RESEARCH PROJECT STUDY PLAN
NONINVASIVE GRIZZLY BEAR POPULATION MONITORING IN NORTHWESTERN MONTANA

STUDY TITLE: Noninvasive Monitoring of Grizzly Bear Population Trend

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BACKGROUND AND JUSTIFICATION:

Wildlife managers need reliable estimates of population size, growth rates, genetic characteristics, and distribution to make informed decisions about how to recover at–risk populations, yet obtaining these estimates is costly and often imprecise. The grizzly bear (*Ursus arctos*) population in the Northern Continental Divide Ecosystem (NCDE) of northwestern Montana has been managed for recovery since being listed under the U.S. Endangered Species Act in 1975, yet no rigorous data had been available to evaluate the program's success. A recently completed U.S. Geological Survey research project, the Northern Divide Grizzly Bear Project (NDGBP), has provided detailed information on animal abundance, relative density patterns, population genetic characteristics, and distribution of grizzlies in the greater NCDE. However, to date there have been no reliable estimates of population growth rates or other trends (e.g., changes in density patterns) in this population. Considerable amounts of time and money are allocated to manage grizzly bears; however, without effective monitoring programs to identify changes in population abundance, distribution, and connectivity, managers are less able to take appropriate actions to ensure the persistence of populations.

Effective programs for monitoring wildlife populations should serve two primary purposes consistent with adaptive management: (1) provide periodic assessments of the status and trends of population metrics of concern, and (2) improve our understanding of how populations respond to management actions (Pollock et al. 2002, Nichols and Williams 2006). As such, effective monitoring programs must focus on acquiring the information needed to make management decisions in a useful timeframe, as well as providing insight into the nature of the parameters being monitored and the factors impacting them (Nichols and Williams 2006). Predicting the response of an animal population to management actions is usually imprecise. In addition, even if a response is detectable, the time lag may be too long to change trajectory within an acceptable timeframe. Imprecise or irrelevant metrics often fail to identify problems until either it is too late to prevent precipitous population declines or rescue would require extraordinary measures. Avoiding such scenarios through early detection of declines should be one of the primary objectives of any monitoring program.

The USFWS Grizzly Bear Recovery Plan (US Fish and Wildlife Service 1993) focuses on monitoring three primary parameters in the NCDE: (1) the number of unduplicated females with cubs observed annually, (2) the distribution of females with dependent offspring, and (3) the number of known, human–caused bear mortalities. The purpose of the first parameter is to generate an estimate of minimum grizzly bear abundance from which allowable human–caused mortality limits can be determined. This method has been shown to dramatically underestimate abundance and, consequently, to overestimate the mortality rate (Kendall et al. 2009). Neither of the first two parameters employs a rigorous sampling design to derive estimates; instead they rely on opportunistic sightings made during routine activities by state and federal management agency personnel. As such, changes in the numbers of family groups detected may be a function of sampling effort, not true changes within the population. Further, these methods provide no measure of uncertainty (e.g., confidence intervals). In general, these monitoring approaches would not meet contemporary evidentiary standards and are, along with the recovery criteria themselves, currently being revised.

The 1993 Recovery Plan states that, "The development of a population monitoring system requires balance between precision and cost. High precision requires intrusive monitoring of the population at relatively high cost. Low precision usually also is low in cost but produces data with wide, sometimes questionable, confidence. The optimum monitoring system should be repeatable and nonintrusive (it should not require continuous capture and handling of animals). The optimum system should not require exorbitant expense or highly trained and specialized personnel whose time is solely devoted to grizzly bear monitoring." The Recovery Plan also calls for development of a conservation strategy that will include population monitoring that continues after recovery and delisting. It follows that such a monitoring program would also be affordable, precise, and not rely on capture and handling of animals.

Recent research based on the results of the NDGBP suggests that noninvasive genetic sampling (NGS) may satisfy this definition of a desirable monitoring program for grizzlies in the NCDE, both prior to and following delisting. A simulation study using detection data from the NDGBP with the temporal symmetry models of Pradel (1996) found that precise and unbiased estimates of population growth rates are possible with just 3–4 years of sampling (Stetz et al. in review). Specifically, genotypes derived from hair samples collected during repeated surveys of naturally occurring bear rubs appear to yield capture probabilities sufficient to estimate gender–specific growth rates and apparent survival. These surveys are conducted entirely on recognized human and animal travel routes, can be performed by personnel with very little training, and do not require any handling of study animals.

In response to the need for rigorous and timely information on grizzly bear population status and trends, the Flathead National Forest (FNF) has committed funding to begin annual surveys of bear rubs throughout the greater NCDE. The FNF has determined that ongoing grizzly bear research in the NCDE does not meet all of their informational needs, and has identified bear rub surveys as a viable option to assist the Forest in management and conservation actions, as well as working towards overall recovery of this grizzly bear population.

OBJECTIVES:

The primary objective of this research project is to establish a network of bear rubs throughout the greater NCDE from which bear hair samples will be collected and genotyped. The resulting detection data will be used to monitor various parameters of the grizzly bear population, including but not limited to changes in: (1) abundance, (2) distribution and relative density patterns, (3) genetic connectivity and population genetic structure, and (4) apparent survival rates. Other potential applications of such broad–scale sampling include dietary analysis via stable isotope signatures, and measuring contaminants via elemental analysis. This information will be used in conjunction with a telemetry–based population monitoring program initiated by Montana Department of Fish, Wildlife, and Parks in the NCDE.

STUDY AREA:

The study area encompasses 31,409 km^2 (7,761,331 acres) and extends from the Canadian border to approximately Hwy 200 (Fig. 1). It includes Glacier National Park (GNP), parts of five national forests (Flathead, Helena, Kootenai, Lewis and Clark, and Lolo), parts of the Blackfeet and Flathead Indian Reservations, and significant amounts of state and private land. Within the national forest lands are five Wilderness areas (Bob Marshall, Mission Mountains, Rattlesnake, Great Bear, and Scapegoat) and one wilderness study area (Deep Creek North). Officially designated roadless areas comprise 34% of the study area. Ninety nine percent of Glacier NP is roadless and managed as wilderness. With the addition of the park, 50% of the study area is roadless. There are 6,900 km (4,300 mi) of trail in the NCDE. The study area is a region of diverse land use with a central core of rugged mountains managed as national park, wilderness, and multiple–use forest lands surrounded by lower elevation state and corporate timber lands, state game preserves, private ranch lands, and towns.

The exact bounds of the study area, which currently coincides with that of the NDGBP, may be modified in the future due to changes in funding and/or the legal definition of this population following the ongoing Status Review by the U.S. Fish and Wildlife Service. For example, there appears to be continuous distribution of grizzlies between the northwest corner of the NCDE and the eastern edge of the Cabinet–Yaak Ecosystem to the west. If these populations are eventually merged, sampling may be extended to the entirety of occupied lands. Also, occasionally grizzly bears are documented west of Hwy 93 in the Flathead and Mission valleys. Because bears occur at low density west of Hwy 93 and the highway with its associated development corridor forms a semi–permeable barrier to bear movement, Hwy 93 was selected as the western boundary of the study area. Grizzly bears also occur at low density south of Highway 200 and in the Garnet Mountains along the southern boundary of the study area. The southern study area boundary lies 5 – 15 km south of Hwy 200, from the junction of Hwy 83 to Hwy 434. The northern study area boundary that follows the US–Canada border for 154 km (12% of study area perimeter) has no geographic closure. However, we are attempting to coordinate with Canadian agencies to conduct bear rub based sampling between the U.S. – Canada border and Canada Highway 3 to address issues of geographic closure violation among other benefits.

PROCEDURES:

Multiple hair collection surveys at naturally occurring bear rubs coupled with microsatellite genotyping analysis to determine species, gender, and individual identity of bear hair samples will provide the detection data to estimate population parameters. Population growth rates and apparent survival will be estimated using mark–recapture based methods, specifically the Pradel (1996) temporal symmetry models. Relative density patterns will be evaluated with occupancy models (MacKenzie et al. 2006). Genetic population structure will be evaluated with factorial correspondence analysis (Belkhir et al. 2004) and other methods.

Field sampling: This study will use periodic bear rub surveys where bear hair is collected from trees and other objects that bears naturally rub against. The bear rubs to be monitored are primarily along trails and roads and are not baited. Bear rubs will be identified during surveys of trails, roads, power lines, and game trails throughout the study area during early and mid summer 2009. To facilitate hair collection, short pieces of barbed wire will be attached to the rubbed surface. Hair samples from barbed wire are larger, have more follicles, require less time to collect than hair deposited on the original rub surface, and define discrete samples with limited opportunity for hairs from more than one individual to be mixed together.

Four 30–cm lengths of barbed wire will be attached to each bear rub using two staples per length. Each piece of wire has three four–pronged barbs. The wire will be positioned to cover as much of the rubbing surface as possible, typically in a zig–zag formation. A small, yellow, metal reflective tag will be nailed to each side of the bear rub at approximately 2 m from the base out of sight from the trail to allow surveyors to locate the rub. Each bear rub will receive an aluminum tag with a unique identification number.

In areas with high levels of packhorse and mule use, approximately 60% of the bear rubs along trails are also bumped by animal packs. Horses and their packs may be cut if barbed wire is installed on these rub trees. Double–stranded, barbless wire will be used as a pack stock–friendly, alternate hair snag device on these bump surfaces. Between 6–10 23–cm lengths with the strands slightly separated on each end will be mounted vertically on the rub surface. Hair collects on the ends that protrude beyond the staples. Barbed wire will be installed only outside of the areas bumped by horse packs.

In years following the establishment of the bear rub network (i.e., years 2–4), and prior to the sampling period, all bear rubs will be cleared of hair that may have accumulated during the fall or winter since the final survey of the previous year. Funding permitting, each bear rub will be visited at least three times annually: once to remove potentially old hairs, and twice for hair collection. All hair deposited on the barbs will be collected during each visit. The number of hair samples to be collected will be a function of the number of surveyed bear rubs and, to a lesser extent, the number of surveys annually.

<u>Sample handling and management</u> – Hair will be removed from each barb and placed in paper envelopes; all hairs from each set of barbs will be considered a separate hair sample. In a previous study in this area, <1% of the hair samples from rubs contained hair from more than one individual black and/or grizzly bear (Kendall et al. 2009). Mixed samples cannot be used to identify individuals because it is not possible to separate the DNA from different bears unless single hairs are analyzed. Genotyping success is a function the number of hairs analyzed; therefore it is desirable to extract DNA from >>1 hair. Hair samples will be brought out of the field as soon as possible and stored in a desiccant chamber containing silica gel beads. Samples will be protected from UV radiation and freeze–thaw cycles to prevent further DNA degradation.

Hair will be collected in 6.4 cm x 10.8 cm paper coin envelopes. The following data will be recorded for each sample: name(s) of collectors, date of collection, bear rub identification number, and where on the bear rub the sample was collected. Samples will be assigned a unique number that appears on two bar code labels. One label stays attached to the hair collection envelope, and the second "piggyback" label with the sample number can be peeled off and stuck to the data form. The peel and stick label means there is no need for field crews to copy the sample number onto the data form. This eliminates transcription errors and problems due to illegible handwriting. The barcode label system will maximize the speed and accuracy of data entry by eliminating keystrokes as the barcodes are automatically scanned into the database for hair sample information, hair snag and rub tree data, and registering hair samples when they arrive at the genetics laboratory. Studies have shown that a proficient data entry operator will make 3,000 errors per million keystrokes, whereas barcode data entry has an error rate of about 1 in 3 million (source: http://www.kcsi.ca/barcoding_adv.html).

A label company will manufacture the barcode labels, as office–quality laser printers will not always print the barcodes consistently (e.g., too dark, too light) over the life of an ink cartridge and the ink required for barcodes is not the same as standard laser printers.

The barcode's input is registered as keystrokes to the computer; therefore the scanning wand does not require any special software. We will use non–contact scanner wands that can read a barcode up to 12" from the label. The labels will have the sample number printed underneath the barcode so that if the barcode scanner cannot read the label for any reason, the number is still available. If the samples are eventually placed in a repository and are not looked at until many years later, the sample number on each envelope will not be lost due to advancing barcode technology.

<u>*Genetic analysis*</u> — Microsatellite genotyping will be used to determine species, gender, and individual identity of bear hair samples. Genetic analyses will be conducted using methods that have a well–established track record and have been published in a peer–reviewed technical journal, e.g., Paetkau (2003) and Kendall et al. (2009). The DNA identification techniques have been used and found reliable with the species that occur in the study area. Peer–reviewed lab–specific error rates associated with those methods will be a factor considered when proposals for conducting the genetic analysis are evaluated. Electrophoretic scores will be examined by at least two technicians, at least one of whom has a minimum of two years of experience with: (1) microsatellite genotyping, (2) working with analysis of small samples of noninvasively collected hair, and (3) experience with or knowledge of ursid marker systems. The chief geneticist will make final decisions regarding divergent scores. Microsatellite separations will be accomplished using laser–induced fluorescence denaturing capillary electrophoresis. Automated processing speeds analysis and reduces the risk of lane jumping and loading errors during electrophoresis. Allele scores will be calibrated with published designations to facilitate comparison to other data sets. Samples will be kept at the lab until the project is completed to facilitate re–running samples as questions arise. All materials related to the project will remain the property of the U.S. Geological Survey, including remaining hair samples and DNA extractions, raw data, and electropherograms.

Each hair sample will be examined using a light microscope to identify hairs with intact follicles. All samples without follicles will be excluded from further analysis. For each remaining sample, approximately 1 cm will be clipped from the root of up to 10 guard hairs for DNA extraction. Hair follicles will be placed in tubes for DNA extraction using Quiagen kits. The extracted genetic material will be amplified using standard polymerase chain reaction (PCR) methods. Black bear samples will be identified via the G10J microsatellite, a definitive marker, and will not be analyzed further. PCR and electrophoresis will be done in separate rooms to prevent contamination of genomic DNA samples with amplified DNA.

A pilot study of the population's genetic profile was conducted to ensure that the marker system has adequate power to produce unique genotypes for each individual sampled. To accomplish this, a subset of 246 individuals from the NCDE were used to determine the degree of heterozygosity for 17 markers used in prior North American and European brown bear populations (Paetkau 2003; NCDE marker selection. Report to USGS, West Glacier, MT). Based on this analysis, the most variable 7 loci were selected for differentiation of individuals; 9–15 additional loci will be run on one sample from each individual bear to examine population structure and to facilitate comparisons with existing data sets. The selected marker system has adequate power to differentiate up to 800 individual grizzly bears for the NCDE population.

The individual identity of the grizzly bear hair samples will be determined using the following microsatellite markers: G1D, G10B, G10P, G10J, G10M, G1A, and G10H. One sample from each individual grizzly bear identified will undergo further analyses to assess substructure within the population. To accomplish this, a 16–22 locus genotype will be generated using the following additional markers: MU23, MU59, MU50, G10C, G10L, G10X, G10U, cxx20, cxx110, P07, MSUT2, MSUT6, MU51, A06, and CPH9. The first 16 of these markers, including the seven for individual identification, correspond to the suite used by the NDGBP to assess population genetic structure (Kendall et al. 2009). We will use the Amelogenin marker to determine gender (Ennis and Gallagher 1994).

Based on previous bear rub survey work in this region and expected budgetary constraints, we anticipate subsampling at the level of each collection visit to each established bear rub. For most bear rubs, it is possible to collect ≤ 12 hair samples per visit. Our expectation is to analyze one sample per visit to each rub initially, as it is rare to identify >1 individual at a single rub in one visit. Also, individuals may leave hair >1 bear rub in a given sampling session, further reducing the risk of excluding a bear from the sample. We estimate that 65% of the hair samples will contain enough follicles to warrant extraction and 25% of extracted samples (pre–subsampling) will produce a useable grizzly bear genotype. There are several arguments for analyzing as many samples as possible that are only offset by cost. In general, as more samples are genotyped, the number of unique grizzly bears identified increases; also, having multiple high–quality data points for an individual increases confidence in that genotype. The exact number of samples to be analyzed will be dependent on funding levels, and may be subject to change across years.

<u>Quality control during genetic analyses</u> – To limit data entry errors, the genetics laboratory will build their database around an electronic copy of our field data. All hair samples will be identified with a unique number that is embedded as a bar code on the hair collection envelope. A bar code scanner will be used to link genetic results to associated field data via a relational database system. The laboratory will be required to rigorously document all sample handling protocols sufficient to meet chain–of–custody requirements including analysis date and the electrophoretic run of each sample. Upon completion of analysis, merging datasets and further error screening will be a cooperative effort between project and lab scientists to identify and address lab results that are inconsistent with bear biology or sampling expectations.

Given the variability of field conditions and wild populations, minimizing laboratory analysis error is a primary concern in DNA–based population studies. The genetics laboratory will be required to use stringent error prevention protocols including: (1) thorough training and close supervision of technicians, (2) using the suite of markers identified by pilot analyses of 246 samples from the NCDE, (3) streamlining laboratory methods, (4) early culling of low quality samples, and (5) confirmation of similar pairs of genotypes (analysis is repeated to ensure that each genotype is correct and not the result of allelic dropout, etc).

A species–specific microsatellite marker that is highly variable in black and brown bears will be used for species determination (Kendall et al. 2009). To safeguard against errors in species determination, an assignment test (Paetkau et al. 1995) will be used to identify samples with black bear allele patterns labeled as grizzly bears. If any discrepancies are found, the species test will be repeated and any questionable samples excluded from the dataset. Because allelic dropout could cause a male to register as a female, two samples from each individual new to the dataset will be run for gender determination. Sex test failure rate per sample is about 10% but the impact is much less serious than that figure suggests because typically there are multiple samples for many of the individuals identified.

Genotyping error rates will be estimated empirically from the frequency of 1, 2, and 3 pairs of mismatched loci (Paetkau 2003). Patterns in the distribution of problem samples will be tracked to check for potential laboratory processing problems and the samples involved will be flagged for closer examination. For example, incomplete data suggest the retention of too many low quality (error–prone) samples. Heterozygote deficit may indicate allelic dropout.

To ensure that differences between two samples are not due to genotyping error, samples with similar genotypes will be verified by repeating the analysis to confirm the original results. Allele scores will be calibrated to be consistent with published base pair length designations. Extraction, PCR, and electrophoresis blank and positive controls will be used at all times and records of these controls will be maintained. Blind testing may be used to monitor the reproducibility of the genotypes. Initial lab observations, hair samples, DNA extracts, and capillary electrophoretic results will be readily accessible to the principle investigator at all times during the analysis period.

To help establish allelic dropout and false allele error rates and monitor the reproducibility of the genotyping, blind testing of the laboratory results may be conducted during the course of genetic analysis following the methods of Kendall et al. (2009). Tests would consist of multiple submissions of hair samples from known bears handled for research and management purposes from this population. These duplicate samples will be added to the field samples before being sent to the laboratory in a way that will make them indistinguishable from original field samples to the laboratory staff. Only the project leaders will know the identity of the test samples and they will be well documented to prevent inclusion in the data used for analyses. Test samples may include hair from grizzly bears and black bears, siblings, parents and offspring, mixed hair from more than one individual and/or species, non–target species, and bears outside the NCDE population. Gender data from known bears will be withheld to monitor the accuracy of gender determinations.

Based on the results of the NDGBP, approximately 1% of bear rub samples will contain hair from more than one bear and will not be useful for identification of individuals. It is extremely unlikely that any hairs from non–target species (e.g., wolf, coyote, lynx, mountain lion, wolverine, elk, deer, cattle, horse, etc.) are ever collected from bear rubs. Regardless, the selected marker system is robust for differentiating grizzly and black bears in the presence of other species that are present in the ecosystem.

Quality control during field activities – There will be differences in experience and previous training among the personnel implementing the field sampling protocols. To mitigate this, the protocols have been simplified as much as possible and have few special rules so it is easy to perform them correctly. Field crews will be supplied with kits that contain everything needed for sample and data collection to help keep every component consistent. All personnel will receive the same technical training. Design assumptions will be explained in detail to enable field personnel to make intelligent choices when unanticipated situations arise.

A system of formal quality checks will be instituted in the field. Due to the exceptionally large size of the study area, the project leaders will take an active role in inspecting fieldwork to ensure consistency in protocol execution and to provide timely feedback to field technicians. Substandard work or repeated failure to follow study protocols will be grounds for dismissal of temporary workers.

To promote understanding and inspire confidence in the scientific methods among field technicians, all project personnel will receive extensive training on project methods. The training will describe the scrutiny the methodology has undergone and will be subject to, e.g., quality controls built into the study design, peer review of the field methods and data analysis, and blind testing of the genetic analysis. Training also will explain the consequences of failure to follow study protocol to the credibility of the science. Rumors will be taken seriously and dealt with directly by talking to staff to dispel misconceptions. Information about project activities and results will be disseminated to affected personnel in partner agencies. The personnel conducting the genetic analysis will be given background information about fieldwork and results to promote lab personnel interest and a sense of ownership in the study.

Due to the controversy surrounding recovery of the grizzly bear population in Montana and the need to access private property and work with staff from other agencies, presentations and materials explaining the project will be provided to partner agency personnel and private organizations, private landowners allowing sampling or access on their lands, the general public, and special focus groups affected by grizzly bear management or project activities, such as the Professional Wilderness Outfitters Association, Backcountry Horsemen clubs, non–profit conservation organizations, etc.

Security – The number of people authorized to handle samples and have access to data will be kept to a minimum. To ensure project integrity, data (hard–copy and electronic), hair samples, and extracted DNA will be kept in secure facilities. Original data forms will be kept in locked file cabinets and hair samples will be stored in a locked room in the project offices in West Glacier. Samples will be hand delivered to the genetics laboratory by project staff when feasible, or sent by registered mail. As samples arrive at the laboratory, they will be logged against a list provided by the project office of samples sent to the lab. From the time of receipt of samples by the analytical laboratory, all hair samples and DNA extractions will be kept in locked rooms when authorized personnel are not present.

Laboratory facilities will be protected by a security system that tracks access by individual and prevents past employees from entering the facilities. Computers used to conduct analyses and store results shall be protected from unauthorized access through password protections, stringent firewall and antivirus software, and/or having no hard–wire connection to the Internet. Field and genetic databases must be backed–up nightly with weekly back–ups stored off–premises.

Data analysis: Analyses will center around three parameters important for managing and recovering the grizzly bear population in northwestern Montana: (1) population growth rates, (2) distribution, relative density, and patch occupancy patterns, and (3) population genetic structure. Gender–specific and gender–pooled estimates will be made for most population parameters. This is especially important with, for example, estimates of relative density where usage may shift between genders, but no overall differences may exist.

Bear rub sampling in the NDGBP, which was a secondary effort compared to baited hair traps, resulted in detecting 53% of the males and 26% of the females estimated to be in the population. With the expected increases in both the geographic and temporal coverage of this project relative to the NDGBP, we anticipate detecting a greater proportion of the population in this study. A greater number of detected bears, along the opportunity to detect them more frequently, will result in more precise population parameter estimates. We will also investigate incorporating data from multiple sources into all analyses (e.g., mortality data; sensu Boulanger et al. 2008), and will use individual, group, and temporal covariates to improve estimate precision and minimize bias.

As a multi–year effort, the greatest value of any analysis will be in estimating changes, and potentially trends, in these parameters which will ideally be correlated with changes on the landscape. Identifying such correlations may allow managers to adapt policies and reverse negative, or enhance positive, changes in the population. This information may be useful for managing populations beyond our study area as well.

(1) Population growth rates: Statistical methods to estimate population growth rates (hereafter, lambda or λ) will focus on the temporal symmetry models of Pradel (1996). The mark–recapture based Pradel models estimate λ over the sampling time period. This is referred to as realized λ, and is different than projection matrix methods that predict

asymptotic growth rates into the future based on estimates of vital rates (e.g., adult female survival), and assume that these rates will not change appreciably. Pradel models appear especially well–suited to noninvasively obtained encounter data, and are seeing increasing use in recent years. For example, Boulanger et al. (2004) used DNA–based detections with the Pradel model to investigate the relationship between salmon availability and grizzly bear numbers in three sampling areas in British Columbia. Compared to using helicopters to count individual bears, they found that mark–recapture based methods yielded improved precision of demographic estimates and a better understanding of how changing environmental conditions affect population trends (Boulanger et al. 2004). Sandercock and Beissenger (2002) directly compared λ estimates derived from the Pradel model to those of asymptotic projection matrices and ratios of population counts. They found estimates to be in general agreement, but the Pradel model had greater precision and required less effort than the matrix–based method. However, Barker et al. (2002) advised that a clear distinction between the realized λ estimates of the Pradel model and asymptotic expectations of projection matrices must be made, and predictions based on retrospective mark–recapture data should be made only cautiously. Likewise, projection matrix predictions should be applied retrospectively with caution.

With proper model formulation, Pradel model estimates of λ have been found to be robust to moderately heterogeneous capture probabilities (Hines and Nichols 2002), such as those found in bear rub data. And although behavioral responses, especially permanent ones, can bias λ estimates (Hines and Nichols 2002), no such response is expected to exist with bear rub sampling. It should be emphasized, however, that λ estimates generated by the Pradel model are only applicable to the cohorts from which the encounter histories are obtained. Although genetic sampling methods do not yield age information, Kendall et al. (2009) concluded that individuals of all sex–age classes were detected in bear rub samples.

Simulations with the Pradel models using the empirical results from the NDGBP suggest that bear rub data has excellent potential to precisely estimate population growth rates with only 3–4 years' data (Stetz et al. in review). These simulations investigated various scenarios, including monotonically declining abundance (λ=0.97), monotonically increasing abundance (λ=1.03), stable abundance (λ=1.0), and varying growth rates representing a net decline of 26% after 10 years (alternating between λ=0.94 and λ=1.01 annually; i.e., identical net change after 10 years as with constant λ=0.97). Percent relative bias in $\hat{\lambda}$ rarely exceeded 0.6% in any scenario, and was <0.05% in year 10 of simulations. Precision in $\hat{\lambda}$ improved rapidly for both gender–pooled and gender–specific models, converging at a coefficient of variation of <3% by year 4, and continuing to decline asymptotically through year 10.

Stetz et al. (in review) also evaluated the robust design Pradel models (Kendall et al. 1997) for their ability to provide annual abundance estimates. Robust design models consist of >1 secondary sampling occasion per primary occasion. For bear rub sampling, this means two or more collection surveys per year. Recent mark–recapture analyses with bear rub data suggest that it is acceptable to pool detections that occur throughout a sampling season into discrete sessions (Boulanger et al. 2008; Kendall et al. 2008, 2009). Pooling detections into only two secondary occasions reduces heterogeneity in capture probabilities, which is difficult to model with sparse data (Boulanger et al. 2008), and lends to the flexibility of bear rub sampling. Robust design simulations used the same underlying capture probabilities regardless of how the model was parameterized for $\hat{\lambda}$, therefore model performance with respect to $\hat{N}$ was essentially identical for all models (e.g., no annual estimates differed by >1.4% between models). Simulations were consistently positively biased for $\hat{N}$; however, this bias remained between 1.5–4% for both genders for all 10 years. Standard errors of $\hat{N}$ declined by approximately 1.5–2% per year for both genders. However, as the simulated population was declining at 3% per year, the net result was a slightly increasing coefficient of variation on $\hat{N}$, although even at year 10 the CV($\hat{N}$) remained <9% for females and <6% for males.

Other advantages of the Pradel (1996) temporal symmetry models include estimation of apparent survival, which reflects both true survival and emigration. Therefore, in populations that are essentially geographically closed, the Pradel model provides approximate estimates of true survival. In simulations, bias levels returned to <5% by year 4. This indicates that estimates from the first few years of a monitoring program must be interpreted with caution for non–robust models. Robust–design models did not display this behavior, and bias levels remained <5% for all parameter estimates. In general, robust design models outperformed non–robust design models in most respects, although robust models required slightly higher capture probabilities or more time to achieve the same precision as non–robust designs.

Encounter data from bear rub detections will be analyzed with program MARK (White and Burnham 1999). As noted above, surveys of a network of bear rubs do not occur instantaneously, therefore multiple detections of each bear will be collapsed into ≥2 discrete sessions for analytical purposes, as in Kendall et al. (2008, 2009) and Boulanger et al. (2008). Multiple, competing models will be developed *a priori;* relative model support will be assessed with the sample–size adjusted Akaike Information Criteria (AICc; Burnham and Anderson 1998). Models with the lowest AICc scores are considered to have the greatest support based on the data. All models are weighted based on their AICc values, and parameter estimates averaged across models to account for model selection uncertainty. Program RELEASE (Burnham et al. 1987) can be used to test for goodness–of–fit and overdispersion parameters using the recapture portion of the data with the Cormack–Jolly–Seber model (Boulanger et al. 2004). If overdispersion is detected, quasi-AICc (QAICc) methods for model selection and averaging will be used.

(2) Relative density, distribution, and occupancy: The number, power, and diversity of analytical methods for presence–absence (or more accurately, detection–non-detection) data have exploded in recent years (MacKenzie et al. 2006). Projects that only 10 years

ago would have likely produced only naïve estimates of patch occupancy rates may now be able to estimate proportion of area used and even regional (patch) abundance. However, sampling design issues are as important in modeling occupancy as in, for example, mark–recapture experiments, although issues with the latter are much more familiar to many researchers.

Density patterns – Relative densities of bears within the NCDE vary widely; for example, approximately half of all grizzlies identified during the NDGBP were found in Glacier National Park, which represents only 13% of the study area. Identifying the landscape characteristics that best describe local variation in bear abundance can help prioritize conservation actions to promote recovery. These landscape characteristics can also be monitored to limit negative impacts on abundance and distribution, a critical component of adaptive management. Ongoing research with data from the NDGBP is attempting to describe correlations of landscape characteristics with local bear abundance in the NCDE (Kendall et al. in prep). Hierarchical models for spatial variation in abundance can also incorporate factors that influenced detection probability. Models include explicit landscape and habitat variables that could influence abundance, and a conditional autoregressive term that accounts for spatial autocorrelation. Generalized linear models are used to assess factors thought to influence abundance, with factors thought to influence the detectability of individuals also included in the models. Standard Markov chain Monte Carlo methods as implemented in the software package WinBUGS are used to analyze models.

Distribution – Grizzly bear distribution in the NCDE is currently assessed annually by state and federal biologists based on sightings of females with young. All indications suggest that the grizzly bear population is expanding into former bear habitats that have been unoccupied for >30 years. However, there are currently no intensive, dedicated efforts to document the true extent of occupancy or distribution; in fact, much of the information on range expansion is based on incidental evidence (e.g., conflicts with humans). Bear rub sampling, while not a statistical sample, may offer more rigorous information on the status and trends of occupied habitat associated with this population. In contrast to telemetry–based studies that monitor approximately 25 animals annually, bear rub surveys obtained detections of 275 bears, often with multiple points per individual. These detections represent 53% of the estimated number of male bears in the population. Males consistently have higher detection probabilities than do females, and as males are more likely to move into currently unoccupied lands, the likelihood of detection is greatest among this cohort. In just three months, nearly a thousand detections across all individuals were made with bear rub sampling. These data provide a tremendous amount of information on the timing and location of grizzlies in the NCDE that could inform managers about changes in distribution, occupancy, and density patterns.

(3) Genetic Structure: Kendall et al. (2009) used Factorial Correspondence Analysis (FCA) of 947 grizzly bears in the NCDE with ≥13–locus genotypes to assess current population genetic structure and to identify changes in that structure since 1999. By

adjusting the number and location of geographic boundaries on an ad hoc basis, they minimized overlap of geographically defined genetic clusters and used Fitch trees (Fitch and Margoliash 1967) to visualize genetic differentiation between regions as estimated with F_{ST} (Weir and Cockerham 1984). Kendall et al. (2009) documented high genetic variability overall, consistent with the hypothesis that this population never experienced a serious bottleneck. Results also suggested that genetic interchange is improving in certain regions of the population. Kendall et al. (2009) also used assignment tests (Paetkau et al. 1995) to estimate gene flow across the United States Highway 2 and BNSF railroad corridor. Although connectivity appeared high for the entire length of this corridor, F_{ST} values along the western portion were approximately four times as great, suggesting incipient fragmentation. This corresponds with the more extensive human development and higher traffic volumes in this area, and supports previous findings that fragmentation is inevitable with unmitigated development (Proctor et al. 2005). Repeated, geographically extensive genetic sampling of this population will allow managers to identify other such risks as they develop, and adapt policies to reduce impacts to gene flow. The genetic archive developed by the NDGBP will allow researchers to apply consistent tests across time with newly acquired data, or revisit existing samples and data to exploit new methods as they are developed.

Metadata: Spatial data will be documented using ArcCatalog v.9.2 or greater. Spatial Metadata Manager System (SMMS) v. 3.2 (Intergraf Inc.) will be used to document all data collection management, forms, sample handling, and genetic and data analysis. Field notes, initial lab observations, hair samples, DNA extracts, and electrophoretic results will be archived in acid–free storage containers at the USGS Glacier Field Station, Glacier National Park, West Glacier, MT.

PERMITS and COMPLIANCE:

Permits to access lands and conduct research pursuant to this project under a variety of jurisdictions will be obtained prior to initiating fieldwork from a number of state, federal, and tribal agencies, private timber and utility companies and cooperatives, and non–profit organizations (Appendix B), as well as potentially hundreds of private landowners (see Appendix D for a copy of the private landowner permission letter). The U.S. Fish and Wildlife Service, U.S. Forest Service, and Glacier National Park requirements for compliance with the Endangered Species Act and National Environmental Policy Act will also be met before field work commences (Appendix C).

EXPECTED PRODUCTS:

Papers in peer–reviewed scientific journals:

- Grizzly bear population growth rates, density patterns, and distribution in northwestern Montana
- Comparison of projection matrix model estimates of population growth rates to the noninvasive methods proposed here

Symposia, conference, workshop presentations:

- International Conference on Bear Research and Management (IBA): 2010, 2011
- The Wildlife Society: national, Northwest Section, and Montana Chapter meetings: 2010, 2011

Progress and completion reports:

- Annual progress and final completion report to IGBC, NCDE Subcommittee
- Annual progress and final completion report to Flathead National Forest, Glacier National Park, Plum Creek Timber Co., various power companies, MT DNRC

Consultation and reports to partner agencies:

- Interagency Grizzly Bear Committee, NCDE Managers Subcommittee in assistance to grizzly bear recovery effort
- Grizzly bear status for National Forest plan revisions: Flathead, Helena, Lewis and Clark, and Lolo National Forests
- Information for Montana Fish, Wildlife, and Parks grizzly bear monitoring program and conservation strategy

Data and maps:

- A variety of spatial formats of grizzly bear density and distribution information
- Database of 16–22 locus genotypes of unique grizzly bears from hair sampling and management actions
- Data on the distribution and characteristics of bear detections and bear rubs

Website:

- Information on the study background, objectives, study area, methods, results and conclusions

PUBLIC OUTREACH:

We will be active in giving presentations to public and private groups, including the Rotary Club, Kiwanis, local high schools, community groups, backcountry horsemen, and raft/backcountry guides working in and around Glacier National Park. Literally dozens of professional and general public presentations have been given related to our grizzly bear research in this region in recent years.

VIDEO AND STILL PHOTO DOCUMENTATION:

An important aspect of the research methods employed by this project is the noninvasive nature of sample collection. Many people are more familiar with traditional grizzly bear research methods (i.e., trapping, drugging, collaring, and tracking) than the new genetic and statistical approaches proposed here. To assist understanding of these techniques, we provide information through presentations, publications, and web pages about how fieldwork is conducted, the planning required, the safeguards instituted, and how it affects bears. To facilitate this objective, we have employed remotely triggered cameras to document bears visiting bear rubs in the backcountry of Glacier National Park. Select video segments are available for viewing on the project web site, and have been featured in numerous popular media outlets. Our methods have been extremely well received by the public in general, and have served to both improve the perception of wildlife research and of the USGS.

ANNUAL SCHEDULE:

• Logistical planning/preparation	Jan–Jun
Purchase equipment, prepare data forms and field protocols, identify bear rub survey routes, develop agreements and contracts	
• Conduct field work:	approx. 1 Jun – 30 Sept
Train field technicians	
Conduct bear rub	
• Genetic analyses:	approx. Oct–Jun
• Progress report to partners	May and Dec
• Data entry	Jun–Dec
• Data analysis, manuscript development	approx. Jun

PERSONNEL:

Principal Investigator:

Katherine C. Kendall, USGS Glacier Field Station, Glacier National Park, West Glacier, MT 59936–0128. Phone: 406–888–7994. Fax: 406–888–5835. Email: kkendall@usgs.gov

Senior Technical Advisor: Jeff Stetz, University of Montana.

Research Associate: Amy Macleod, University of Montana.

Information and Technology Specialist: Marilyn Blair, USGS.

Bear rub survey technicians: approx. 14 positions annually. Field technicians will be hired through the USGS and the University of Montana.
Short– and long–term volunteers will be recruited by announcing volunteer positions on the project website, university job announcement services, and various listservs specializing in wildlife and conservation–related employment opportunities.

TRAINING

Introduction: Training is critical to ensuring that field crew personnel correctly perform technical duties and safely travel and work under remote and rugged conditions. Crew members will experience a diverse range of field conditions and wide range of specific duties. As such, project training is designed to address the full extent of what crews may encounter over the course of the field season.

Prior to training, crewmembers will be given recommended reading lists and suggestions for how to prepare for the upcoming season. Recommended readings include technical articles detailing the methods employed by the project, popular materials about bears and the study area, and safety–related articles about river crossings, diseases, and general first aid. Employees also receive a list of ways to better prepare themselves for the physical demands of the season. This list includes developing an exercise program, purchasing appropriate gear, and becoming familiar with its proper use. We will attempt to hire people with extensive experience working under demanding field conditions such as those found in the northern Rocky Mountains, and ideally with experience performing the specific duties of this project.

Agenda: Day 1 of training will provide crewmembers with the background on project methods and objectives necessary to fully understand the scope and complexity of the project. Protocols, data forms, and use of handheld Global Positioning System (GPS) units will be reviewed. Basic bear biology will also be addressed. We will address "project etiquette," which will introduce crewmembers to the significance of interacting with the public and persons from other agencies. Crews will be given adequate background on the project to understand the importance of public perception and how to address questions that they will likely encounter over the course of the field season. General expectations and responsibilities of project members will be discussed as well administrative issues such as time keeping and purchasing.

Day 2 will cover backcountry safety including wildlife encounters and bear safety in particular. This section includes a presentation by a Glacier National Park ranger who presents this material each year to Park employees, as well as a bear safety video sanctioned by the International Association of Bear Research and Management (IBA). We will review principles of wilderness first aid, focusing on avoidance of injuries by making good decisions. Specific topics include dehydration, hypothermia, hyperthermia, anaphylaxis, scene assessment, snowfield and river crossings, infections, wound dressing, diseases (e.g., hantavirus, West Nile virus), and communications. Crews will be trained in how to deal with emergency situations that may occur under extreme field conditions, and how to effectively adapt and use the materials they will likely have available, such as backpacks and 2–way radios. We will also discuss how to prepare for field work, such as proper care of gear and packing for extended backcountry trips, defensive driving, and Leave No Trace ethics.

Day 3 will be intensive field training. Topics covered during the first days of training will be reinforced with on–the–ground activities. Crewmembers will be instructed in the use of topographic maps and GPS units. Personnel will be instructed in conducting bear rub surveys, which consist of hiking trails, identifying and establishing new bear rubs, and data form completion. Surveys also include locating previously identified bear rubs, recording pertinent data, and collecting hair samples.

WORK AREAS

Office work primarily will be conducted at:

- USGS Glacier Field Station, Glacier National Park, West Glacier, MT
- University of Montana, Missoula, MT

Fieldwork will be conducted throughout the study area.

SAFETY

A Safety Plan for this project has been submitted to the Safety Officer for the Northern Rocky Mountain Science Center. The plan contains the following sections:

- Description of the office, laboratory, and fieldwork including the potential for encountering bears
- Safety Officers for the USGS–NRMSC
- Hazards, hazard prevention and controls including chemical hazards (desiccating agent, bear pepper spray), biological hazards (mountain lions, bears, ticks, mosquitoes, giardia, hantavirus, West Nile virus), physical (UV light, falling, driving), environmental (lightning, hypothermia, snowfield crossing, wind)
- Safety precautions (communication with backcountry crews, handling barbed wire, avoiding bear encounters)
- Fitness and health of project employees (selection criteria)
- Training requirements (first aid, driver safety)
- Safety equipment (field gear, personal protective equipment)
- Communication plan
- Emergency plan
- Prevention of injury, illness, and property damage

HAZARD ASSESSMENT

Workplace Assessed: Noninvasive monitoring of grizzly bears in northwestern Montana
Assessed By: Katherine Kendall
Date of Assessment: 17 Dec 2008

Northern Divide Grizzly Bear Project Job Tasks Assessed:

- Office Work
- Field Work
- Wire Cutting/Dying
- Travel

OFFICE WORK

HAZARDS	*CONTROLS*	*PPE Required*
Eye Strain	Ensure proper lighting. Ensure computer monitor and document copy stand are at approximately the same height and distance. Reduce computer screen strain by using flat screen monitors.	
Wrist Strain	Ensure computer keyboards are adjusted so that the elbows are at a 90–degree angle and arms and hands are parallel to the floor. Use wrist rests or other supports so that wrists are maintained in a neutral position.	
Neck/Shoulder Fatigue	Ensure video display terminals are properly adjusted so that the top of the screen is slightly below eye level and the screen is between 18 and 28 inches away.	
Slips/Trips/Falls	Use good housekeeping practices. Secure tripping hazards (cords) to the floor. Do not leave file drawers open when unattended.	
Lifting	Use proper lifting techniques. Get assistance when necessary. When lifting, keep the load close to the body and lift with the legs.	
Electrical Shock	Ensure equipment is properly maintained and grounded. Protect electrical cords from damage by using cord covers. Do not overload outlets.	
Walking	Be alert of walking surface. Wear flat shoes with a non–skid sole.	
Falling off Furniture	Use a step stool. Do not climb on furniture.	
Cutting tools	Cut in the direction away from hands and body.	
File Cabinets/Shelves	To avoid tipping, fill the bottom file first. Do not open more than one drawer at a time. Place heavy objects in the bottom shelves/drawers.	

Field Work

HAZARDS	***CONTROLS***	***PPE Required***
Noise	Wear proper hearing protection devices.	Ear Plugs
Ankle Injuries	Wear proper field boots with ankle support.	Appropriate Field Boots
Eye Injuries	Wear appropriate eye protection as necessary.	Safety Glasses
Injuries from Barbed Wire	Take your time when rolling barbed wire out, using staples long enough to insure wire is tight on trees. Use foam to wrap wire in and place bundle on pack.	Double–palmed Gloves
Slips/Trips/Falls due to unstable footing, steep terrain, and dense vegetation, etc.	Be observant of walking/working surfaces. Take your time when climbing/descending mountain trails. Use handholds when possible on steep ground. Avoid slick/wet surfaces such as logs, rocks, or moss. Take time to select best route if possible. Do not run downhill. When ground surface is hidden due to dense vegetation, place feet deliberately or slowly before putting full weight down.	
Head Injuries	Always be cautious of falling trees/snags, especially when hiking in burned areas.	
Exposure to the elements	Wear proper clothing. Be aware of exposure duration and limit duration if necessary. Be knowledgeable of the symptoms of exposure related illnesses; e.g., hypothermia, hyperthermia. Keep hydrated. Always carry rain gear and warm layers when in backcountry	
Poisonous plants	Knowledge of and avoidance of poisonous plants. Wash after contact.	
Boats	Obey all water safety rules. A trained rafting guide will operate raft. Only people with the knowledge and skills of boat operation will use boats.	Life jackets
Snake Bites	Wear proper field boots or snake chaps. Do not harass/kill snakes.	

FIELD WORK
(Continued)

HAZARDS	*CONTROLS*	*PPE Required*
Animal Attacks/Bites	Make noise while hiking to warn bears and other wildlife of your presence. Be especially careful when visibility is limited, it is windy, or there is background noise Do not approach animals. Use caution and composure when encountering animals. Carry pepper spray at all times. If evidence of bear in the area, leave and come back later in the day.	Bear Pepper Spray, First Aid Kit, Radio
Lightning / Storms	Know weather forecast before going into the field. Plan to be at a lower elevation later in the day to avoid late afternoon mountain storms. If caught in a storm descend to a safe area and wait out the storm before continuing planned hike. Avoid trees, rock caves, and exposed areas.	
Other injuries	Two person teams are advised for all aspects of the fieldwork for this project. If a crew person has to miss a field day, an appropriate replacement person will be assigned to accompany the other crew member. It is acceptable for personnel with experience working in grizzly bear country and mountainous terrain to work alone if equipped with radio and other required safety equipment. Crews are assigned GPS, compass, and maps. Crews are trained in orienteering, first aid, river crossing, and snow crossing,	All crews are given first aid kits and communication equipment (radio or cell phone)
Insect bites and stings	Knowledge of and avoidance of insects that bite and sting. Knowledge of diseases that can be caused by insect bites (e.g.,West Nile, Rocky Mountain Spotted Fever, etc.) Knowledge of any allergies to bites or stings. Do not wear perfume or cologne. Know where to obtain first aid. If attacked by bees/hornets select safe route and move quickly away. If allergic, contact co–workers and take medication. Head for office immediately, don't drive unless necessary.	Insect sting reliever, personal bee sting medications (if allergic)

WIRE CUTTING & DYING

HAZARDS	*CONTROLS*	*PPE Required*
Eye Injuries	Wear appropriate eye protection as necessary.	Safety Glasses
Injuries from Barbed Wire	Take your time when cutting and bundling barbed wire. Use only sharpened tools. Use appropriate gloves when handling barbed wire.	Double–palmed gloves, long pants, thick soled shoes
Injuries from Fire (Used to dye wire)	Be cautious of heat, steam, and flying embers when working near fire and boiling barrel. Wear appropriate clothing.	

TRAVEL

HAZARDS	*CONTROLS*	*PPE Required*
Secondary Roads, Forest Service Roads, ATV trails, Bicycle trails		
Bicycle and ATV Travel	Obey traffic and trail laws. Adjust speed to road, trail, and weather conditions.	Helmet designed for the activity (i.e. biking or ATV riding)
City, Highway, Secondary Roads, Forest Service Roads		
Motor Vehicle Accidents	Obey traffic laws. Adjust vehicle operation to road and weather conditions. Employ defensive driving techniques. Drive slow – maximum speed limit on forest roads is 25 mph	
Uneven Surfaces	Reduce speed appropriately	
Deer and other wildlife	Stay alert, use caution, and drive defensively.	
Dust	Drive with windows closed.	
Reduced Visibility	Ensure windows/mirrors are free from snow and ice. Drive with headlights on. Reduce speed appropriately.	
Slick, Snowy, or Icy Roads	Use studded or chained tires, reduce speed, and increase following distances.	
Commercial Travel		
Airlines	Obey safety rules on common carrier transportation.	

BUDGET:

EXPENSES	Cost ($ x 1,000)		
	FY 2009	FY 2010	FY 2011
Salaries and Benefits			
USGS Permanent	78.5	100.0	110.7
USGS Seasonal	162.0	–	–
USFS Salaries/OE	–	1,045.3	–
Travel and Housing	21.0	25.0	–
Equipment and Supplies	187.0	300.0	–
Vehicle leases	68.0	112.2	–
Contracts			
CESU–University MT	133.0	218.5	218.3
NW Connections: Fieldwork	15.5	158.3	–
Blackfeet Tribe: Fieldwork	80.0	74.8	–
Genetic analysis	13.0	115.0	758.4
Professional consultation	57.0	328.0	15.0
MT FWP: Fieldwork	22.0	–	–
USFS: Fieldwork	65.5	–	–
Publication	–	–	–
Indirect costs			
USGS	218.8	60.9	51.1
USFS	–	54.7	–
TOTAL	**1,121.3**	**2,592.7**	**1,153.5**

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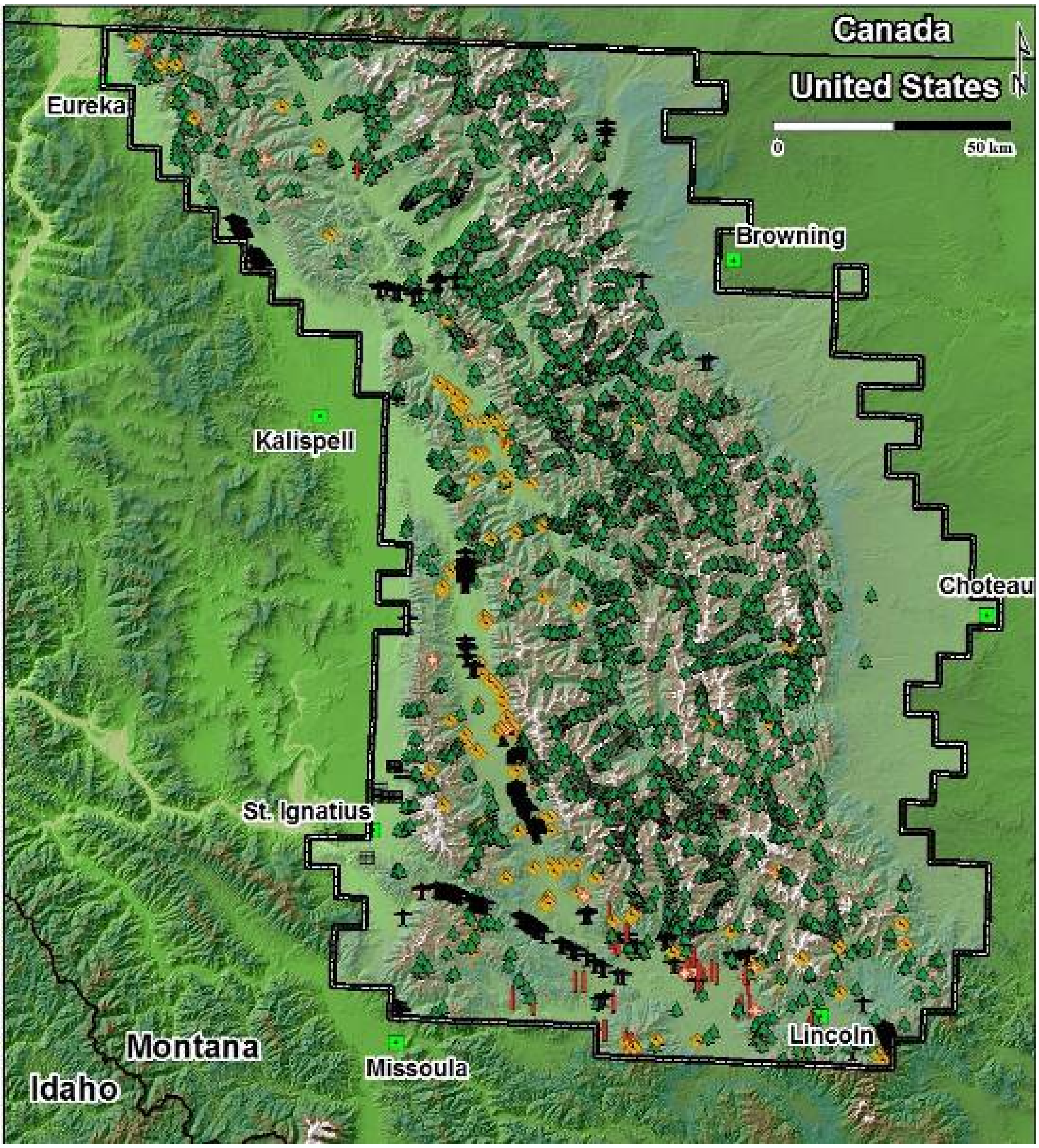
CLEARANCES:

Submitted by: ____

Principal Investigator Date

Center approval: ____

Center Director Date



Bear rub type and count

Tree (4,070)
FencePost (72)
PowerPole (330)
Fence/Gate (79)
SignPost (167)
Other (77)

Northern Divide Project study area; U.S. portion of proposed study area

Figure 1. U.S. portion of proposed grizzly bear monitoring study area, Montana, USA, and distribution of bear rubs surveyed by the NDGBP during 15 June–15 September, 2004.

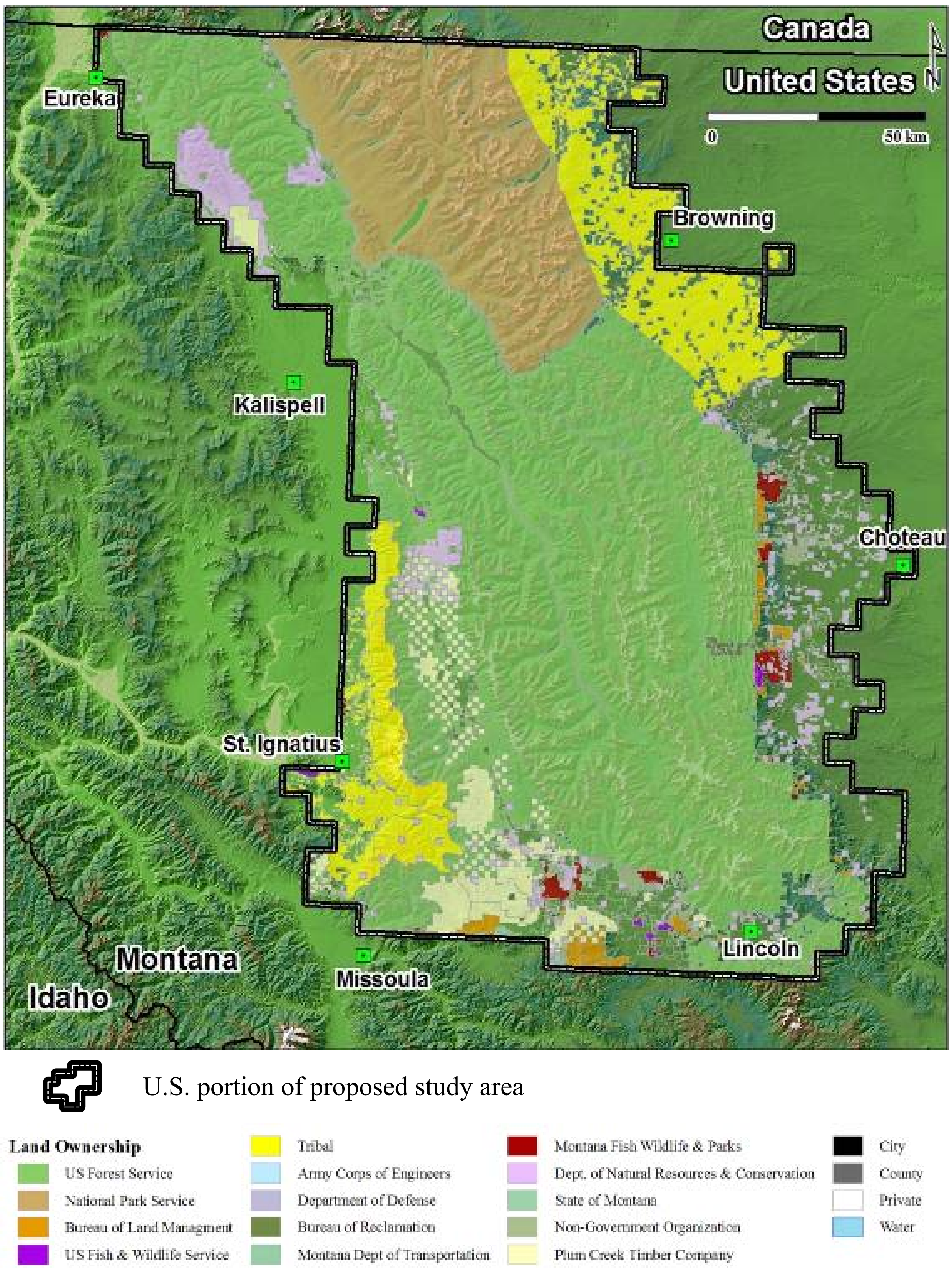


Figure 2. Land ownership within U.S. portion of proposed grizzly bear monitoring study area, Montana, USA.

APPENDIX A: Project partners and cooperators

Federal

- US Geological Survey
- US Forest Service: Flathead, Helena, Kootenai, Lewis and Clark, and Lolo National Forests
- US Fish and Wildlife Service
- National Park Service: Glacier National Park
- Bureau of Land Management

State

- Montana Department of Fish, Wildlife and Parks
- University of Montana Cooperative Ecosystem Studies Unit
- Montana Department of Natural Resource Conservation
-

Tribal

- Blackfeet Tribe
- Confederated Salish – Kootenai Tribe

Interagency

- Interagency Grizzly Bear Committee
- Northern Continental Divide Ecosystem Managers Subcommittee

Nonprofit Organizations

- Northwest Connections
- Boone and Crockett Club, Roosevelt Ranch
- The Nature Conservancy, Pine Butte Preserve

Corporate

- Plum Creek Timber Company
- Flathead Electric Cooperative
- Glacier Electric Cooperative
- Lincoln Electric Cooperative
- Missoula Electric Cooperative
- Mission Valley Power

Private

- Approximately 200 private landowners

APPENDIX B. **PERMITS RECORD**

AGENCY/ COMPANY	PERMIT FOR	PERMIT GIVEN	PERMIT #	ACQUIRE DATE	EXPIRE DATE	AREA COVERED BY PERMIT	COMMENTS
U.S. Fish and Wildlife Service	Research on Endangered Species (collecting grizzly bear hair noninvasively and possessing the hair)	Letter of Authorization (permit) for collecting and possessing grizzly bear hair and scats issued under Chris Servheen's (USFWS Grizzly Bear Recovery Coordinator) permit (Research and Management Subpermit issued March 3, 2003)	(Memorandum)			NCDE	subject to annual renewal, and end of year report required
National Park Service (Glacier National Park)	Research within Glacier National Park (collecting grizzly bear hair noninvasively and possessing the hair)	Scientific Research and Collecting Permit	GLAC–2003–SCI–0013 (Study # GLAC–00041)			GNP	IAR required annually (notice end of December, submit by March 31) (IAR = Investigators Annual Report)
Department of Natural Resources	Access to their land and/or conducting research activities on their land	DNRC – Land Use License (LUL)	DNRC–LUL #8435			DNRC (State Land)	$125 fee ($25 application fee + $100 rental fee); No report required, however DNRC reps have to be notified of where sites are
Confederated Salish and Kootenai Tribe of the Flathead Nation	Access to their land and/or conducting research activities on their land	CKST Tribal Collecting Permit	No permit #s assigned			CSKT Land (Flathead Indian Reservation)	2003 permit (5/25/2003 – 9/30/2003); 2004 permit (6/1/2004 – 9/30/2004) Annual Report (by Dec 31 each year)
Blackfeet Tribe	Access to their land and/or conducting research activities on their land	NOT A PERMIT Blackfeet crews will collect samples – see email in binder					
Plum Creek Timber Company	Access to their land and/or conducting research activities on their land	Letter of Permission				PCTC land	PCTC kept in loop throughout 2003 field season – they were involved in site selection especially for cattle exclusions. Progress report will be sent at end of each year .

AGENCY/ COMPANY	PERMIT FOR	PERMIT GIVEN	PERMIT #	ACQUIRE DATE	EXPIRE DATE	AREA COVERED BY PERMIT	COMMENTS
University of Montana Forest and Conservation Experiment Station	Access to their land and/or conducting research activities on their land	Letters of Permission	Permission Letter to conduct work on land 2003–2004			Lubrecht Experimental Forest AND Bandy Ranch (separate letters of permission)	The Montana Forest and Conservation Experiment Station is the research unit of the University of Montana College of Forestry and Conservation. MFCES is devoted to the scientific investigation of natural resources and their management.
Nature Conservancy	Access to their land and/or conducting research activities on their land	Letter of Permission	Permission Letter to conduct work on land 2003–2004			Pine Butte Swamp Preserve	In East Front Subunit
Lincoln Electric Cooperative	Access to their land and/or conducting research activities on their power poles	Letter of Permission 2003 – scout power pole rub objects, put up markers but no wire	Permission Letter to conduct work on land 2003			Lincoln Electric Land and Power Poles	Need to get okay for poles put up in 2003 before they grant permission for 2004 field work (including put up wire)
Flathead Electric Cooperative	Access to their land and/or conducting research activities on their power poles					Flathead Electric Coop. land and power pole	Will let them know where we have installed wire on the trees.
Mission Valley Power	Access to their land and/or conducting research activities on their power poles	Letter of Permission 2003 – scout power pole rub objects, put up markers but no wire	Permission Letter to conduct work on land 2003			Mission Valley Power Land and Power Poles	Need to get okay for poles put up in 2003 before they grant permission for 2004 field work (including put up wire)
Missoula Electric Cooperative	Access to their land and/or conducting research activities on their power poles	Letter of Permission 2003 – scout power pole rub objects, put up markers but no wire	Permission Letter to conduct work on land 2003			Missoula Electric Land and Power Poles	Need to get okay for poles put up in 2003 before they grant permission for 2004 field work (including put up wire)
Sun River Electric	Access to their land and/or conducting research activities on their power poles						

AGENCY/ COMPANY	PERMIT FOR	PERMIT GIVEN	PERMIT #	ACQUIRE DATE	EXPIRE DATE	AREA COVERED BY PERMIT	COMMENTS
Glacier Electric Cooperative	Access to their land and/or conducting research activities on their power poles	Letter of Permission 2003 – scout power pole rub objects, put up markers but no wire	Permission Letter to conduct work on land 2003			Glacier Electric Land and Power Poles	Need to get okay for poles put up in 2003 before they grant permission for 2004 field work (including put up wire)

APPENDIX C. NORTHERN DIVIDE GRIZZLY BEAR PROJECT

COMPLIANCE RECORD

AGENCY	COMPLIANCE FOR	COMPLIANCE GIVEN	DOCUMENT #	ACQUIRE DATE	EXPIRE DATE	AREA COVERED	COMMENTS
U.S. Fish and Wildlife Service	Importation and Exportation of grizzly bear hair samples	Convention on International Trade in Endangered Species of Wild Fauna and Flora Permit (i.e. CITIES permit)	CITIES PERMIT #03US064443/9 (2/25/2003–8/24/2004; 9/24/2003–3/23/2004; expect renewal to be processed very soon)			U.S.A.	Permittee: Christopher Servheen, University Hall, University of Montana, Grizzly Bear Recovery Coord. USFWS, Missoula, Mt 59812, USA
U.S. Fish and Wildlife Service	Research on Endangered Species	IN THE FORM OF A PERMIT Letter of Authorization (permit) for collecting and possessing grizzly bear hair and scats issued under Chris Servheen's (USFWS Grizzly Bear Recovery Coordinator) permit (Research and Management Subpermit issued March 3, 2003)	(Memorandum)			NCDE	The LOA subpermit is subject to annual renewal. Document to summarize Endangered Species Act Compliance: the process of obtaining the LOA written by Amy Macleod and filed in binder as well as Compliance folder in file cabinet (electronic: J:\Admin\Permits and Compliance\ESA_Compliance_LOA)
National Park Service (Glacier National Park)	Research within Glacier National Park on an Endangered Species (collecting grizzly bear hair noninvasively and possessing the hair)	Categorical Exclusion (DO–12, Section 3.4 E. 6 "Non–destructive data collection, inventory (including field, aerial and satellite surveying and mapping), study, research, and monitoring activities.")	L76 (GLAC–03–062) This approved due to acquisition of LOA from Chris Servheen (USFWS)			GNP	Document to summarize the process of obtaining Environmental Compliance in Glacier National Park written by Amy Macleod and filed in binder as well as Compliance folder in file cabinet (electronic: J:\Admin\Permits and Compliance\Compliance_GNP)

APPENDIX D: Landowner permission letter.

United States Department of the Interior

U. S. GEOLOGICAL SURVEY
Northern Rocky Mountain Science Center
AJM Johnson Hall
Montana State University
Bozeman, Montana 59717–3492

To: Landowner

Subject: Permission to Access Private Land

The U.S. Geological Survey, Northern Divide Grizzly Bear Project, in cooperation with the Blackfeet Fish and Game Department, Salish–Kootenai Tribe, Montana Department of Fish, Wildlife, and Parks, U.S. Forest Service, and National Park Service, is planning a study to estimate the number of grizzly bears in the Northern Continental Divide Ecosystem.

The U.S. Geological Survey (USGS) appropriations language states that, “Any of these funds provided for the biological research activity shall not be used to conduct new surveys on private property, unless specifically authorized in writing by the property owner. We seek permission to enter your land and establish temporary, non–obtrusive sampling sites to collect hair samples of free–ranging grizzly bears that might pass through your land.

Our activities will not cause damage to your property or endanger humans or livestock. Collection of small samples of bear hair does not involve trapping the bears. We will remove all bear hair snagging sites we install and we will return the area to its normal condition. Every effort will be made to minimize disturbance or disruption to your property. However, in the unlikely event that property damage results while a field crew is conducting a survey, you are entitled to file a claim to recoup your damages.

We understand our concerns regarding impacts and liability and would like to address these concerns. Please be advised that all Federal Government employees acting within the scope of their employment are covered for personal injury by the Federal Employees Compensation Act (5 U.S.C. 2671 et seq.). Also, Federal Government employees are covered for liability resulting from negligence, wrongful acts, or omissions while performing duties within the scope of their employment by the Federal Tort Claims Act (28 U.S.C. 2671 et seq.) All other non–USGS personnel assigned to this project will be covered for liability. You may direct all claims for damage through Judy O’Dwyer, at (406) 994–7544, if any property damage should occur.

If you agree to allow us access to your land for this study, please sign this letter in the area indicated below. We thank you for your permission and participation in this very important research project.

Sincerely,

Katherine Kendall
Research Biologist

Permission to enter my land under the conditions described above is approved.

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Signature of landowner/Responsible Party Date