough understanding of existing environmental conditions, potential impacts, and appropriate mitigation. Montanore Minerals Corporation (MMC) requested an investigation of non-invasive methods to monitor grizzly bear as part of their comprehensive environmental baseline data collection program. The use of grizzly bear scat monitoring was determined to be a viable alternative. MMC engaged the University of Washington to use a bear scat monitoring method that they had developed and allowed them to design a survey to demonstrate its effectiveness as a monitoring tool for the Project. MMC approached the U.S. Forest Service, U.S. Fish and Wildlife Service, and the Montana Department of Fish, Wildlife, and Parks to discuss the method and invite their participation.

This report focused mainly on the Cabinet Mountains portion of the CYE because it is most relevant to the Project. The potential for continued use of bear scat surveys for monitoring impacts from the Project was assessed. In addition, available information, including results of the 2009 bear scat survey, was utilized to critique the most recent CYE grizzly bear population size and trend estimates (Kasworm *et al.* 2009) and the predicted impacts of the Project (USDA 2009).

### *Assessment of the 2009 University of Washington Bear Scat Survey*

The objectives of the 2009 bear scat survey were to collect baseline data for the Project and to evaluate the potential use of the method for monitoring. During 2009, specially trained dogs were used to survey bear scat in part of the Cabinet Mountains surrounding the Project area and a second area in the Yaak River portion of the CYE. The Project survey area encompassed 675 km<sup>2</sup> that surrounded the Project area, including 452 km<sup>2</sup> (11%) of the Cabinet Mountains portion of the CYE and 220 km<sup>2</sup> to the east of the CYE (Map 2). DNA from scat was used to confirm bear species and analyses were conducted to determine levels of a stress hormone, gonadal hormones, and thyroid hormone metabolite. For some samples, individual identity and sex were also able to be determined. This information was linked to scat location data, allowing comparison to other mapped data pertaining to habitat attributes and potential sources of stress. The complete University of Washington (2010) report is attached to this report.

The results provided some data that can be used for assessing baseline abundance and distribution of grizzly bears in the Project area, although the University of Washington sampling design does not appear to have been optimal for this purpose. More importantly, the study demonstrated the effectiveness of the methods and provided data that can be used for development of an optimized monitoring plan. Based on the University of Washington (2010) report, the following should be considered when designing a monitoring plan:

- Difficulty in assessing observed versus expected grizzly bear distribution from transects that were not representative of available habitat;
- Development of a method to provide objective estimates of scat age;
- Non-independence of samples collected during the various sessions (see Petit and Valiere 2006 and discussion below);
- An inability to assess family relationships due to limitations in analyzing scat DNA;
- Justification for surveying the Yaak River area (see discussion below);

- An unknown underestimation of grizzly bear abundance and possible between-dog bias because the method relied on availability of grizzly bear scat from the survey area for dog training;
- An inability to identify causes of elevated stress hormones or physiological implications (see von der Ohe *et al.* 2004 and discussion below).

By attempting to return to each cell once during each of four sessions, differences in results among cells due to timing were minimized. For this reason, the multiple session approach was warranted. However, as discussed by Petit and Valiere (2006), scat samples collected during a given session may have been deposited during a previous session and cannot be treated as being independent when analyzing the data. Subjective judgment of scat age does not adequately address this limitation. Multi-session hair snag surveys are superior in this regard. Fortunately, this weakness of scat surveys does not preclude its use as a monitoring method for the Project, although conclusions would be limited if samples could not at least be assumed to have been deposited during the survey year.

The approach of the 2009 sampling design was to consider the Project survey area as a potential impact site and the Yaak River survey area as a control, or reference site. A Before-After-Control-Impact (BACI) design is implied by the 2009 approach (Stewart-Oaten and Murdoch 1986, Osenberg and Schmitt 1996, Stewart-Oaten 1996). One assumption of this approach is that the grizzly bear population or hormone attributes in both areas will vary together closely enough that deviations in the relationship during operation can be identified. Another assumption is that the Project would be the overriding cause of any deviations between the two areas. This approach demands a substantial understanding of the pre-impact relationship of the two areas. The required length of this time-series increases as a function of variability, with an eventual conclusion possibly being that no definable relationship exists. Ideally, a BACI design would include multiple controls and thorough documentation of similarities and differences between the control and impact sites.

No patterns were apparent in the 2009 data with regard to levels of fecal cortisol, a stress hormone (Map 3). If it is assumed that fecal cortisol level reflects the experiences

of a grizzly bear from the previous 24 hours (S. Wasser, personal communication) and the average daily movement distance of a grizzly bear is ~3 km (Gibeau 2000), then the locations of the scats were reasonably representative of the area that influenced the cortisol levels in the scats. Given the lack of spatial pattern in the 2009 data (Map 3), it does not appear that stress hormones will be a useful component of a grizzly bear monitoring plan. For example, the six scats that were found in the Cabinet Wilderness had a higher average cortisol level than the six that were in areas of the highest road densities. While it is sensible to analyze scat for anything possible and affordable given the effort it takes to collect it, it appears that it may be difficult to determine cause and effect with regard to cortisol levels.

The University of Washington (2010) report noted a significantly higher level of cortisol in grizzly bear scat in the Project survey area relative to the Yaak survey area, but it provided no analysis of the possible causes of this finding, given that the Project is not underway. The report implied that the 2009 Project activities and logging may have resulted in increased stress of grizzly bears in the Project area. However, no data regarding logging was provided, and there was actually a slight increasing trend in cortisol levels with increasing distance from the Libby Adit, where the 2009 Project activity occurred.

In addition, it should not be assumed that stress is detrimental to grizzly bears. Studies cited by Bowles (1995) found that elevated heart rate, catecholamine levels, and corticosteroid levels in wildlife in response to noise, including helicopters, were short term and did not correlate well with distress. Some of these physiological responses were found to be similar to the response to common occurrences such as the sounds produced by biting insects. Perhaps the higher stress levels in the Project area were due to a greater number of biting insects, or a greater number of grizzly bears. These examples of a lack of meaningful consequence of stress to wildlife in general are consistent with the findings of Cattet *et al.* (2008b) for grizzly bears:

*“Our finding of a positive association between stress and growth is counterintuitive as it suggests bears exhibiting the greatest growth were also the most stressed. However, some insight is offered by observations that bears with greatest growth also inhabit areas*

*where road density is greatest whereas bears with lowest growth inhabit areas of higher elevation where human access is less. We suggest this pattern may be due to availability of better food resources in disturbed areas (as reflected by road density) where bears are more likely to be stressed by human activities and/or landscape conditions, than in higher elevation areas where human activity is less, but so too is food quality and availability.”*

The 2009 bear scat survey (University of Washington 2010) provided locations for grizzly bears that were not influenced by the sources of bias that the predicted impacts of the Project are based on (see below). Bias that was created by the criteria that were used to select transects for the bear scat survey can be corrected for, or can be avoided in future surveys depending on the sampling design that will best meet the monitoring objectives. A more concentrated effort in the Project area during operation will define objective, site-specific zones of influence and disturbance coefficients for roads, helicopter use, and all Project activities, and will provide information on habitat preference that can be used to optimize mitigation.



## *Population Size*

The most recent CYE grizzly bear recovery report (Kasworm *et al.* 2009) provided a minimum population estimate of 18 grizzly bears for the Cabinet Mountains portion of the CYE, up from 16 grizzly bears in the previous annual report (Kasworm *et al.* 2008). The minimum population estimate for the Yaak River portion remained at 29 grizzly bears. While these are minimum estimates, it would seem that an objective, central estimate would be important when making management decisions. Two methods of estimating population size are presented below. The datasets are independent of each other, yet both analyses indicated that there are substantially more than 18 grizzly bears in the Cabinet Mountains.

### *2003 USFWS Hair Snag Study*

Hair snag surveys were conducted in the Cabinet Mountains during 2002-2008, with one of the objectives being to determine a minimum population estimate using DNA analysis (Kasworm *et al.* 2007, 2009). The most intensive of these surveys was conducted during 2003. A similar but more intensive survey was conducted in the Northern Continental Divide Ecosystem (NCDE) during 2004, which resulted in a grizzly bear population estimate that was two and a half times the previous estimate (Kendall *et al.* 2009). The following passages, taken together, indicated that additional analysis of the Cabinet Mountains data could be conducted by comparing the results to the NCDE results.

*“Capture-recapture estimates of the population were not thought to be appropriate because expected sample sizes from the Cabinet Mountains population ( $n < 15$ ) would not likely provide population estimates with reasonable precision. Capture-recapture estimates would require at least 4 sessions of sampling the entire area, and sufficient funds were not available to implement this approach.”* (Kasworm *et al.* 2009).

*“Because small sample sizes associated with small populations of grizzly bears preclude mark-recapture analyses, catch-effort data can be useful in evaluating relative density and population sizes. Recognizing there are few other means to sample and*

*estimate density and population sizes for extremely small, threatened and endangered grizzly bear populations, we advocate hair-sampling techniques and CPUE models as a potentially useful method to obtain such data.” (Romain-Bondi et al. 2004).*

Based on a comparison of hair trap catch per unit effort (CPUE) from the 2004 NCDE survey (Kendall *et al.* 2009) to the survey conducted during 2003 in the Cabinet Mountains (Kasworm *et al.* 2007), an estimated 37 grizzly bears were in the Cabinet Mountains during 2003 (Table 1). For this exercise, CPUE was defined as the number of unique individuals (genotypes) identified from grizzly bear hair samples collected from hair traps, standardized to 100 hair trap days. This estimate was based on incomplete data summaries that were readily available for the NCDE and the Cabinet Mountains. I was unable to calculate confidence limits for this estimate.

The major assumptions that the CPUE estimate was based on are discussed below. These assumptions and the calculations described in Table 1 were reviewed by WEST, Inc., Cheyenne, WY. Some of the assumptions are addressed more thoroughly in Romain-Bondi *et al.* (2004). Some of the assumptions would be eliminated if the exercise were repeated using the complete data sets.

1. There was an equal probability of capture in the Cabinet Mountains during 2003 and the NCDE during 2004.

This assumption can be restated as: There was an equal proportion of trap-shy and trap-happy bears in the Cabinet Mountains and the NCDE during the surveys. If the proportions were similar, this assumption should have only had a minor influence on estimation variance.

2. CPUE exhibits a 1:1 relationship with bear density.

This assumption is intuitive and supported, at least as an approximation, by the findings of Romain-Bondi *et al.* (2004).

3. CPUE is the same for a grid with 7x7 km cells as for a grid with 5x5 km cells.

The number of unique individuals identified for a given sampling period should be proportional to the number of hair traps until the density of hair traps approaches saturation, when CPUE would be expected to decrease. The difference in grid cell

size is unlikely to have influenced the population estimate. If anything, it may have resulted in an underestimate for the Cabinet Mountains.

4. CPUE change over time was the same for the Cabinet Mountains and NCDE studies.

The number of unsampled individuals in both studies can be assumed to have been smaller after each 14-day session, which should have decreased the CPUE for the next 14-day session. While the Cabinet Mountains study only used one 14-day session per cell, the effort was spread over the same total study length because hair traps were moved to different cells after each 14-day session. This could have eliminated any bias resulting from this factor. However, based on the population estimates, the proportion of grizzly bears that were sampled in the NCDE study was greater than in the Cabinet Mountains study (Table 1). This would be expected due to the greater sampling effort in the NCDE study. As such, the reduction in CPUE over time may have been greater in the NCDE study, which would have resulted in an overestimate for the Cabinet Mountains population.

5. Relocation of hair traps to different grid cells after each 14-day period during the Cabinet Mountains study did not influence CPUE.

This assumption would be valid if relocations would have been unbiased. However, Cabinet Mountains hair trap relocations were stratified by elevation to follow expected shifts in grizzly bear distribution during the study period. If grizzly bear elevation stratification during the June through August study period was appreciable and predictable, this factor could have resulted in an overestimate of the Cabinet Mountains population.

6. The proportion of grizzly bears vs. black bears was the same each year during 2002-2005 in the Cabinet Mountains.

Using the pooled data that were available introduced estimation variance based on this factor that could be eliminated if the complete data sets were analyzed.

7. The effective radii of the baits used for each study were similar.

Both studies used a mixture of blood and fish. As such, this possible source of bias was probably minimal.

Table 1. Calculation of a grizzly bear population estimate for the Cabinet Mountains (CM) based on comparison to data from the Northern Continental Divide Ecosystem (NCDE).

Parameter	Data		Reference, calculation or comment	
	NCDE	CM	NCDE	CM
field season	Jun-Aug '04	Jun-Aug '03	Kendall <i>et al.</i> 2009	Kasworm <i>et al.</i> 2007
study area (km <sup>2</sup> )	31,410	4,300		
number of grid cells	641	187		
size of grid cells (km)	7x7	5x5		
number of days per session	14	14		
number of 14 day sessions per cell	4	1		
number of hair traps	2,558	184	Each relocation after 14 days within a cell counts as a separate hair trap. This number is slightly different than the number of cells multiplied by number of sessions.	Traps were relocated to different cells after each 14 day session, totalling 184 over the course of the field season. This number is from Kasworm <i>et al.</i> 2009, and is different than the number of cells multiplied by number of sessions because 3 sites could not be accessed.
number of hair trap days	35,812	2,576	14 x 2558	14 x 184
number of grizzly bear genotypes from hair traps	448	11.4	Kendall <i>et al.</i> 2009	908/1194 x 15. This assumes that the proportion of grizzly bears vs. black bears was the same each year during 2002-2005. Kasworm <i>et al.</i> 2007 stated that 1194 black and grizzly bear hair samples were collected during 2002-2005 and that 908 were from 2003. They also stated that there were 15 different grizzly bear genotypes, but did not state how many of the 15 were from 2003.
CPUE*, grizzly bear genotypes from hair traps standardized to 100 hair trap days.	1.251	0.443	448/35812 x 100	11.4/2576 x 100
number of grizzly bear per 100 km <sup>2</sup>	2.44	0.86	765/31410 x 100	0.443/1.251 x 2.44
<b>grizzly bear population estimate</b>	<b>765</b>	<b>37.0</b>	Kendall <i>et al.</i> 2009	0.86 x 4300/100
proportion of grizzly bear that were sampled at least once from hair traps	0.59	0.31	448/765	11.4/37.0

\*CPUE = Catch per unit effort.

2009 University of Washington Bear Scat Survey

Eighteen grizzly bear scats were found within the Project survey area in the Cabinet Mountains during 2009. Individual identities were able to be made on eight of these 18 scats. Each of the eight scats was from a different individual grizzly bear. The number of individual grizzly bears that deposited scat in the survey area could not be estimated because no duplicate scats were located, however, the chances of collecting one, and only one, scat from each individual in a population of any given hypothetical size were calculated using the following equation that I developed for this report (see Table 2 for example calculations):

$$\text{Equation 1: } U_n = \prod_{i=2}^n ((A - (C^{i-1} + E^{i-2})) / A)$$

Where:

$U_n$  = Chances of  $n$  unique scats after collecting  $n$  scats for any  $A$  of interest.

$n$  = Number of samples collected or extrapolated number of interest.

$A$  = Hypothetical available number of unique scats in the survey area.

$C$  = Chances of sample  $i$  being a unique scat =  $(A - E^{i-1}) / A$

$E$  = Expected number of unique scats after collecting  $i$  samples =  $C + E^{i-1}$

$i$  = Sample number. For  $i = 3$ ,  $E^{i-2} = 1$ . For  $i = 2$ ,  $C^{i-1} + E^{i-2} = 1$

Put simply, the likelihood of unique samples is greater for larger populations, and the likelihood decreases with each sample. A unique scat is defined here as a scat that was identified to the level of individual grizzly bear from a grizzly bear that had not previously been identified (8 of 8 in the Project survey area). This calculation assumes there were an equal number of scats from each individual grizzly bear. This assumption was certainly violated, which had the effect of underestimating the number of grizzly bears represented by the results.

Based on Equation 1, the chances of collecting one, and only one, scat from each individual in a population of eight are 2% (Table 2). Given the likelihood of unequal scat abundance from each individual grizzly bear, the chances were an unknown amount less than 2%. The chances of obtaining eight of eight unique scats increase with the number

of unique scats present in the survey area and do not become likely (>50%) until scats from >40 different grizzly bears are present (Figure 1). While it is unlikely that 40 grizzly bears in and around the Project area would be virtually undetected to date, there is a >80% chance that the number of unique scats in the 675 km<sup>2</sup> survey area (Equation 1, Figure 1) was greater than the minimum population estimate of 18 for the 3,944 km<sup>2</sup> Cabinet Mountains (Kasworm *et al.* 2009).

Several possible explanations for the results of the 2009 bear scat survey in the Project area are discussed below.

1. The minimum population estimate grossly underestimates the actual population.

This supports the results of the CPUE comparison presented above. These results are not conclusive, but indicate that a more definitive grizzly bear population survey of the Cabinet Mountains should be conducted. The results may be of particular relevance to the Montanore Project with regard to population augmentation and allowable human-caused mortality.

2. The laboratory results were erroneous.

A description of the methods is provided in the University of Washington (2010) report.

3. The scat ages spanned multiple years.

The University of Washington (2010) report stated that all samples were from the year of collection and virtually all were  $\leq 1$  month of age. This statement is somewhat supported by published estimations of grizzly bear scat age and comparison of success rates for DNA analysis given known scat age, scat characteristics, and weather conditions (Wasser *et al.* 2004, Murphy *et al.* 2007).

4. The survey area was large enough to include the yearly range of most Cabinet Mountains grizzly bears.

Although grizzly bear ranges overlap extensively, the average life range for CYE grizzly bears has been estimated as 1,172 km<sup>2</sup> for native adult males and 431 km<sup>2</sup> for native adult females (Kasworm *et al.* 2009). The 675 km<sup>2</sup> survey area approximated the average life range of one CYE grizzly bear. Given this, it seems

unlikely that  $\geq 8$  of 18 Cabinet Mountains grizzly bears would have overlapping ranges in the period of the few months that the scat represented, unless most of the Cabinet Mountains grizzly bears were concentrated in the survey area (see below).

5. The survey area was located in an area of high grizzly bear density relative to other portions of the Cabinet Mountains.

This is possible given the scale of variation in grizzly bear population density that has been reported elsewhere (e.g. Kendall *et al.* 2008, Kendall *et al.* 2009). Figures in Kasworm *et al.* (2009) indicate a relatively dense pattern of grizzly bear sightings in the vicinity of the Project survey area, but there also appears to have been a disproportionately high level of trapping and hair snag effort in the same area. Variation in grizzly bear density could not be assessed for this report because a definitive population survey has not been conducted in the Cabinet Mountains. Based strictly on land area, the density of grizzly bears in the Project survey area that is indicated by the bear scat survey results is not unreasonable. Greater than eight grizzly bears within or passing through the 675 km<sup>2</sup> survey area equates to  $>12$  bears/1,000 km<sup>2</sup>. This is below the range of 16 to 80 grizzly bears/1,000 km<sup>2</sup> that has been reported for other interior North American populations (Kendall *et al.* 2008 and references therein).

6. The eight grizzly bears were transients so few scat were present from any one individual.

The University of Washington (2010) report suggests that the eight grizzly bears were transients. The relative amount of time spent in the survey area by each individual could have been estimated if multiple scats from individuals were located. As it is, the data indicate equal time was spent in the survey area by each of the eight grizzly bears. Whether transients or not, the chances of there being more than eight grizzly bears in the survey area during 2009 are the same as presented in Figure 1 based on Equation 1. Depending on the spatial scale used to define transient, the idea that there may have been  $\geq 8$  transient grizzly bears in the Project survey area could be interpreted as indicating that Cabinet Mountains grizzly bears are not genetically isolated.

Table 2. Calculation of the likelihood that eight of eight scats would be unique from a population of eight.

Sample	Chance of this sample being unique	Calculation	Expected number of unique samples	Calculation
1	1.000		1.000	
2	0.875	$(8 - 1.000) / 8$	1.875	$0.875 + 1.000$
3	0.766	$(8 - 1.875) / 8$	2.641	$0.766 + 1.875$
4	0.670	$(8 - 2.641) / 8$	3.311	$0.670 + 2.641$
5	0.586	$(8 - 3.311) / 8$	3.897	$0.586 + 3.311$
6	0.513	$(8 - 3.897) / 8$	4.410	$0.513 + 3.897$
7	0.449	$(8 - 4.410) / 8$	4.858	$0.449 + 4.410$
8	0.393	$(8 - 4.858) / 8$	5.251	$0.393 + 4.858$
Chance of 8 of 8 unique samples	<b>0.024 *</b>	$0.875 \times 0.766 \times 0.670 \times 0.586 \times 0.513 \times 0.449 \times 0.393$		

\* This was recalculated for hypothetical population sizes ranging from 8 to 50 to create Figure 1 (see below).



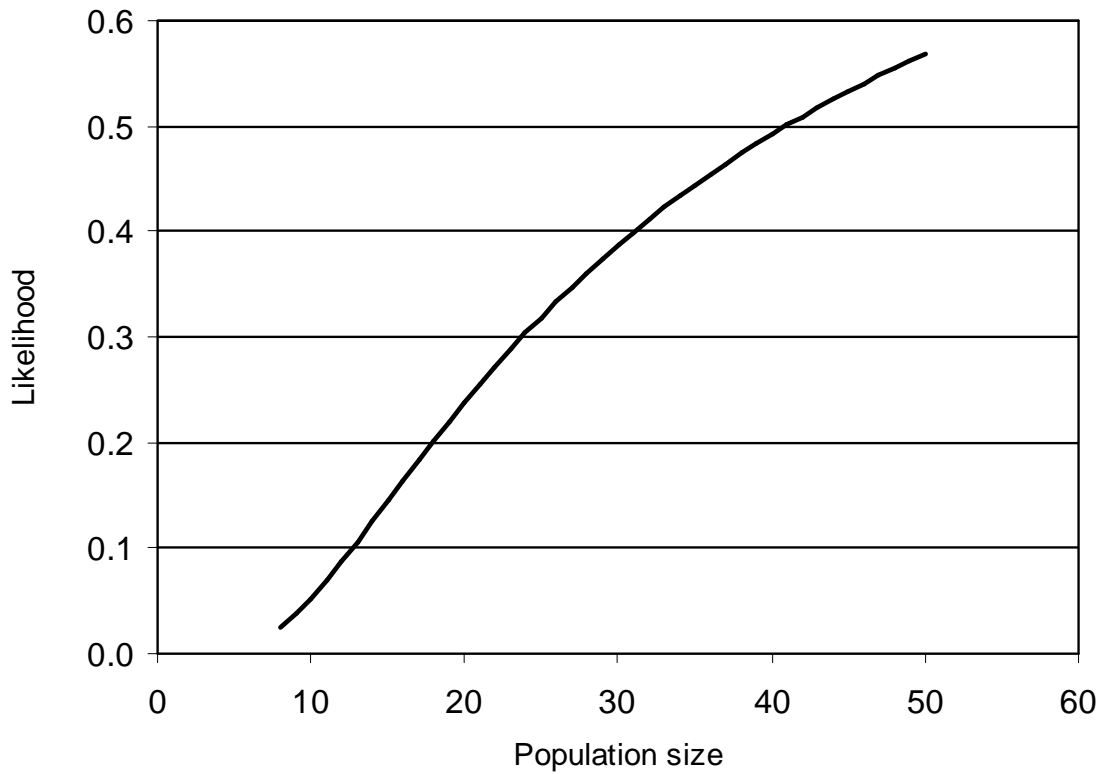


Figure 1. Likelihood that eight of eight scats would be unique based on Equation 1 and hypothetical numbers of unique scat (population size) that were present in the Project survey area.

### ***Population Trend***

The grizzly bear carrying capacity of the Cabinet Mountains is not known. Given the finding that there were  $\geq 8$  grizzly bears in one small portion of the Cabinet Mountains during 2009, combined with the CPUE comparison presented above, one has to consider whether the population has reached its carrying capacity. If so, the population would be expected to cycle between periods of increase and decrease.

Based on the minimum population estimates, the grizzly bear populations in the Cabinet Mountains and the CYE as a whole are increasing slightly (Figure 2, compiled data from Kasworm *et al.* 2009 and previous annual reports). The estimated finite rate of increase ( $\lambda$ ) for CYE grizzly bears, derived through population viability analysis (PVA), was 1.067 for the period of 1983-1998, suggesting an increasing population. The most recent  $\lambda$  for the 1983-2008 period was 0.960 (Kasworm *et al.* 2009), suggesting a decreasing population. The 95% confidence interval for the most recent  $\lambda$  included the possibility that the population is stable or increasing (95% C.I. 0.844-1.056). These varying findings, with confidence intervals including stability ( $\lambda=1$ ) are consistent with a population that is at its carrying capacity, although, based on the following statements, PVA cannot be defensibly used for identifying the trend of the Cabinet Mountains grizzly bear population.

*"Approximately 90% of the data used in this calculation (population trend) came from bears monitored in the Yaak River portion of this population and the result is most indicative of that portion of the recovery area." (Kasworm et al. 2009).*

*"Research information from small populations of animals is typically relegated to small sample sizes, and management decisions must be based on these sparse data sets. Though point estimates of most parameters have wide confidence intervals and would not pass our standard tests of statistical rigor, they often remain our only indication of the welfare of these populations. Managers must consider this information and adopt conservative policies." (Wakkinen and Kasworm 2004).*

*"We agree with Boyce et al. (2001) that the state-of-the-art for population viability analysis has not sufficiently matured for accurate predictions of minimum viable population estimates or probabilities of extinction." (Proctor et al. 2004).*

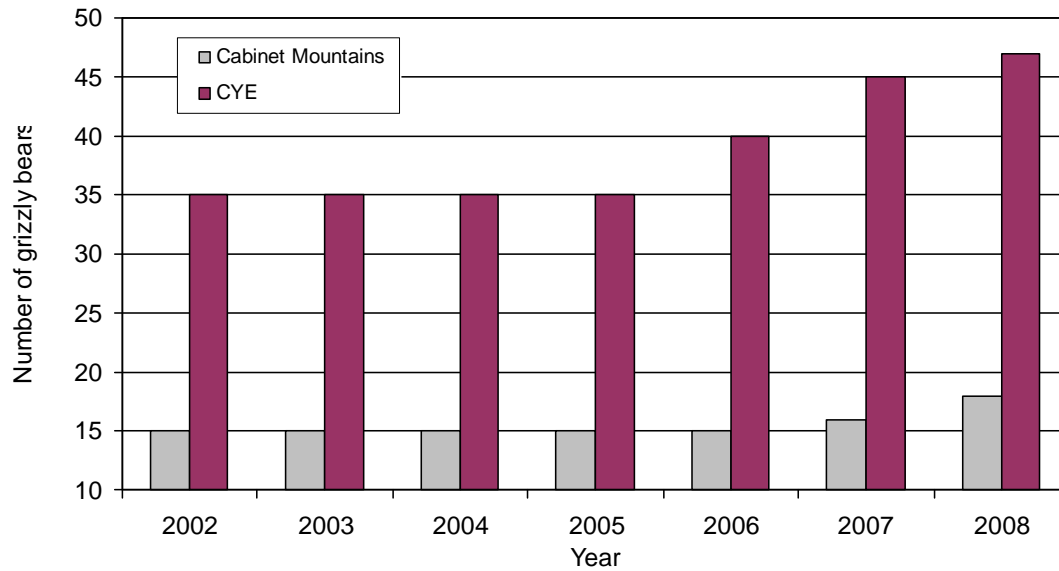


Figure 2. Minimum grizzly bear population estimates for the Cabinet Mountains and Cabinet-Yaak Ecosystem (Kasworm *et al.* 2009 and previous annual reports). CYE estimates shown for 2002-05 are the center of the reported range of 30 to 40.

## ***Predicted Impacts***

Predicted impacts of the Project on grizzly bear are based largely on disturbance coefficients and zones of influence for roads, helicopter use, and other Project activities that are provided in: Cumulative Effects Analysis Process for the Selkirk/Cabinet-Yaak Grizzly Bear Ecosystems (USDA Forest Service 1988) and Grizzly Bear and Road Density Relationships in the Selkirk and Cabinet-Yaak Recovery Zones (Wakkinen and Kasworm 1997).

In defending the use of Wakkinen and Kasworm (1997) as “best science” for assessing the impact of roads on grizzly bear distribution in the Selkirk and Cabinet-Yaak Ecosystem (SCYE), Johnson (2007) acknowledges that the sample size in Wakkinen and Kasworm (1997) was small, and he uses results from similar studies conducted in the Northern Continental Divide Ecosystem (NCDE) to support the conclusions of Waakinen and Kasworm (1997). The problem is, all of these studies are outdated.

One assumption of these studies is that the behavior of bears that have been captured and collared represents normal behavior. This assumption is invalid in the short-term, and difficult to test in the long-term. Boulanger *et al.* (2008) found that previously captured grizzly bears had lower detection probabilities in a hair snag grid. The authors suggested that the presence of human odors and the association of this with previous capture likely contributed to their finding. Another study found that movement rates of grizzly bears that had been captured and collared were decreased by an average of 57% for 20 to 37 days after capture, relative to extended data that was assumed to represent normal movement rates (Cattet *et al.* 2008a). The authors state “...descriptions of activity patterns or determination of home ranges may be inaccurate if time elapsed after capture is not considered as a potential factor in analysis of movement rates or locations.” It seems plausible that a grizzly bear that has been captured and collared may exhibit long-term avoidance of human activity, and that even the extended data from Cattet *et al.* (2008a) may not have represented normal behavior.

Another assumption of Wakkinen and Kasworm (1997) is that bear locations, which were obtained during daylight hours, primarily during morning, under weather conditions that were safe for flying, were representative of 24-hour distribution. More recent

research that was based on four years of GPS radiotelemetry data has shown that grizzly bear distribution can be significantly different during crepuscular/nocturnal periods (Nielsen *et al.* 2004). This more sophisticated study was based on 21 bears of both sexes and various ages, fitted with collars that were programmed to acquire locations every four hours, regardless of weather.

As with roads, the predicted impacts of helicopter use on grizzly bear distribution are based on very little data. There also appears to be some inconsistencies that resulted in overly conservative estimates of helicopter impacts. The Cumulative Effects Model (CEM) that the habitat effectiveness predictions are based on assumes that the zone of helicopter influence is a one mile corridor (USDA 1988), not one mile from the flight line as assumed in the DEIS. This appears to be an error in interpretation of the 1988 CEM, considering that the 2007 habitat-based recovery criteria for the Greater Yellowstone Ecosystem describes secure habitat, in part, as >500 meters from a recurring helicopter flight line. Furthermore, a disturbance coefficient of 0.1 was used for the Montanore Project, while a more recent document uses a disturbance coefficient of 0.61 for aircraft (Mattson *et al.* 1999). Even these more recent parameters are crude professional judgments. These parameters are difficult to objectively determine due to a lack of data and highly variable responses of grizzly bears to disturbance. This is why impact-based mitigation is called for.

A study that was not cited in the DEIS supports the contention that predicted helicopter impacts are overly conservative. Helicopters were used to conduct seismic surveys in Alberta across a dense network of transects. The surveys included detonation of dynamite, 12-15 meters below the surface at horizontal intervals of approximately 120 meters. The occurrence of grizzly bears in an area with ongoing blasting and other human activities is interesting in and of itself, although this was not specifically addressed in the report. The objective of the study was to assess the influence of helicopter activity on grizzly bear distribution by analyzing distribution data collected before, during, and after helicopter activity. The results indicated 46% avoidance of areas that had intense helicopter activity (Ritson-Bennett 2003). This finding suggests that the disturbance coefficient of 0.1 used for the Montanore Project is overly conservative. Furthermore, many of the collared bears in the Alberta study were

tranquilized by a shooter from a helicopter. The possibility that these bears thus learned to avoid helicopters is acknowledged in the report, and was possibly a major source of bias in the study design.

The following passage is from a study that evaluated the predictive capability of grizzly bear Cumulative Effects Models (CEMs) using field data from a comprehensive and sophisticated research program (Stenhouse *et al.* 2002). This passage supports the use of effective monitoring methods to determine impact-based mitigation.

*“A model’s utility is its ability to be predictive. Comparing model outputs with data gathered from field studies tests the predictive capability of the model. The results of this analysis suggest that predicted distribution and use of BMUs by bears using cumulative effects models is weakly correlated with the distribution of bears identified using DNA methods. It is not correlated with the level of use by GPS (collared) bears for each of the BMUs run as indicated by the relative proportion of points in each BMU for each GPS bear. It is negatively correlated with the distribution of GPS bears however this may be an artifact of a biased distribution of GPS bears for the Foothills study area. Security area, a fundamental component of Cumulative Effects Assessment models, is also not significantly correlated with the distribution of DNA bears on the Foothills study area.”* (Stenhouse *et al.* 2002).

## *References*

- Boulanger, J., G.C. White, M. Proctor, G. Stenhouse, G. Machutchon, and S. Himmer. 2008. Use of occupancy models to estimate the influence of previous live captures on DNA-based detection probabilities of grizzly bears. *Journal of Wildlife Management* 72:589-595.
- Bowles, A.E. 1995. Responses of wildlife to noise. In: *Wildlife and recreationists: coexistence through management and research*. Eds: Knight,RL; Gutzwiller,KJ, Island Press, Covelo, California, 109-156
- Boyce, M.S., B.M. Blanchard, R.R. Knight, and C. Servheen. 2001. Population viability for grizzly bears: a critical review. *International Conference on Bear Research and Management*. Monograph 4.
- Cattet, M., J. Boulanger, G. Stenhouse, R.A. Powell, and M.J. Reynolds-Hogland. 2008a. An evaluation of long-term capture effects in ursids: implications for wildlife welfare and research. *Journal of Mammalogy* 89:973-990.
- Cattet, Vijayan, and Janz. 2008b. *Wildlife Health*. In: Stenhouse, G. and K. Graham (eds). *Foothills Research Institute Grizzly Bear Program 2007 Annual Report*. 2004 pp.
- Gibeau, M.L. 2000. A conservation biology approach to management of grizzly bears in Banff National Park, Alberta. PhD thesis, Univesity of Calgary.
- Johnson, W.J. 2007. In defense of Wakkinen and Kasworm (1997) paper as “best science” in the Selkirk and Cabinet-Yaak Grizzly Bear Ecosystems. Unpublished Report, USDA Forest Service, KNF. Libby, MT. 8pp.
- Kasworm, W.F., H. Carriles, T.G. Radandt, M. Proctor, and C. Servheen. 2009. Cabinet-Yaak grizzly bear recovery area 2008 research and monitoring progress report. U.S. Fish and Wildlife Service, Missoula, Montana. 76 pp.
- Kasworm, W.F., H. Carriles, T.G. Radandt, and C. Servheen. 2008. Cabinet-Yaak grizzly bear recovery area 2007 research and monitoring progress report. U.S. Fish and Wildlife Service, Missoula, Montana. 75 pp.
- Kasworm, W.F., M.F. Proctor, C. Servheen, and D. Paetkau. 2007. Success of grizzly bear population augmentation in northwest Montana. *Journal of Wildlife Management* 71(4):1261-1266.
- Kendall, K.C., J.B. Stetz, D. Roon, L.P. Waits, J. Boulanger, and, D. Paetkau. 2008. Grizzly bear density in Glacier National Park, Montana. *Journal of Wildlife Management* 72:1693-1705.
- Kendall, K.C., J.B. Stetz, J. Boulanger, A.C. Macleod, D. Paetkau, and G.C. White. 2009. Demography and genetic structure of a recovering grizzly bear population. *Journal of Wildlife Management* 73:3-17.
- Mattson, D. J., K. Barber, R. Maw, and R. Renkin. 1999. Appendix 2 in *Coefficients of habitat productivity for Yellowstone’s grizzly bear habitat*. Technical Report. USGS Forest and Rangeland Ecosystem Science Center, Corvallis OR.

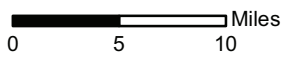
- Murphy, M.A., K.C. Kendall, A. Robinson, and L.P. Waits. 2007. The impact of time and field conditions on brown bear (*Ursus arctos*) faecal DNA amplification. *Conserv. Genet.* 8:1219-1224.
- Nielsen, S.E., Boyce, M.S., and Stenhouse, G.B., 2004. Grizzly bears and forestry I: selection of clearcuts by grizzly bears in west-central Alberta, Canada. *Forest Ecology and Management* 199, 51–65.
- Osenberg, C.W. and R.J. Schmitt. 1996. Detecting ecological impacts caused by human activities. In: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats* (eds R.J. Schmitt and C.W. Osenberg). Academic Press, Inc., San Diego, CA, pp. 3-16.
- Petit, E. and N. Valiere. 2006. Estimating population size with noninvasive capture-mark-recapture data. *Conservation Biology* 20:1062-1073.
- Proctor, M.F., C Servheen, S.D. Miller, W.F. Kasworm, and W.L. Wakkinen. 2004. A comparative analysis of management options for grizzly bear conservation in the U.S.-Canada trans-border area. *Ursus* 15(2):145-160.
- Ritson-Bennett, R.A. 2003. Assessing the effects of a heli-portable 3D seismic survey on grizzly bear (*Ursus arctos horribilis*) distribution. Masters thesis, University of Calgary.
- Romain-Bondi, K.A., R.B. Wielgus, L. Waits, W.F. Kasworm, M. Austin, and W. Wakkinen. 2004. Density and population size estimates for North Cascade grizzly bears using DNA hair-sampling techniques. *Biological Conservation* 117:417-428.
- Stenhouse, G., J. Dugas, J. Boulanger, D. Hobson, and H. Purves. 2002. Grizzly bear cumulative effects assessment model review for the regional carnivore management group. Foothills Model Forest, Hinton, Alberta.
- Stewart-Oaten, A. 1996. Goals in environmental monitoring. In: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats* (eds R.J. Schmitt and C.W. Osenberg). Academic Press, Inc., San Diego, CA, pp. 17-27.
- Stewart-Oaten, A. and W.W. Murdoch. 1986. Environmental impact assessment: "pseudoreplication" in time? *Ecology* 67:929-940.
- U.S. Department of Agriculture (USFS Kootenai National Forest) and Montana Department of Environmental Quality. February 9, 2009. Draft Environmental Impact Statement for the Montanore Project.
- U.S. Department of Agriculture. 1988. Cumulative effects analysis process for the Selkirk/Cabinet-Yaak Grizzly Bear Ecosystems. 32 pp.
- University of Washington. 2010. 2009 progress report to: Montanore Minerals Corp. grizzly and black bear project.
- von der Ohe, C.G., S.K. Wasser, K.E. Hunt and C. Servheen. 2004. Factors Associated with fecal glucocorticoids in Alaskan brown bears (*Ursus arctos horribilis*). *Physiol. Biochem. Zool.* 77:313-320.



- Wakkinen, W. and W. Kasworm. 1997. Grizzly bear and road density relationships in the Selkirk and Cabinet-Yaak Recovery Zones. Idaho Department of Fish and Game (Bonners Ferry, ID) and USFWS. Libby, MT. 28 pp.
- Wakkinen, W.L. and W.F. Kasworm. 2004. Demographics and population trends of grizzly bears in the Cabinet-Yaak and Selkirk ecosystems of British Columbia, Idaho, Montana, and Washington. *Ursus* 15(1) Workshop Supplement: 65-75.
- Wasser, S.K., B. Davenport, E.R. Ramage, K.E. Hunt, M. Parker, C. Clarke, and G. Stenhouse. 2004. Scat detection dogs in wildlife research and management: application to grizzly and black bears in the Yellowhead Ecosystem, Alberta, Canada. *Canadian Journal of Zoology* 82:475-492.

**Legend**

- +— BNSF - RR
- US Highway 2
- +— Project Powerline
- Project Permitted Areas
- ▨ Cabinet Wilderness
- Core Habitat
- Bear Management Units/CYE
- BORZ



**Cabinet Mountains Portion of Cabinet-Yaak Ecosystem**

**Yaak Portion of Cabinet-Yaak Ecosystem**

**BNSF Railroad**

Control Area Cells

*Kootenai River*

Troy BORZ



Project Area Cells

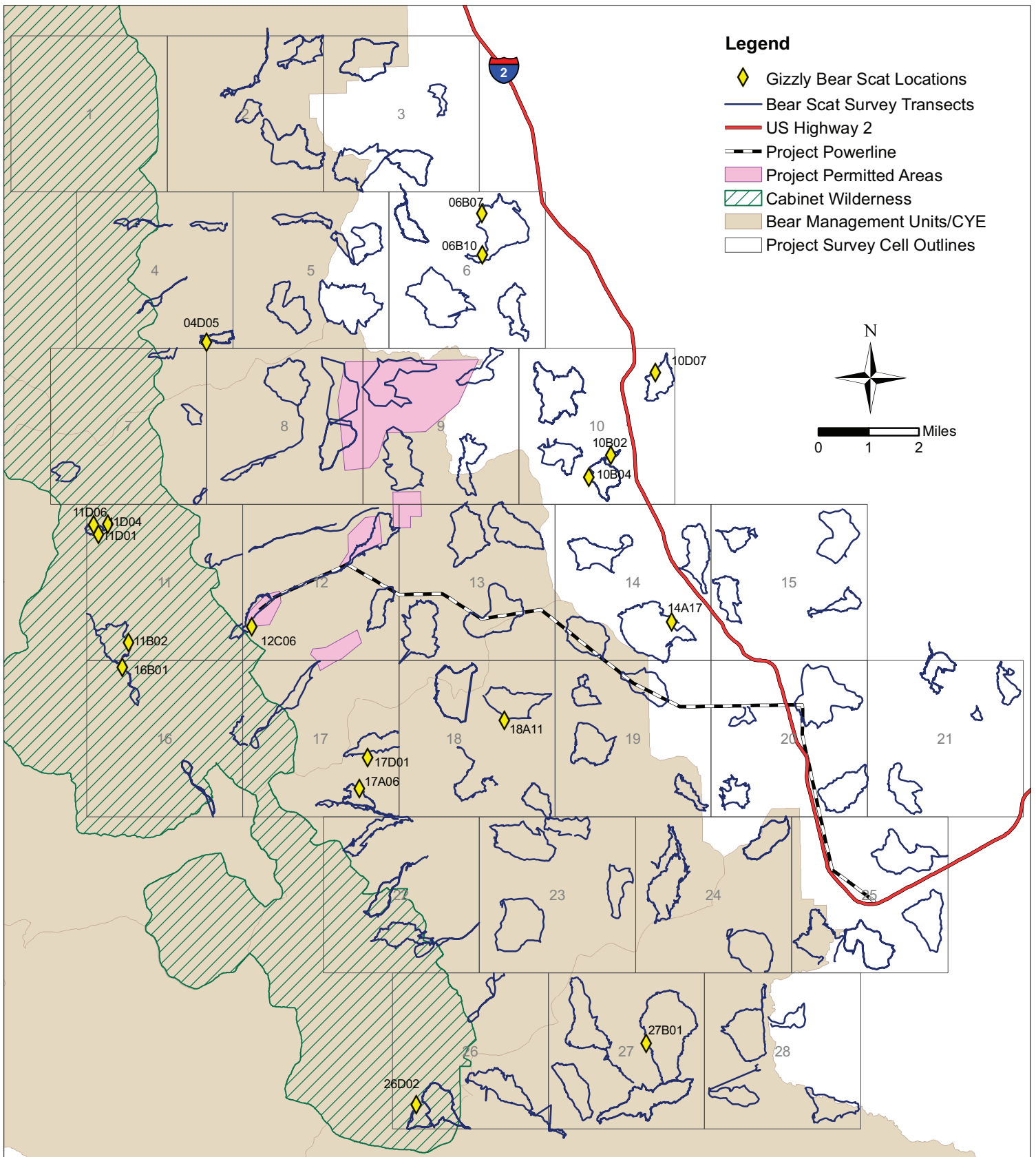
CF BORZ

**Map 1 Cabinet-Yaak Ecosystem and Bear Scat Survey Areas**  
 Grizzly Bear Report, May 2010  
 Kline Environmental Research, LLC

Montanore Project - Lincoln County, Montana

Sources: KNF & U. Washington, 2010

Jasper Geographics

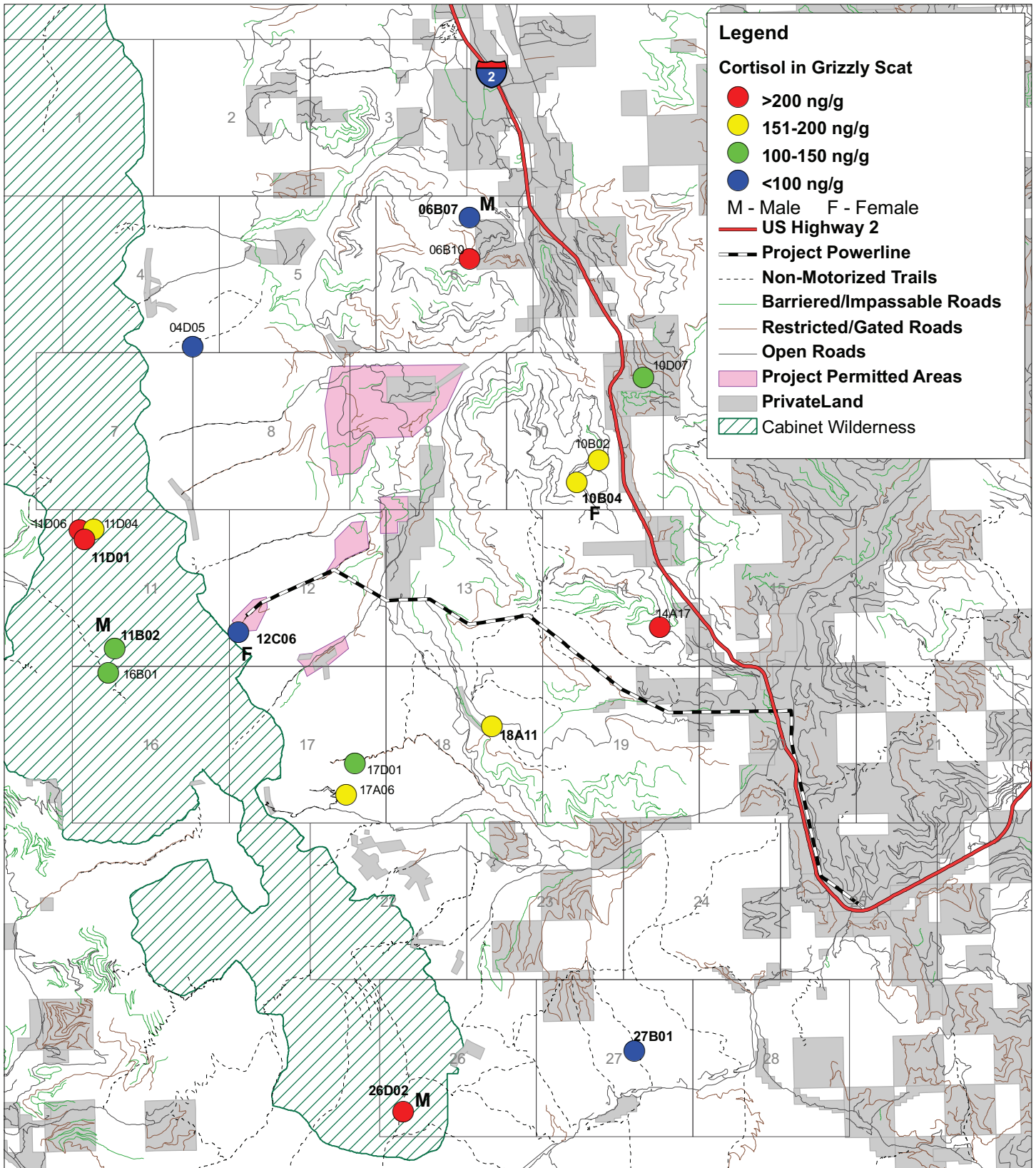


Note: Sample 11D04 moved east for clarification

Sources: KNF & U. Washington, 2010

**Map 2 Bear Scat Survey Transects in the Project Area**  
**Grizzly Bear Report, May 2010**  
**Kline Environmental Research, LLC**

Montanore Project - Lincoln County, Montana

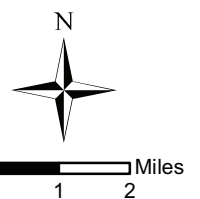


Note 1: Sample 11D04 moved east for clarification  
 Note 2: Number for scat sample of known individual bear shown in bold

Sources: KNF & U. Washington, 2010

**Map 3 Grizzly Bear Scat Characteristics Relative to Roads & Land Status**  
**Grizzly Bear Report, May 2010**  
**Kline Environmental Research, LLC**

Montanore Project - Lincoln County, Montana



**2009 Progress Report to:  
Montanore Minerals Corp.  
Grizzly and Black Bear Project**

**Prepared by:  
Center for Conservation Biology  
Department of Biology  
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Seattle, WA 98195-1800**

**Overview**

The Cabinet-Yaak Ecosystem, a remote area of northwestern Montana, consists of approximately 1000 square miles in the Yaak River valley and 1620 square miles in the Cabinet Mountains. The Kootenai River flows through the area, with the Yaak River drainage to the north, and the Cabinet Mountains to the south. The Cabinet Mountains Wilderness Area encompasses 147 square miles of the ecosystem, with elevations ranging from 3000 to 8740 feet. The warm summers and heavy winter snowfalls create a habitat characterized by ponderosa pines, firs, western red cedars, and spruces, interspersed with huckleberry and other shrubs, mixed deciduous trees, riparian shrubs, and wet meadows near drainages. The Cabinet Mountains Wilderness is home to wolves, lynx, wolverine, and at least 18 grizzly with an estimated 30 to 40 grizzly bears in the entire Cabinet-Yaak Ecosystem (Kasworm et al. 2009).

The area is known for its huge deposits of copper and silver, located on the eastern side of the Cabinet Mountains. The Montanore Deposit alone is estimated at more than 230 million ounces of silver and nearly 2 billion pounds of copper. A subsidiary of Mines Management, Inc., Montanore Minerals Corporation has proposed to mine this deposit from underneath the Cabinet Mountains Wilderness Area.

We used scent detection dogs during July through September 2009 to locate the scat of grizzly and black bears in the area surrounding the Montanore mining project, and a relatively undisturbed control area. The control and project areas were in close proximity (35 miles apart), with similar habitat, although the control area had relatively less anthropogenic disturbance, especially logging, than in the project area. It is anticipated that the control area will experience minimal change relative to the project area once mining is underway. These temporal differences should allow us to assess the effects of mining activity by comparing the abundance, distribution, resource selection, and overall health of bears in the mining and control areas.

**Methods**

**Study Area** - The study took place in the Cabinet-Yaak Ecosystem, near Libby, Montana (Figure 1). The main project area was located in and around the Cabinet Mountains Wilderness Area, and originally consisted of 28 adjacent 5x5km cells, covering 700km<sup>2</sup>. This area fell within Bear Management Units 2, 5, and 6, as well as the Cabinet Face Bears Outside Recovery Zone. The control area was located in the Yaak River valley and consisted

of 10 adjacent 5x5km cells, covering 250km<sup>2</sup>, approximately 35 miles northwest of the project area.

**Sampling Design** – Scat sampling was conducted by four teams. Each team consisted of a scent detection dog, a dog handler, and an orienteer. The strength of our sampling method derives from the obsessively high play-drive of detection dogs. The dogs receive a play reward for locating samples from any of the two target species. This makes sample location unlikely to be influenced by instinctive preferences for species, gender, or capture history because sample detection is motivated solely by the dog's extraordinary drive to receive its play reward (Wasser et al. 2004). Lures are not required to draw animals in from a larger radius; dogs detect samples where they lie, from a large spectrum of the population, providing a more accurate assessment of landscape use and its physiological consequences than alternative methods.

Both project and control cells were sampled in the same manner. Each cell was visited four times (one time per session) during the study period. During the first visit, one team sampled a predetermined transect measuring 8-10 kilometers in length. On each subsequent visit, a different team sampled a different predetermined transect located in a different area of the cell. Each transect was placed to ensure sampling of a variety of habitats, including but not limited to old and used roads, trails, stream drainages, and avalanche chutes. The total area covered each day varied by team due to access, undergrowth vegetation, dog's working speed, sample collection, daytime temperatures, and driving times to and from sites (Tables 1-5). Teams were often not able to cover the entire 8-10 kilometers due to high temperature, poor access and steep terrain, and thus adjusted transect lengths to maximize coverage of in the time allotted.

Cell 1 was dropped from the main project area before it was ever sampled because of poor access and high daytime temperatures. Cells 16 and 21 were dropped from session D due to time constraints. Cell 16 was dropped because of poor access and the fact that only one scat was found during the first three sessions combined. Cell 21 was dropped because it is one of the furthest cells from the mine area, and because of the high human and timber company activity in that cell.

**Data Collection** - Orienteers carried handheld computers wirelessly connected to GPS units for electronic data collection. The handheld computers allowed for track log recordings and collecting information pertaining to each sample collected. Upon sample detection, the following data were recorded: date; sample number; session; location; handler, dog, and orienteer names; confidence levels; odor strength; freshness; contents; presence of mold; vegetation cover type; and presence of water.

Dog harnesses were outfitted with data-loggers to record dog movements at a rate of a point per second, and handlers' track logs were recorded using Garmin Foretrex GPS units. All data were downloaded to a central location each evening, and samples were double checked for possible labeling errors.

**Sample Collection** - Once a scat was detected, it was collected by orienteers. Latex gloves were worn at all times during the collection process. DNA samples were obtained by swabbing the surface of each scat twice with cotton swabs soaked in phospho-buffered saline solution. The cotton swab tips were placed in tubes containing a small amount of ethanol, and then labeled with the date and sample number. For hormone analysis, the rest of the scat was then mixed together before placing a golf ball-sized sample in a Ziploc freezer bag. Date, sample number, and GPS coordinates were recorded on the Ziploc bag. When teams returned home at the end of the day, this information was recorded in a written scat inventory, as well as entered into an electronic copy of the scat inventory. The tubes containing the DNA swabs were opened to allow the ethanol to evaporate, and then stored at room temperature. Hormone samples were placed in a freezer for preservation until the samples were sent to the university in coolers packed with dry ice at the end of each session.

It was common to get into an area heavily laden with scat. In addition, dogs often hit on very moldy or very old samples. To obtain quality samples from as many individuals as possible, and to keep teams moving at a reasonable pace, teams would collect the first sample found. If another sample was found within a distance of about 300 meters and it appeared to have the same contents, size, shape, or freshness as the first scat, that scat would not be collected and a GPS point would be marked. After 300 meters, the next scat to be found was collected, and then another 300 meters would be covered, and so on. If multiple scats were found in the immediate area, only the freshest scat was collected.

**DNA Analyses** - DNA was extracted using a method modified from Ball et al (2007), aimed to minimize the high concentrations of PCR inhibitors contained in grizzly bear diet. The mucosal surface of the frozen scat sample was swabbed using a cotton-tipped applicator (see above). The swabbing removed a small amount of the scat matrix, leaving most PCR inhibitors behind. DNA was liberated from the cotton swab by overnight proteinase K digestion followed by purification using silica absorption and standard DNA extraction protocols from a Qiagen DNeasy 96 tissue kit. All extracts were assayed for mtDNA to determine species identity (Wasser et al. 1997). Positively identified grizzly bear samples were then analyzed for gender using the nuclear DNA amelogenin locus, and individual identity based on 6 microsatellite loci (G1A, G1D, G10B, G10C, G10J, G10M; Wasser et al. 2004).

Microsatellite allele frequencies were consistent with Hardy Weinberg equilibrium (HWE) at all loci examined. Samples were extracted twice to compensate for the uneven distribution of DNA in scat (Wasser et al. 2004), with each extract PCR amplified at least twice to minimize allelic drop-out. Confirmation of heterozygous alleles required both alleles to be observed at least twice whereas confirmation of homozygous alleles required the single allele to be observed at least three times in the same sample. Single locus exclusion genotypes were also examined for the frequency of homozygotes and found to be consistent with expectations of HWE.

Eleven samples amplified at enough loci ( $\geq 4$ ) to distinguish individual identities. Since all 11 samples were unique, probability of identity was 100% and there was no need to calculate

a probability of identity ( $P_{id}$  = probability that two individuals sharing all alleles are actually different individuals).

**Hormone Analyses** - The homogenized, 100g frozen scat sample was freeze-dried to remove all moisture. This allowed hormone concentrations to be expressed per g dry weight to control for potential dietary variation in hormone excretion (Wasser et al. 1993). Fecal glucocorticoid (GC), gonadal hormones (testosterone and progesterone; Wasser et al. 1994; Velloso et al. 1998; Wasser et al. 2004), and thyroid hormone metabolite (T3; Wasser et al., in press) extractions and assays were performed on all grizzly bear samples, using a modified version of the pulse vortex extraction method described in Wasser et al. (2000; in press). Briefly, 15mL of 70% ethanol was added to 0.1g of freeze dried and thoroughly homogenized fecal powder, vortexed on a multi-tube pulsing vortexer for 30 minutes at 1 pulse/second (Glas-Col, Terre Haute, IN), and then centrifuged for 20 minutes at 2200 rpm. The supernatant was decanted from the fecal pellet and stored in an airtight tube. Another 15mL of 70% ethanol was added to the original pellet and the extraction process was repeated a second time. The supernatant from the second extraction was combined with the first, and then stored at -20° C until assayed.

## Results and Discussion

During the 2009 field season, a total of 1641 scat locations (a location could consist of more than one scat) were detected throughout the main project and control areas (Tables 1-5). Scats were collected at 998 of these locations. Based on a combination of odor strength and the distribution of moisture throughout the sample (Wasser et al. 2004), we estimate that 57% of the black bear samples and 52% of the grizzly bear samples were  $\leq 2$  weeks old. All samples collected were from the year of collection and virtually all were  $\leq 1$  month of age. We amplified mtDNA for species ID from 850 of the collected samples, giving an 85% mtDNA amplification success rate. Twenty-three of the 850 samples were positively identified as grizzly bear (18 in the main study area and 5 in the control area; Table 6, Figs. 3-4). All other samples were black bear. Eleven of the 23 grizzly bear samples were genotyped at enough loci to identify them to the individual (Table 7). Eight of these individuals were from the mine area and 3 were from the control area. All 11 grizzly bear were unique individuals. There were no grizzly bear recaptures. Substantially fewer samples amplified for gender because the amelogenin marker used to assign gender is more difficult to amplify than most microsatellite loci among bears.

Several lines of evidence suggest that the grizzly bears that were “captured” were all transients. The large number of black bear samples acquired indicates that the area was thoroughly covered (Fig 3-4). Yet, there was a disproportionately high number of black bear samples recovered compared to grizzly bear samples, despite the fact that grizzly bear typically displace black bear when sympatric. Each grizzly bear sample was amplified for DNA at any given microsatellite locus a minimum of 4 times, to assure that individual identities were accurate and not the result of genotyping error. This, coupled with a total absence of grizzly bear recaptures suggests that the grizzly bears that were in the area, remained there for a very short time, typical of transients.



Glucocorticoid (stress) hormone concentrations were twice as high in grizzly bear samples collected in the project area ( $168.0 \pm 18.6$ ,  $n=18$ ) than in the control area ( $83.8 \pm 35.3$ ,  $n=5$ ), and this difference was significant ( $p < 0.04$ ). The disturbance difference may have resulted from there being considerably more logging in the project area compared to the control area. There also appeared to be disturbance in the immediate area where mining was taking place, although this was highly localized. A more detailed analysis of these differences was not possible given the level of detail on the GIS maps we were provided. No other hormone analyses were significant, although this may have been due to the small sample size of grizzly bears.

### **Additional Analyses**

Our previous studies of ursids in the Yellowhead region of Alberta found it quite illuminating to compare resource patterns among sympatric black bear and grizzly bear. Grizzly bear and black bear have very similar foraging behavior and select for nearly identical food resources. However, grizzly bear tend to be less tolerant of disturbance compared to black bear. We found both species to readily co-occur in multi-use areas that contained good habitat. However, only black bear occurred in high tourist areas in Jasper National Park, despite good habitat. Presumably, grizzly bear avoided these latter areas because of high tourist pressure—tourists concentrating around bears and getting out of their cars to take photographs (Wasser et al. 2004). Since that time, our team has developed very sophisticated models for resource selection analysis (Lele and Keim 2006; Wasser et al, in review) able to pinpoint the habitat covariates that subjects are attracted to, or avoiding. We have also been able to link these responses to physiological correlates of nutrition and emotional stress (Wasser et al., in press; in review). Using resource selection guided sampling can also markedly enhance the precision of population estimates from scat collected by detection dogs (Wasser et al, in review) by significantly increasing detection probabilities of the target species.

We acquired a large number of black bear samples ( $n = 850$ ) in 2009 despite collecting very few grizzly bear samples. We are now using the black bear samples to conduct resource selection probability function (RSPF; Lele and Keim 2006) analyses and endocrine analyses in an effort to reveal the principle environmental factors impacting black bear. As long as such data are interpreted with caution, we believe that such analyses will also lend considerable insight to environmental factors impacting grizzly bears that could greatly improve our study design in 2010.

Resource selection models are being estimated in a use and available study design using two competing model forms: the exponential resource selection function (RSF) and the logistic resource selection probability function (RSPF) (Lele and Keim 2006). Model selection is conducted using Schwarz's Information Criterion. Locations for each black bear scat define the used locations while available points are defined by thousands of random locations from within the surveyed transects, defined by the track-logs worn by each dog. This allows us to restrict available habitat in the analyses to only the area covered by the dogs. Our analyses identify the key covariates that are attracting or repelling ursids by determining the subset of covariates that best predict used versus available locations. We will test the final model on the small number of grizzly samples acquired, once the final model covariates have been identified for black bear. This should improve our precision for assessing resource selection

in grizzly bear since we will already have a model in-hand from the black bear analyses and will not have to rely on a small number of grizzly bear samples for its formulation. Similarly, linear regression is being used to associate physiological indices of stress and nutritional status with the final resource selection models (e.g., distance to high-use roads) in black bear. These results are similarly expected to provide insight into impacts facing the less stress tolerant grizzly bear particularly given their comparable nutritional needs.

**Improvements for Next Year:** As previously discussed, the following improvements to the study design could improve grizzly bear sampling efficiency by increasing their detection probabilities in subsequent years.

**Training Samples:** First, it is vital to have more wild grizzly bear samples to train the dogs on prior to the study onset. This will help lock the dogs onto grizzly bear scent as early as possible, and before they experience the high density of black bear samples in the area. The ideal way to achieve this would be to convince state or federal authorities to allow us to follow several days of consecutive GPS points from radiocollared grizzly bears in Montana. Dogs would indicate on all encountered bear scats, the majority of which will be from the radiocollared individual (Wasser et al. 2004). This would provide the dogs multiple opportunities to detect and be rewarded for locating wild grizzly bear scats. It would also help if state or federal authorities could provide us training scats known to be from wild grizzly bear.

### **Difficulties and Solutions**

#### ***Access***

Difficulties:

- Cell 1 was dropped because of poor access
- Project cells 4, 7, 11, and 16 and control cells 7 and 8 had poor access, which resulted in spatially unequal sampling across the cells
- Some cells required long hikes or backpacking before sampling could even begin because of gated or overgrown roads
- Most of the gated roads serve to protect wildlife habitat, so even use of four-wheelers in the future is unlikely
- Some cells had private property (mostly near Highway 2), which teams had to work around

Improvement for next season:

- Visit site beforehand for reconnaissance
- Schedule more time to allow for backpacking
- Teams could backpack for multiple days at a time, completing several transects before returning to home base, saving time and energy in hiking/driving in and out multiple times
- Greater opportunity to review access and maps before project onset

#### ***Plum Creek Land***

Difficulties:

- It was not clear before the project started (or even well into project completion) what kind of permission needed to be obtained from Plum Creek Timber Co. in order to access their lands
- Obtaining permission proved difficult
- Plum Creek land could not be accessed until session C, resulting in unequal survey efforts in some of the cells that covered PCT property Improvement for next season:
- It is *essential* for reliable data collection that a relationship with PCT be established and permission to access their lands be obtained before project onset.

### ***DNA amplification success***

We used a new DNA extraction method this year because of its considerable promise. We are in the process of conducting preservation studies using this new method that should further improve DNA amplification success by decreasing DNA degradation post-collection.

### **References**

- Ball MC, R Pither, M Manseau, J Clark, SD Peterson, S Kingston, N Morrill, P Wilson. Characterization of target nuclear DNA from faeces reduces technical issues associated with the assumptions of low-quality and quantity template. *Conserv. Genet.* **8**, 577-586 (2007). DOI 10.1007/s10592-006-9193-y
- Kasworm, W.F., H. Carriles, T.G. Radandt, M. Proctor, and C. Servheen. 2009. Cabinet-Yaak grizzly bear recovery area 2008 research and monitoring progress report. U.S. Fish and Wildlife Service, Missoula, Montana (2009), 76 pp.
- Lele SR, JL Keim, Weighted distributions and estimation of resource selection probability functions. *Ecology* **87**, 3021-3028 (2006). doi: 10.1890/0012-9658.
- Velloso AL, SK Wasser, SL Monfort, JM Dietz. Longitudinal fecal steroid excretion in the maned wolves (*Chrysocyon brachyurus*). *General and Comparative Endocrinology* 112: 96-107 (1998).
- Wasser SK, KE Hunt, JL Brown, K Cooper, CM Crockett, U Bechert, JJ Millspaugh, S Larson, SL Monfort. A Generalized Fecal Glucocorticoid Assay for Use in a Diverse Array of Nondomestic Mammalian and Avian Species *Gen Comp Endocrinol*, **120**, 260-275 (2000). doi:10.1006/gcen.2000.7557.
- Wasser SK, B Davenport, ER Ramage, KE Hunt, M Parker, C Clarke, G Stenhouse. Scat detection dogs in wildlife research and management: application to grizzly and black bears in the Yellowhead Ecosystem, Alberta, Canada. *Can. J. Zool.* **82**, 475-492 (2004). doi:10.1139/z04-020.
- Wasser, SK, CS Houston, GM Koehler, GG Cadd, SR Fain. Techniques for application of fecal DNA studies of Ursids. *Mol. Ecol.* **6**, 1091-1097 (1997).
- Wasser SK, A Shedlock, K Comstock, E Ostrander, B Mutayoba, M Stephens. Assigning African elephant DNA to geographic region of origin. Applications to the ivory trade. *Proc. Natl. Acad. Sci. U.S.A.* **101**, 14847-14852 (2004). doi/10.1073/pnas.04
- Wasser, S.K., R. Thomas, P.P. Nair, C. Guidry, J. Southers, J. Lucas, D.E. Wildt and S.L. Monfort. Effects of dietary fiber on faecal steroid measurements. *Journal of Reproduction and Fertility* 97: 569-574 (1993).
- Wasser, S.K., S.L. Monfort, J. Southers and D.E. Wildt. Excretion rates and metabolites of oestradiol and progesterone in baboon (*Papio cynocephalus*) faeces. *Journal of Reproduction and Fertility* 101: 213-220 (1994).

- Wasser, SK. Lucky dogs: rescued from the pound, single-minded dogs sniff out the scat of endangered animals, trumping more technical tracking methods. *Natural History* **117**: 48-53, (October, 2008).
- Wasser SK, Cristòbal-Azkarate JA, Booth RN, Hayward L, Ayres K, Vynne C, Gobush K, Hunt K, Canales-Espinosa D, and Rodríguez-Luna E. in press. Non-invasive Measurement of Thyroid Hormone in feces of a Diverse Array of Avian and Mammalian Species. *Gen Comp Endocrinol* (in press). [doi:10.1016/j.ygcen.2010.04.004](https://doi.org/10.1016/j.ygcen.2010.04.004)
- Wasser S.K., JL Keim, ML Taper, and SR Lele. What ails caribou in the Alberta oil sands, wolves or intense human activity? (in review) *Frontiers in Ecology*

## Tables

Table 1. Number of scats detected per handler/dog in both the project and control areas during all sessions in 2009. \* Does not include distance hiked in/out to get to/from transect.

<b>ALL SESSIONS</b>	<b>Jodi/Scoob</b>	<b>Liz/Lexi</b>	<b>Keeg/Chest</b>	<b>Jen/Max</b>	<b>Keeg/Max</b>	<b>Jen/Orion</b>	<b>Keeg/Orion</b>	<b>Liz/Orion</b>	<b>Jodi/Sash</b>	<b>Liz/Sash</b>	<b>Keeg/Sash</b>	<b>TOTAL</b>
<b>Scats Collected</b>	344	101	148	164	81	45	29	5	32	15	34	<b>998</b>
<b>Scats Not Collected</b>	326	48	46	105	56	9	13	3	20	12	11	<b>649</b>
<b>Total Scat Locations</b>	670	149	193	264	137	54	42	8	52	27	45	<b>1641</b>
<b>% Collected</b>	51.3	67.8	76.7	62.1	59.1	83.3	69.0	62.5	61.5	55.6	75.6	<b>60.8</b>
<b>Transects Completed</b>	39.0	24.0	22.0	22.0	15.0	5.0	3.0	1.0	6.0	3.0	6.0	<b>146.0</b>
<b>Total Distance*</b>	223.4	117.0	105.6	110.1	68.5	24.5	11.9	4.8	34.5	12.7	25.4	<b>738.4</b>
<b>Avg. Dist./Transect</b>	5.8	4.8	4.7	5.0	5.3	5.3	4.0	4.8	5.7	3.9	4.2	<b>4.9</b>
<b>Avg. Scat Locations/Trans.</b>	16.5	6.8	8.8	11.2	11.6	9.3	10.6	9.4	9.3	10.1	7.5	<b>10.1</b>
<b>Avg. Scat Locations/Km</b>	2.9	1.5	1.7	2.3	2.2	2.3	2.3	2.8	2.0	2.1	1.8	<b>2.2</b>

Table 2. Number of scats detected per handler/dog in both the project and control areas during session A in 2009. \* Does not include distance hiked in/out to get to/from transect.

<b>SESSION A</b>	<b>Jodi/Scoob</b>	<b>Liz/Lexi</b>	<b>Keeg/Chest</b>	<b>Jen/Max</b>	<b>Jen/Orion</b>	<b>Keeg/Orion</b>	<b>TOTAL</b>
<b>Scats Collected</b>	62	41	81	60	33	12	<b>289</b>
<b>Scats Not Collected</b>	13	13	11	25	2	0	<b>64</b>
<b>Total Scat Locations</b>	75	54	92	80	35	12	<b>348</b>
<b>% Collected</b>	82.7	75.9	88.0	75.0	94.3	100.0	<b>83.0</b>
<b>Transects Completed</b>	7.0	10.0	9.0	7.0	3.0	1.0	<b>37.0</b>
<b>Total Distance*</b>	43.3	57.1	46.3	32.5	13.0	4.1	<b>196.3</b>
<b>Avg. Dist./Transect</b>	6.2	5.9	5.1	4.6	4.3	4.1	<b>5.1</b>
<b>Avg. Scat Locations/Trans.</b>	10.7	5.5	10.2	12.1	11.7	12.0	<b>10.4</b>
<b>Avg. Scat Locations/Km</b>	1.7	0.9	2.0	2.5	2.7	2.9	<b>1.8</b>

Table 3. Number of scats detected per handler/dog in both the project and control areas during session B in 2009. \* Does not include distance hiked in/out to get to/from transect.

<b>SESSION B</b>	<b>Jodi/Scoob</b>	<b>Liz/Lexi</b>	<b>Keeg/Chest</b>	<b>Jen/Max</b>	<b>Jen/Orion</b>	<b>Liz/Orion</b>	<b>Jodi/Sash</b>	<b>Liz/Sash</b>	<b>TOTAL</b>
<b>Scats Collected</b>	96	37	55	61	7	5	6	7	<b>274</b>
<b>Scats Not Collected</b>	70	20	29	41	4	3	1	4	<b>172</b>
<b>Total Scat Locations</b>	166	57	83	102	11	8	7	11	<b>445</b>
<b>% Collected</b>	57.8	64.9	66.3	59.8	63.6	62.5	85.7	63.6	<b>61.6</b>
<b>Transects Completed</b>	9.0	7.0	8.0	9.0	1.0	1.0	1.0	1.0	<b>37.0</b>
<b>Total Distance*</b>	48.5	30.9	38.8	48.2	8.2	4.8	5.1	2.6	<b>187.1</b>
<b>Avg. Dist./Transect</b>	5.4	4.4	4.9	5.4	8.2	4.8	5.1	2.6	<b>5.1</b>
<b>Avg. Scat Locations/Trans.</b>	18.4	8.1	10.3	11.3	11.0	8.0	7.0	11.0	<b>10.6</b>
<b>Avg. Scat Locations/Km</b>	3.4	1.8	2.1	2.1	1.3	1.7	1.4	4.2	<b>2.4</b>

Table 4. Number of scats detected per handler/dog in both the project and control areas during session C in 2009. \* Does not include distance hiked in/out to get to/from transect.

<b>SESSION C</b>	<b>Jodi/Scoob</b>	<b>Liz/Lexi</b>	<b>Keeg/Chest</b>	<b>Jen/Max</b>	<b>Keeg/Max</b>	<b>Jen/Orion</b>	<b>Keeg/Orion</b>	<b>Jodi/Sash</b>	<b>Liz/Sash</b>	<b>TOTAL</b>
<b>Scats Collected</b>	68	23	12	43	17	5	17	16	8	<b>209</b>
<b>Scats Not Collected</b>	76	15	6	39	20	3	13	7	8	<b>187</b>
<b>Total Scat Locations</b>	144	38	18	82	37	8	30	23	16	<b>396</b>
<b>% Collected</b>	47.2	60.5	66.7	52.4	45.9	62.5	56.7	69.6	50.0	<b>52.8</b>
<b>Transects Completed</b>	8.0	7.0	5.0	6.0	3.0	1.0	2.0	3.0	2.0	<b>37.0</b>
<b>Total Distance*</b>	50.5	29.0	20.5	29.4	19.2	3.3	7.8	17.3	10.1	<b>187.1</b>
<b>Avg. Dist./Transect</b>	6.3	4.1	4.1	4.9	6.4	3.3	3.9	5.8	5.1	<b>4.9</b>
<b>Avg. Scat Locations/Trans.</b>	18.0	5.4	3.6	13.7	12.3	8.0	14.5	7.7	8.0	<b>10.1</b>
<b>Avg. Scat Locations/Km</b>	2.9	1.3	0.9	2.8	1.9	2.4	3.8	1.3	1.6	<b>2.1</b>

Table 5. Number of scats detected per handler/dog in both the project and control areas during session D in 2009. \* Does not include distance hiked in/out to get to/from transect.

<b>SESSION D</b>	<b>Jodi/Scoob</b>	<b>Keeg/Max</b>	<b>Jodi/Sash</b>	<b>Keeg/Sash</b>	<b>TOTAL</b>
<b>Scats Collected</b>	118	64	10	34	<b>226</b>
<b>Scats Not Collected</b>	167	36	12	11	<b>226</b>
<b>Total Scat Locations</b>	285	100	22	45	<b>452</b>
<b>% Collected</b>	41.4	64.0	45.5	75.6	<b>50.0</b>
<b>Transects Completed</b>	15.0	12.0	2.0	6.0	<b>35.0</b>
<b>Total Distance*</b>	81.1	49.3	12.1	25.4	<b>167.9</b>
<b>Avg. Dist./Transect</b>	5.4	4.1	6.1	4.2	<b>5.0</b>
<b>Avg. Scat Locations/Trans.</b>	19.0	8.3	11.0	7.5	<b>11.5</b>
<b>Avg. Scat Locations/Km</b>	3.5	2.0	1.8	1.8	<b>2.7</b>

Table 6. Grizzly bear scat samples that have been indentified through mtDNA and their status.

STATUS	SPP ID	DATE	DOG	CELL	UNIQUE ID	CONTENTS	FRESHNESS	ODOR STRENGTH	HABITAT
Confirmed	Grizzly	9/10/2009	Scooby	04	04D05	Seeds	Moist	Strong	Forest
Confirmed	Grizzly	8/5/2009	Orion	06	06B07	Fruit	Dry Throughout	None	Forest
Confirmed	Grizzly	8/5/2009	Orion	06	06B10	Vegetation	Dry Throughout	None	Other
Confirmed	Grizzly	8/4/2009	Max	10	10B02	Other	Moist	None	Forest
Confirmed	Grizzly	8/4/2009	Max	10	10B04	Vegetation	Moist	None	Forest
Confirmed	Grizzly	9/10/2009	Sasha	10	10D07	Vegetation	Dry Throughout	Weak	Shrub
Confirmed	Grizzly	8/10/2009	Sasha	11	11B02	Fruit	Dry Throughout	None	Forest
Confirmed	Grizzly	9/13/2009	Scooby	11	11D01	Vegetation	Dry Throughout	Strong	Shrub
Confirmed	Grizzly	9/13/2009	Scooby	11	11D04	Hair	Dry Throughout	Strong	Shrub
Confirmed	Grizzly	9/13/2009	Scooby	11	11D06	Vegetation	Dry Throughout	Strong	Shrub
Confirmed	Grizzly	8/25/2009	Scooby	12	12C06	Fruit	Ext Dry / Int Moist	Weak	Forest
Confirmed	Grizzly	7/27/2009	Scooby	14	14A17	Vegetation	Dry Throughout	None	Forest
Confirmed	Grizzly	8/17/2009	Chester	16	16B01	Vegetation	Moist	Weak	Forest
Confirmed	Grizzly	8/3/2009	Max	17	17A06	Vegetation	Dry Throughout	None	Forest
Confirmed	Grizzly	9/25/2009	Scooby	17	17D01	Vegetation	Dry Throughout	Moderate	Rock
Confirmed	Grizzly	8/1/2009	Max	18	18A11		Ext Dry / Int Moist	Moderate	Forest
Confirmed	Grizzly	9/21/2009	Max	26	26D02	Seeds	Ext Dry / Int Moist	Weak	Shrub
Confirmed	Grizzly	8/10/2009	Chester	27	27B01	Hair	Dry Throughout	None	Forest
Confirmed	Grizzly	7/23/2009	Lexi	C06	C06A03	Hair	Dry Throughout	Weak	Forest
Confirmed	Grizzly	8/19/2009	Max	C06	C06C07	Hair	Ext Dry / Int Moist	None	Forest
Confirmed	Grizzly	8/8/2009	Lexi	C07	C07B01	Vegetation	Ext Dry / Int Moist	Moderate	Shrub
Confirmed	Grizzly	8/8/2009	Lexi	C07	C07B04	Vegetation	Ext Dry / Int Moist	Moderate	Forest
Confirmed	Grizzly	8/6/2009	Scooby	C10	C10B24	Seeds	Dry Throughout	Moderate	Forest

Table 7. Hormone and nuclear DNA results from the 23 fecal samples confirmed to be from grizzly bear. Fecal hormone metabolites include: Cort= cortisol, T3 = thyroid, P4 = progesterone, T = testosterone. Sex was determined by the amelogenin nuclear marker. All microsatellite DNA loci begin with a G, the last number refers to allele 1 or 2 of that locus. E and N refer to north and west UTMs, respectively (NAD83 Zone 11). The green rows indicate grizzly bear samples that amplified at enough microsatellite loci to provide an individual ID.

Sample ID	CORT NG/G	T3 NG/G	P4 NG/G	T NG/G	Sex	G1A -1	G1A -2	G1D -1	G1D -2	G10B -1	G10B -2	G10C -1	G10C -2	G10J -1	G10J- 2	G10M -1	G10M -2	E	N	Date
04D05	85	85	295	49		194												602050	5338417	9/10/09
06B07	65	102	505	269	M	192	194	168	168	158	166	99	99	200	206	212	216	610872	5342536	8/5/09
06B10	240	142	953	281		194				158	166	99						610875	5341216	8/5/09
10B02	168	103	453	420								103	105					614996	5334793	8/4/09
10B04	161	101	1765	613	F	192	194	176		152	164	99	115	200	208	212	212	614297	5334085	8/4/09
10D07	146	131	589	32														616431	5337435	9/10/09
11B02	111	181	885	355	M	192	194	168	188	158	166	103	111	186	206	210	214	599550	5328792	8/10/09
11D01	241	104	538	533		192	198	182	184	160	162	105	105	190	194	210	212	598595	5332261	9/13/09
11D04	168	97	546	461														598465	5332563	9/13/09
11D06	222	150	1022	1448														598439	5332565	9/13/09
12C06	77	203	686	259	F	192	194	175	184	162	162	105	107	190	194	206	212	603508	5329295	8/25/09
14A17	303	192	793	116														616942	5329462	7/27/09
16B01	106	207	604	531														599359	5328004	8/17/09
17A06	160	172	606	617								89						606938	5324108	8/3/09
17D01	144	173	899	728						158		105						607211	5325114	9/25/09
18A11	152	85	623	1605		194	198	175	184	158	162	103	105	190	202	206	212	611585	5326296	8/1/09
26D02	395	112	551	140	M	192	194	175	184	158	162	105	105	190	194	210	212	608761	5314012	9/21/09
27B01	80	119	769	184		190				158	160	99	103	186	206	212		616129	5315958	8/10/09
C06A03	45	202	630	138		194		180	180	158	160	105	107	190	194	214	216	587461	5396473	7/23/09
C06C07	45	82	148	low	f	192	194	179	180	160	160	105	111	186	186	210	212	588101	5393351	8/19/09
C07B01	96	106	657	368	m			175		156	156	111	111	194				589582	5393296	8/8/09
C07B04	133	98	721	222				175	175									589530	5393348	8/8/09
C10B24	100	102	660	705		184		171	175	156	158	99	103	197	197	208	212	595484	5388156	8/6/09



**Figures**

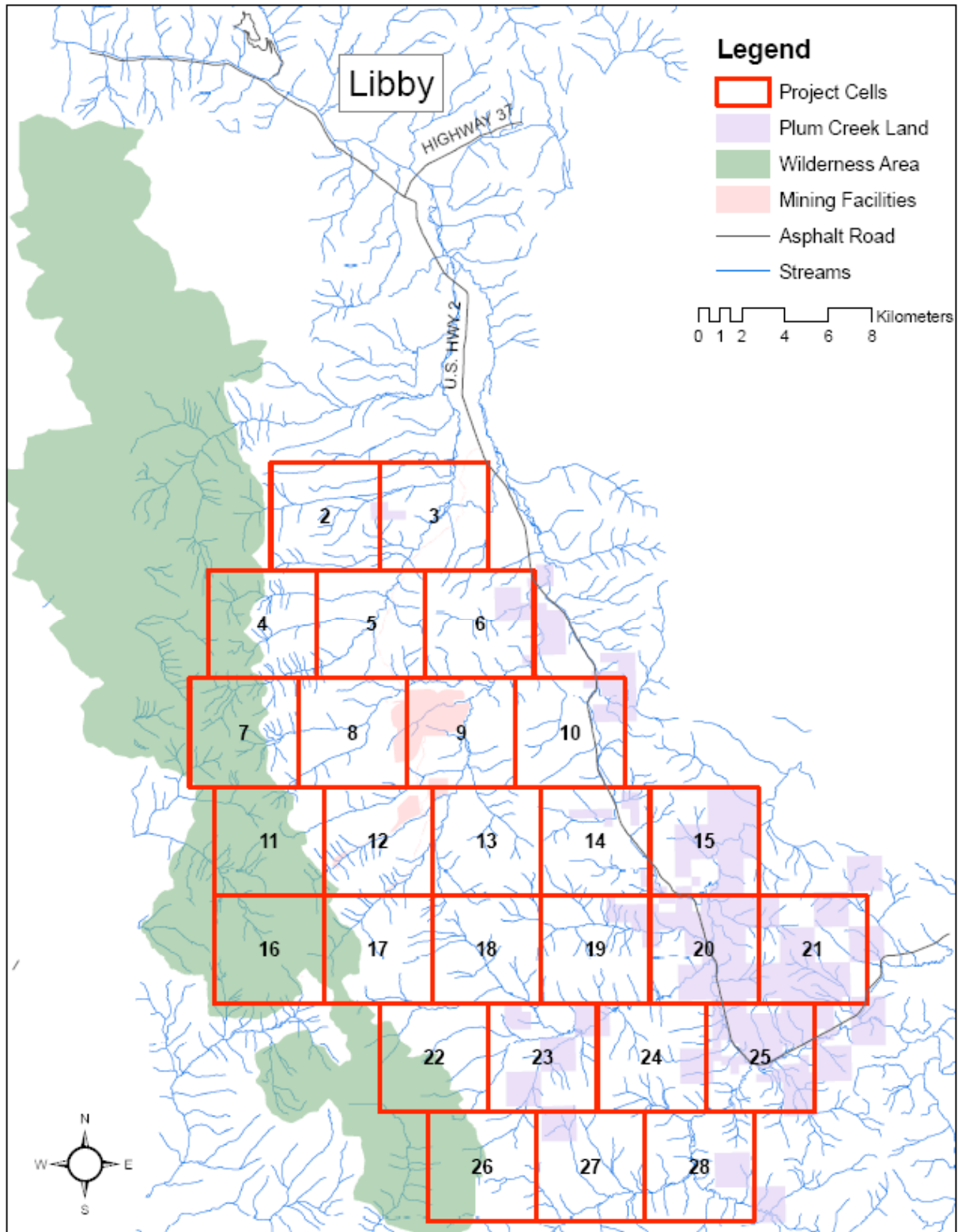


Figure 1. Main project area in 2009.

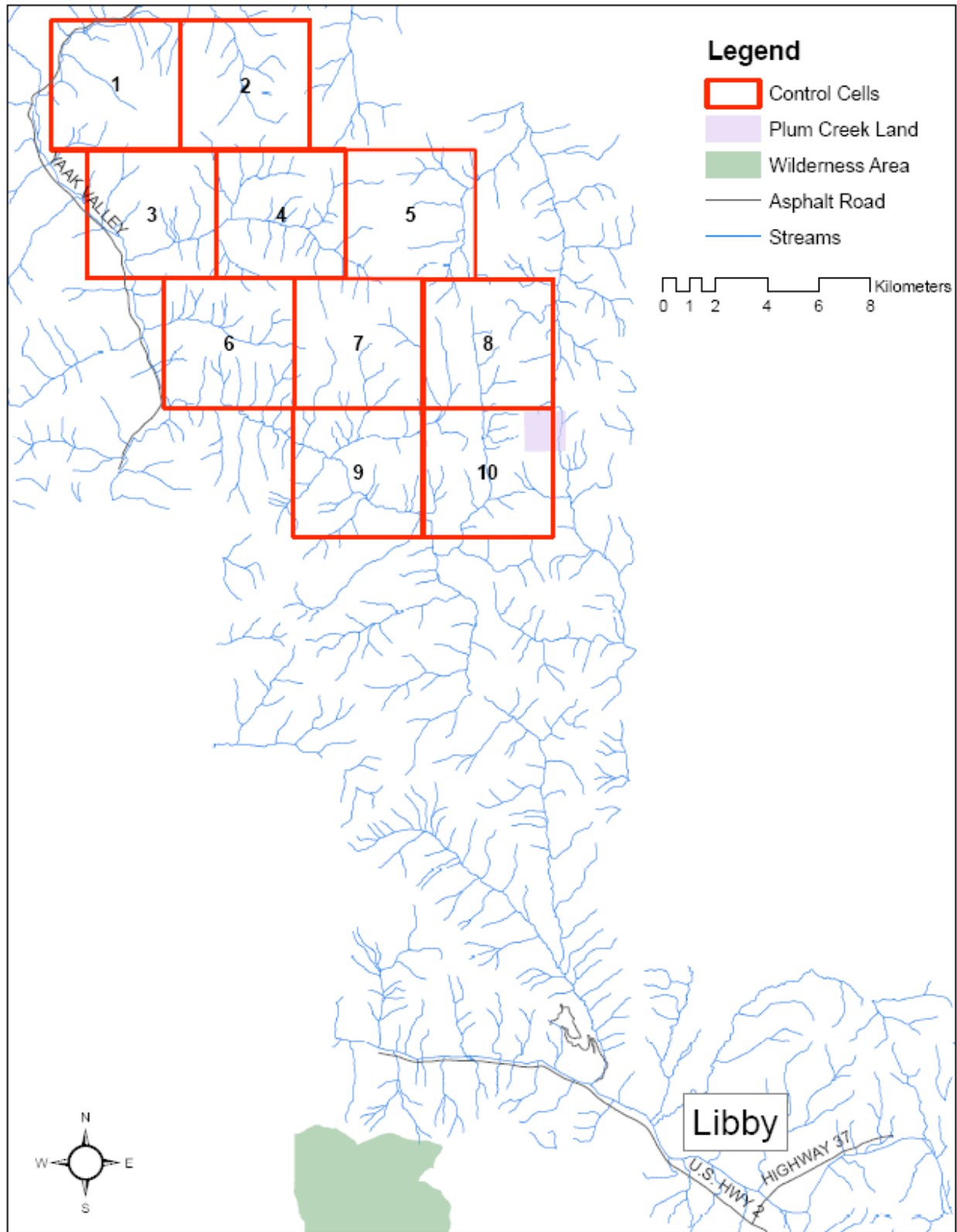


Figure 2. Control area in 2009.

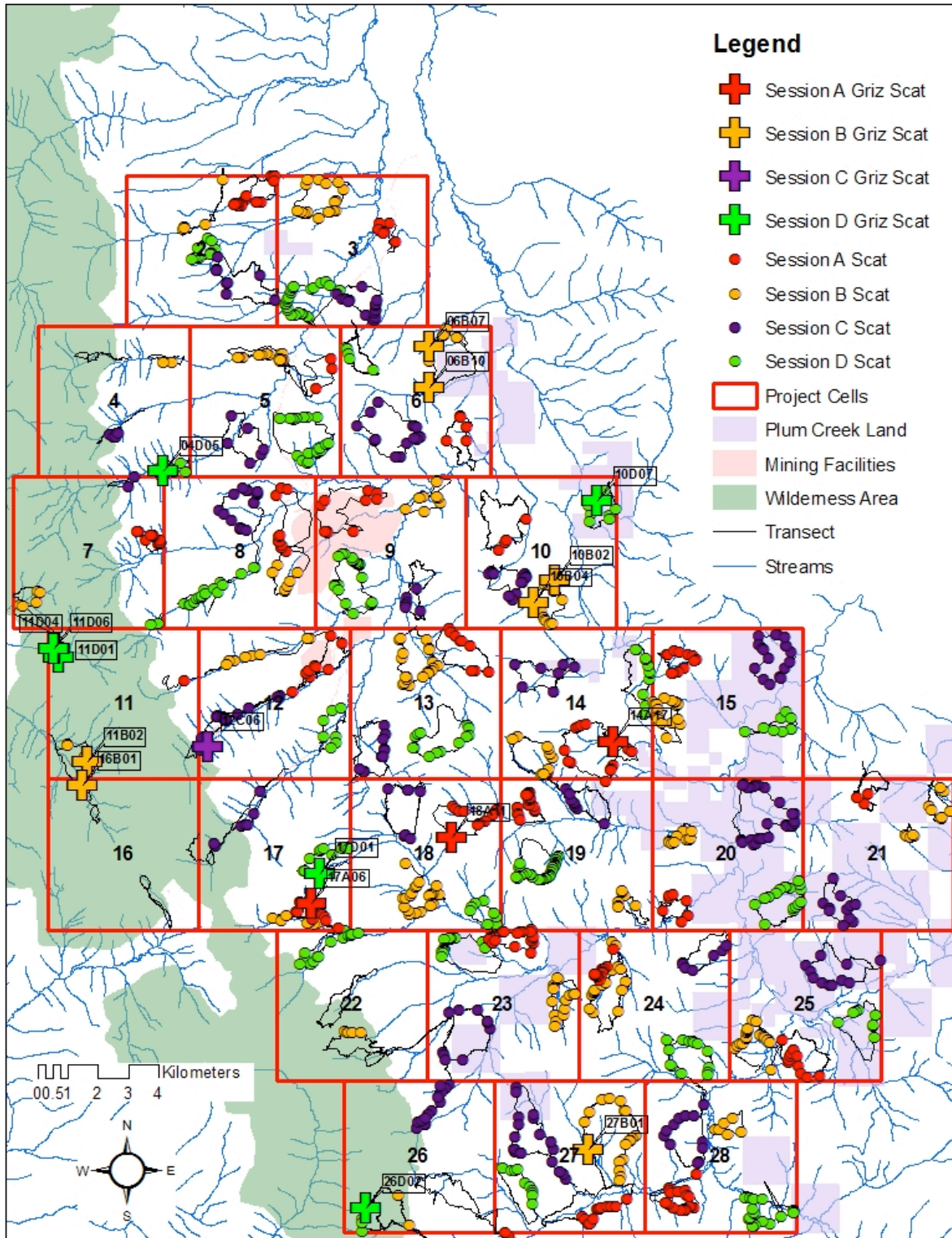


Figure 3. Locations of grizzly scats detected on transects completed in main project area during all sessions in 2009.

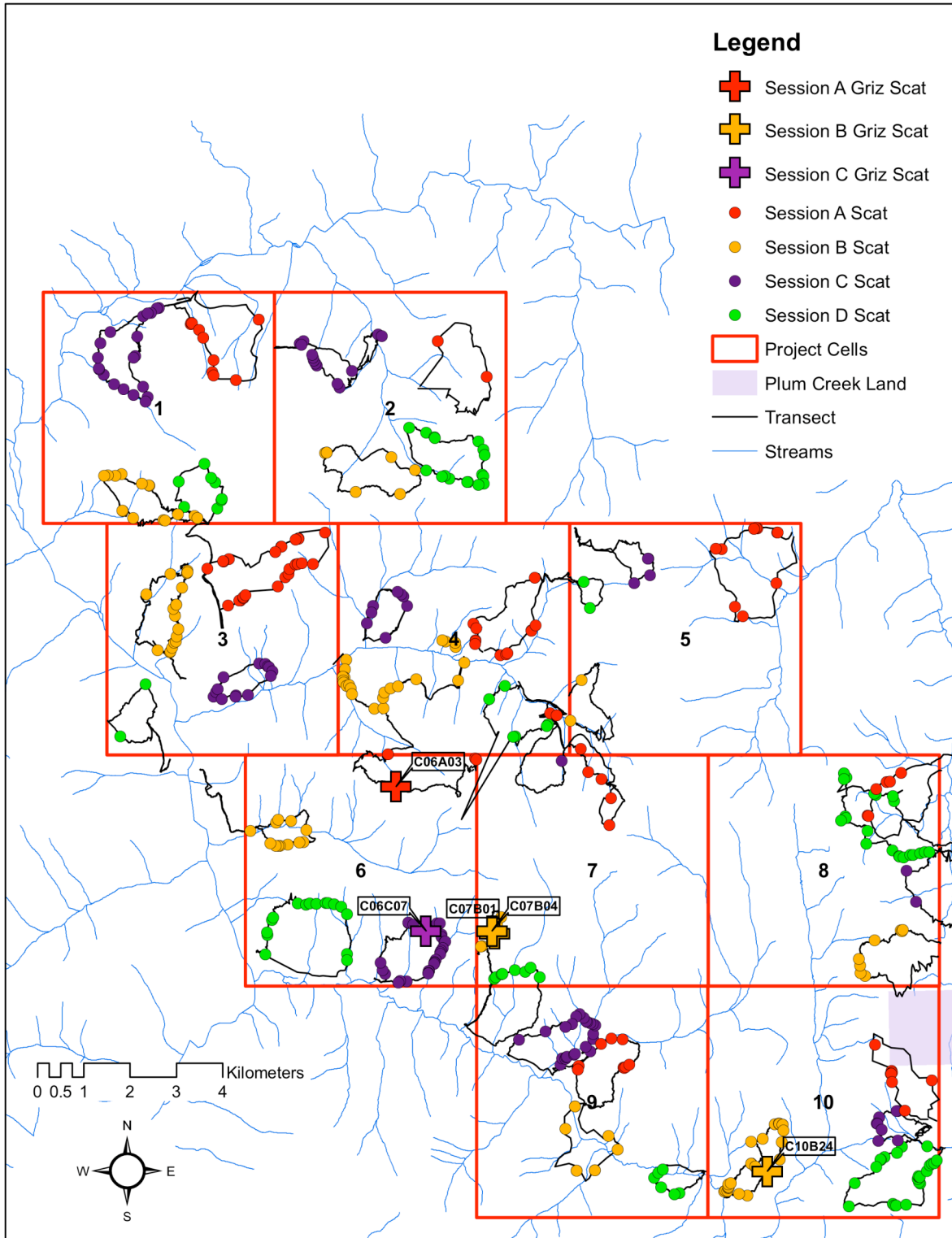


Figure 4. Locations of grizzly scats detected on transects completed in control area during all sessions in 2009.