NORTHERN CONTINENTAL DIVIDE ECOSYSTEM

GRIZZLY BEAR POPULATION MONITORING

ANNUAL REPORT – 2009 and 2010

April 2011

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This annual report summarizes data collection efforts to date. It is not a peer-reviewed document, and data summaries and interpretations are subject to change.

Suggested Citation: Mace, R. and L. Roberts. 2011. Northern Continental Divide Ecosystem Grizzly Bear Monitoring Team Annual Report, 2009-2010. Montana Fish, Wildlife & Parks, 490 N. Meridian Road, Kalispell, MT 59901. Unpublished data.

This Annual Report is available on the web at:
http://fwp.mt.gov/wildthings/tande/Monitoring.html.

Cover Photo by R. Mace: Grizzly bear cub-of-year, Glacier National Park

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ABSTRACT

A program to monitor the population trend of grizzly bears in the Northern Continental Divide Ecosystem (NCDE) of Montana was initiated in 2004. The goal of this program is to estimate population trend by monitoring the survival and reproductive rates of radio-instrumented female grizzly bears. Since 2004, we have monitored the survival and reproductive output of 104 female grizzly bears. In 2009, we captured 17 females 18 times, and 17 males 20 times. In 2010, we captured 23 females 25 times, and 10 males 11 times. Including conflict males and females, we radio-monitored 109 and 98 grizzly bears in 2009 and 2010 respectively. Annual survival rates were estimated for females and males. Mean subadult and adult female survival was 0.884 and 0.923 for bears used in trend analyses. Survival rates for male bears captured for trend research averaged 0.815 and 0.862 for subadults and adults. Survival rates for management bears were lower. The ratio of reported to unreported deaths for both sexes suggest that for every 1 reported death, there were 1.46 deaths were not reported to management authorities. In 2009 and 2010, we followed the fate of 44 and 40 dependent young respectively. Home range size (95% isopleths) was largest for subadult females ($\bar{x}$ = 242 km^2) followed by solitary adults ($\bar{x}$ = 164 km^2). Home range sizes of females were nearly twice the size outside of Glacier National Park than inside. To date, we have analyzed 54 hair samples from the NCDE for stable isotope signatures. In general, we observed a higher incidence of meat in samples from the east side of the Continental Divide compared to samples from the west side. In 2010, we obtained BIA readings and actual weights on 44 grizzly bears in the NCDE at time of capture. Although samples sizes were low, mean % body fate estimates were >8% for both sexes each month. We document further expansion of grizzly bear occupancy beyond the federal recovery zone. There were 21 and 23 known/probable mortalities of grizzly bears in the NCDE during 2009 and 2010, respectively.

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I. INTRODUCTION AND STATEMENT OF NEED

The grizzly bear *(Ursus arctos horribilis*) occupies over 8 million wilderness and non-wilderness acres in the Northern Continental Divide Ecosystem (NCDE) of western Montana. Notable regions within this ecosystem include Glacier National Park and the Bob Marshall wilderness complex. Grizzlies were listed as Threatened under the Endangered Species Act in 1975 for lack of information on its population status and habitat requirements. The NCDE has the largest population of grizzly bears in the lower 48 states; mean population size during 2004 was 765 bears (Kendall et al. 2009).

Managers and the public agree that information on both population size and trend is needed. Having these estimates will greatly improve our collective knowledge of grizzly bear ecology, and provide more measurable and precise information with which to judge the status of the grizzly population in the NCDE. Therefore in 2004 Montana Fish, Wildlife & Parks (MTFWP), in cooperation with other state, federal, and tribal agencies, established a team to monitor the population trend of grizzly bears in the NCDE. The purpose of this long-term program is to monitor the vital population parameters by assessing the survival, reproductive rates, and population trend. This will be accomplished by radio-monitoring female grizzly bears.

II. PROGRAM OBJECTIVES

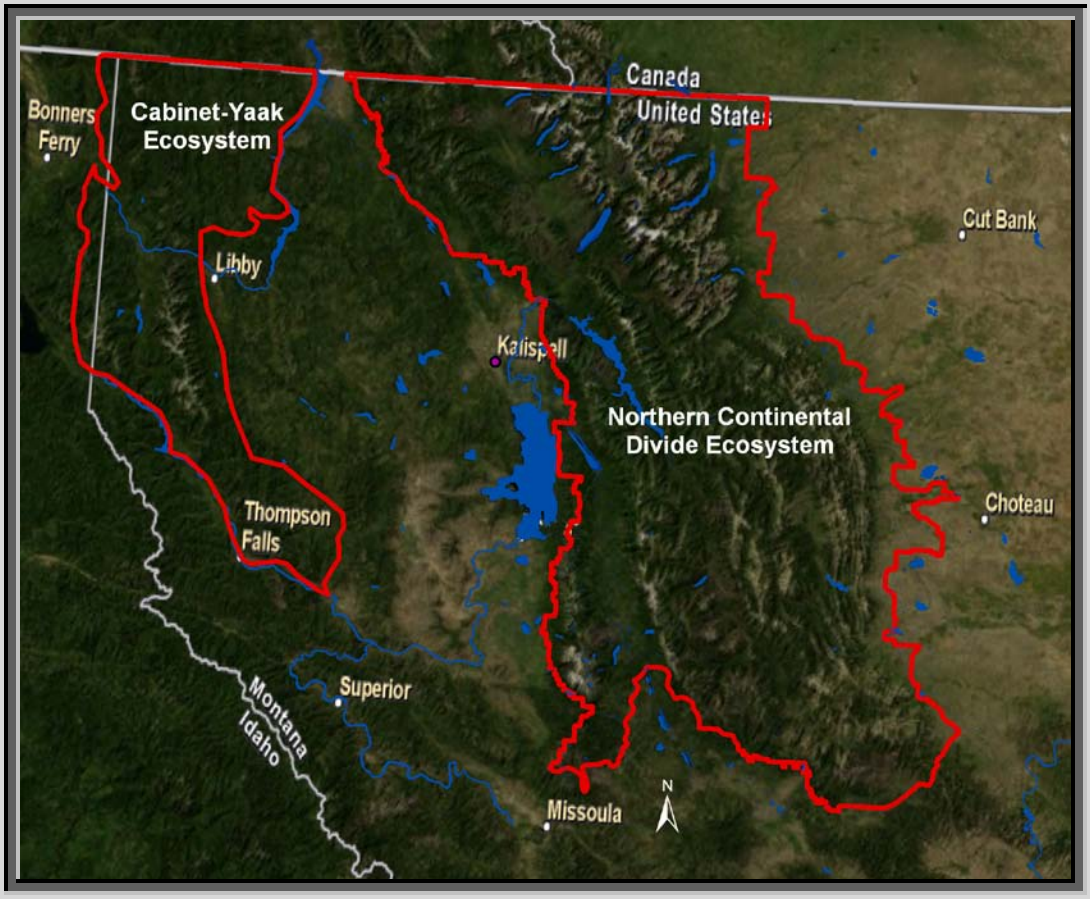
The primary objective of this program is to monitor the population trend of grizzly bears in the NCDE using known-fate estimators of survival, and documentation of reproductive rates. This will be accomplished by following the survival and reproductive rates of female grizzly bears throughout the Ecosystem. Estimates of both population size and trend will be required for recovery programs in this area as dictated by the Endangered Species Act. The ultimate responsibility of the monitoring team is to collect life history and habitat data on grizzly bears in western Montana and summarize findings in a comprehensive annual report. Major population monitoring categories will initially include:

1. population trend,
2. grizzly bear survival rates,
3. grizzly bear reproductive rates,
4. grizzly bear movements and habitat selection,
5. grizzly bear distribution in western Montana,
6. mortality levels in the NCDE, and
7. levels of reported and unreported mortality.

III. GEOGRAPHIC SCOPE OF THE MONITORING PROGRAM

Monitoring emphasis for grizzly bear populations will be placed within the designated NCDE Recovery Zone (U.S. Fish and Wildlife Service, 1993) and surrounding portions of Montana, British Columbia, and Alberta (Fig. 1). As resources permit, monitoring will be expanded to include areas outside of the recovery zone with special emphasis on the area between the NCDE and the Cabinet-Yaak Ecosystem, and areas to the south of the NCDE.

Fig. 1. Location of the Northern Continental Divide Grizzly Bear Ecosystem in western Montana.



IV. METHODS

Delineation of Study Bears and Capture Methods

This study was designed by an interagency team of biologists in 2004 (Mace 2005). Female grizzly bears were captured, radio-instrumented, and monitored throughout the NCDE and into southern British Columbia and Alberta, Canada. Capture effort was density-distributed; more collars were placed in areas with higher grizzly bear density. The relative density of bears across the NCDE was determined using data from the USGS ecosystem-wide DNA study conducted in 2004 (Kendall et al. 2009). From these data, capture zones for the NCDE were established in a Delphi fashion using broad-scale geographic and administrative boundaries. The population of grizzly bears in the NCDE intermixes with grizzly bears in Canada.

Because grizzly bears may move extensively throughout the NCDE, and will probably occupy several capture zones, proportional use of each zone by females is assessed annually, and based upon this use, adjustments made in capture effort during subsequent years. Take for example a capture zone that is scheduled to have one radioed bear. If ½ the home ranges of 2 females from adjacent zones overlap with the zone in question, then bear equivalent use of that zone will equal 1 bear, and sampling will be deemed adequate.

We used the methods of Schwartz et al. (2006) to delineate study bears. Adult or subadult females first captured and radioed at a research site were termed “study animals.” Females first captured and radioed at a conflict site by bear managers, including non-target captures, were members of a “conflict” sub-

sample. A conflict bear could become a study bear if later captured at a research site. Conversely, study animals captured at a conflict site retained their place as a study bear if wearing a functional radio collar at time of conflict capture. Study bears whose collars failed or fell off and were later captured at a conflict site were reclassified as members of the conflict sub-sample.

Grizzly bears were captured using leg-hold snares, culvert traps, and some were free-ranged over bait. Road-killed deer and other lures were used to attract bears to sites. Beginning in 2007, we used remote-controlled door openers for culvert traps in the backcountry of Glacier National Park. Winches and remote controllers were obtained from Bwieagle, Inc. (www.bwieagle.com). We used the 38-2000INT-HP-WINCH and the Air-Eagle SR PLUS 2.4 GHz transmitter #36-1300 for these traps. These transmitters successfully opened aluminum culvert trap doors at a distance of 180 m.

From 2004 through 2006, bears were immobilized using either Ketamine/ Rompun® (ketamine HCL/xylazine HCL) or Telazol® (tiletamine HCL/zolazepam HCL). Beginning in 2007, we began using the combination of Telazol® and Medetomidine, with atipamezole as the antagonist. We used drug dosages as per Kreeger et al. (2002). All captured bears were micro-chipped. Morphological measurements were taken on each bear. Cotton spacers and mortality sensors were used on all radio collars. Tooth (Stoneberg and Jonkel 1966) and hair samples were taken for age estimation and DNA genotyping, respectively. Adult bears were considered to be those $\geq$ 5 years of age.

Several types of radio transmitters and duty cycles were used during the course of the study to accommodate ancillary studies of grizzly bear movements and habitat selection. We used 5 types of radio transmitters, all of which had a 6-hr mortality sensor. Standard VHF neck-mounted collars (Telonics Inc. 932 E. Impala Ave., Mesa, AZ, 85204-6699) and VHF ear-tag transmitters (Advanced Telemetry Systems Inc., PO Box 398 470 First Ave. N. Isanti, MN 55040) were used on some bears. Three global positioning system (GPS) collar types, built by Telonics Inc. were used; standard GPS (TGW-4500), GPS/Argos (Models TGW-3580 and TGW-3583), and spread-spectrum (SST) (TGW-3690).

All GPS collars had data store-on-board capabilities and were programmed to obtain a GPS location once every 1-4 hrs. GPS collars were programmed to turn off when bears were in winter dens to preserve battery life (early to mid-November through 1 April). GPS collars were equipped with an automatic collar release mechanism (Telonics Inc. model CR2-a), programmed to release from the bears' neck after 2 years for subadults or 3 years for adults.

Telemetry

The location of each collared bear was determined at least once per month, as possible, using fixed-wing aerial telemetry. Locations from bears fitted with Argos GPS collars were downloaded weekly from the Argos web site. During the bears' active season, we also monitored the status of each bear's mortality sensor to determine if the bear was alive.

Mortality

Mortality censors on radio-collars, or multiple Argos locations at the same coordinate, indicated when a collar had either been prematurely cast by a study bear or when a bear had died. Bears with a questionable mortality status were promptly investigated by field crews to ascertain whether the bear had died or simply dropped its collar and to document cause of death when possible. Necropsies were most commonly conducted in the field, and relevant tissue and hair samples were collected for laboratory analyses. We used a metal detector or x-ray technology to ascertain whether dead bears had been shot. Except for arduous backcountry situations, whole carcasses were retrieved from the field and sent to the MTFWP or USFWS laboratories for analyses.

Field personnel completed a mortality form describing the specific circumstances of each mortality in the NCDE. These reports were entered into an interagency database for coordination among agencies. Terminology for mortalities followed those in Cherry et al. (2002, Table 1).

The fate of each radio-instrumented bear was determined for each year it carried a functional radio-collar. Each bear was classified as belonging to one of 5 fate categories as defined below:

1. *Alive*: a bear that was known to survive the year
2. *Dead*: a bear that was known to have died during the year
3. *Censored*: a bear which was monitored for a portion of the year, but who ultimately shed the radio collar during the year
4. *Unresolved*: a bear whose fate could not be ascertained during the year. In most cases these were individuals who we lost radio contact with. Either the radio collar failed prematurely based on expected battery life, or

the bear moved to an unknown location. Occasionally, mortality signals were received from a bears' collar, but it was not investigated or could not be found during the year. Thus it could not be determined if the bear shed the collar or died.

5. *Unexplained*: premature failure of a working transmitter occurred that could not logically be attributed to expected battery life; bear was never recaptured, so loss was unexplained.

Table 1. Terms and definitions used to classify the cause, certainty, and discovery of grizzly bear mortalities (Cherry et al. 2002).

Terms	Definitions
Cause of mortality	
Natural	Positively or reasonably attributed to natural cause.
Human-caused	Positively or reasonably attributed to humans.
Undetermined	Cause could not be determined.
Under Investigation	Cause of mortality is has not been positively determined. Laboratory work, to ascertain cause, is ongoing.
Certainty of mortality	
Known	A carcass or parts to substantiate death.
Probable	Strong evidence to indicate mortality, but no carcass recovered. Included cases where evidence indicates severe wounding, and observations suggest the bear displayed abnormal behavior.
Possible	Some presumptive evidence of mortality, but no prospects for validation. Includes defense-of-life situations where shots were fired (no evidence of significant wounding was found). Hearsay evidence of poaching or malicious death is included here.
Unresolved	Pulse rate and stationary location of a transmitter indicated a cast-off collar or mortality, and transmitters could not be retrieved due to location (i.e., cliff, log-jam in river) or failure; bear never recaptured, so fate was unresolved.
Unexplained	Premature failure of a working transmitter occurred that could not logically be attributed to expected battery life; bear never recaptured, so loss was unexplained.
Discovery of mortality	
Reported	Mortality of an instrumented or non-instrumented bear discovered without the aid of telemetry.
Unreported	Mortality of an instrumented bear discovered due to telemetry and not reported by the public.
Unexplained	Premature failure of radio collar that could not be attributed to battery life. Bear never encountered again.

Estimation of Independent Bear Survival Rates

We estimated survival of independent bears using the staggered-entry Kaplan-Meier method (Pollock et al. 1989) within Program MARK using the logit scale. Estimates were made for both sexes of trend monitoring bears and management bears. Sampling units were the 12 months of the year, and data were pooled from 2004-2010. An individual's annual survival history began the month and year it was first captured and concluded the month and year it was

censored or died. Bears known to be alive in October or November and who emerged from dens the following spring with functional collars were classified as being alive during the denning season.

Bears fitted with GPS, or GPS/Argos collars were classified as alive during each month that ≥1 GPS fix was obtained, even if the bear was not monitored via VHF telemetry during that month. Thus monthly fate was ascertained retrospectively by examination of telemetry data after the shed collar was retrieved and the data were downloaded. We were often able to determine the exact date that bears shed collars or died. Bears wearing VHF beacons were searched for as possible at least once per month during the active season. However, there were months when the bear could not be found, or telemetry flights were not conducted due to poor weather. During the active season, we considered bears alive during a 2-month gap if we knew they were alive before and after the gap. If the gap exceeded 2 months during the active season, individuals were not credited as being alive, but were censored in the last month they were known to be alive, and were again classified as alive the month following the gap.

Estimation of Unreported Mortality

Grizzly bear mortalities in the NCDE are recorded annually. The number grizzly bear of deaths involving agency removals, and those that die while wearing functional radio collars are know with certainty. However, managers acknowledge that not all dead bears discovered by the public are reported to authorities. To more accurately estimate the total number of bear mortalities

occurring each year requires an estimate of the level of these unreported mortalities. Although such estimates are available for the Greater Yellowstone Ecosystem, and are incorporated into annual total mortality tabulations no such estimates have been made for the NCDE. To more accurately estimate annual total mortality in the NCDE, we employed the methods of Cherry et al. (2002) using a sample of radio-instrumented bears.

Cherry et al. (2002) provided a method wherein radio-collared bears that died were used to estimate additional grizzly bear deaths that go undetected. Each death of an independent aged (2 + years old) radioed-instrumented bear, monitored between 1999 and 2010, was classified as being either reported by the public or unreported by the public. We defined a reported death as one where either a radioed or non-radioed bear that was reported to wildlife management authorities by the public without the aid of radio-telemetry. We defined an unreported death as the death of a radioed bear discovered by telemetry. Bears reported by employees of other state, federal, or tribal agencies were considered publicly reported deaths. Likewise, bear/train collisions reported by Burlington Northwestern personnel were considered to be public reportings.

We used a sample of independent-aged (2+ years old) grizzly bears radioed-monitored at time of death from 1999-2010. We included those deaths where bears were wearing a functional radio collar at time of death, and were radio-located within 2 months of death. Additionally, the death had to be either a known death (a carcass or other evidence) or a probable death (Strong evidence of death, but no carcass) (Cherry et al. 2002). We excluded radioed bears that

were removed from the ecosystem due to conflicts with humans (management removals) as their deaths were known with certainty.

The number of reported and unreported deaths of radioed bears was then used in the Bayesian method of Cherry et al. (2002), to estimate the number of grizzly bear deaths that go unreported each year. As per the Interagency Grizzly Bear Study Team document (2005), we used the median of the creditable interval for the estimated reported and unreported loss.

Home Range Size of Females

Annual home ranges for female grizzly bears were estimated using the fixed kernel method (Worton 1989) in ARCMap. We used the Hawths Tools extension (www.spatialecology.com/htools/), and developed 50%, 90%, and 95% isopleths for those bears with $\geq$ 50 locations/year throughout the active season regardless of collar type. Home ranges were constructed for both research and management bears. Each female was coded as being in one of the following reproductive states: subadult, solitary adult, female with cubs, female with yearlings, or female with 2+yr old young. In most cases the female with 2+yr. old young category transitioned back to a solitary adult sometime during the year.

Grizzly Bear Distribution in the NCDE from Telemetry, Mortality, and Genetic database

Grizzly bear data from males and females were used to assess the distribution of bears in and adjacent to the NCDE recovery zone from 1999-2010. Data used included the location of mortalities and captures, telemetry locations from research and management bears, and sites where bears were detected by DNA in 2004 (Kendall et al. 2009). Mortality, capture, and telemetry data were

stored in a database managed by Montana Fish, Wildlife and Parks. Primary telemetry data sets used were those of Waller (2005) for the Middle Fork Flathead River/Glacier National Park area, those of Mace and Waller (1997) for the Swan Mountains, and bears monitored for estimating population trend (this study). Management bears monitored by MTFWP and both tribes (Blackfeet Indian Tribe and the Confederated Salish and Kootenai Tribe) were also included in analyses. Several females that were trans-located from the NCDE to the Cabinet-Yaak Ecosystem for purposes of population augmentation were also included.

These data were placed on a 10 x 10 km grid overlaying western Montana and the NCDE recovery zone. Grid cells that were occupied by a bear location were highlighted in ARCMAP, and we distinguished cells occupied by males from those of females.

Grid size was based on estimates of the daily movement distance of male grizzly bears over the active season. We used a sample of 10 males equipped with gps collars to estimate the average distance (km) moved per day. There was a relationship between the number of locations per day, and the distance moved. We determined that dates with >12 locations produced similar results. We had data for 692 days from these 10 males, and the mean distance moved per day was 10.01 kms (SE = 361.83, 95% CI= 9.38 – 10.81 km).

Grizzly Bear Stable Isotopes

Stable isotopes of carbon and nitrogen, obtained from hair samples, can be used to assess the assimilated diet of bears (Robbins et al. 2004). Stable isotopes are non-radioactive atoms containing an extra neutron. Isotope ratios are used to determine the percent of carbon or nitrogen in a sample that came from plant or animals foods. Isotope concentrations in hair samples collected in the NCDE were analyzed at Washington State University by Dr. Charles Robbins using an isotope ratio mass spectrometer.

Isotope signatures from hair samples represent the foods that were consumed when the hair was growing. Further bears would have to feed on a particular food group (vegetation or meat) for several weeks so that enough hair had grown to affect the isotope signature. In captive bears, hair grows about 1.5 cm/month (Robbins pers. comm.). Therefore, the signature may not represent what the bear was feeding on just prior to hair collection. Carbon values varying from approximately -21 to -25 are typical of C3 (wild) plants.

Body Condition Index Values

Knowledge of the body condition of bears has applied management implications. The health of bears provides insight into seasonal habitat productivity, nutrition, and ultimately carrying capacity. In 2010, we began investigating more accurately the body condition of grizzly bears in the NCDE by using bioelectrical impedance analysis (BIA). BIA machines measure the flow resistance of a small electrical current through the bears' body. Resistance is proportional to % body fat.

V. RESULTS

Population Trend of Grizzly Bears in the NCDE; abstract of paper submitted to Journal Wildlife Management

We estimated grizzly bear (*Ursus arctos*) population vital rates and trend for the Northern Continental Divide Ecosystem, Montana, between 2004-2009 by following radioed-collared females and observing their fate and reproductive performance. Our estimates of dependent cub and yearling survival were 0.612 (95% CI = 0.300-0.818) and 0.682 (95% CI = 0.258-0.898). Our estimates of subadult and adult female survival were 0.852 (95% CI = 0.628-0.951) and 0.952 (95% CI = 0.892-0.980). From visual observations, we estimated a mean litter size of 2.00 cubs/litter. Accounting for cub mortality prior to the first observations of litters in spring, our adjusted mean litter size was 2.27 cubs/litter. We estimated the probabilities of females transitioning from one reproductive state to another between years. Using the stable state probability of 0.322 (95% CI = 0.262-0.382) for females with cub litters, our adjusted fecundity estimate (m_x) was 0.367 (95% CI = 0.273-0.461). Using our derived rates, we estimated that the population grew at a mean annual rate of approximately 3% (λ = 1.0306, 95% CI = 0.928–1.102), and that 71.5% of 10,000 Monte Carlo simulations produced estimates of $\lambda > 1.0$. We discuss population and habitat management programs that have fostered an increasing trend in this population.

Trend Monitoring Captures, 2004-2010

Grizzly bears have been captured since 2004 for population trend monitoring. Although females were the focus of the research, males were inadvertently captured as well. Annual capture of females has varied from 12 in

2007, to 25 in 2005 and 2009 (Table 2). In 2009, the team captured 40 individuals of both sexes, 45 times. Twenty-three trend females were captured 25 times in 2009. In 2010, we captured 27 individual males and females 29 times. Seventeen trend females were captured 18 times in 2010 (Table 2).

We have captured 104 individual female grizzly bears in the first 7 years of monitoring in the U.S. and Canada (Table 3). Twenty-two and 9 new females were added in 2009 and 2010 respectively. A list of bears captured for population monitoring is given in Appendix A.

We have captured 7 females that have transitioned from the management subsample to the trend bear sample. Adult female #205 was captured in 1997 and 2002 as a management bear along the Rocky Mountain Front. This bear was recaptured for trend monitoring in 2005. Similarly, female #067006850 was captured at a conflict site 2004 on the Blackfeet Indian Reservation and relocated to the west side of Glacier National Park. In 2005, she was captured for trend monitoring in the North Fork Flathead River. This bear spends approximately ½ of her time in the Park. Bear #093638000 transitioned from a trend bear to a management bear in 2008. This female was first captured for trend on 6/7/2008 along the western front of the Mission Mountains. Several weeks later this bear shed its radio collar, and became a non-target bear captured at a conflict site in the Swan Valley. Female #037885843, 084628512, along with her mother was a management capture in 2003, and was captured at a research site in 2004. This female was illegally killed in the spring of 2004. Female #064054290 was first captured at a conflict site in 2007, but was not radioed at that time. She was

Table 2. The number of grizzly bear captures and recaptures in the NCDE for population trend monitoring, 2004-2010. Data include Canadian captures. Some individuals were captured in multiple years, thus total captures does not mean total individuals.

Capture year	Sex	Number of individuals	Number of recaptures	Total captures
2004	Female	15	1	16
2004	Male	9	0	9
2004	Total	24	1	25
2005	Female	24	1	25
2005	Male	18	2	20
2005	Total	42	3	45
2006	Female	17	1	18
2006	Male	31	4	35
2006	Total	48	5	53
2007	Female	10	2	12
2007	Male	10	2	12
2007	Total	20	4	24
2008	Female	18	2	20
2008	Male	16	0	16
2008	Total	34	2	36
2009	Female	23	2	25
2009	Male	17	3	20
2009	Total	40	5	45
2010	Female	17	1	18
2010	Male	10	1	11
2010	Total	27	2	29

Table 3. Number of new individual female grizzly bears captured each year for Trend Monitoring in the NCDE.

Year	Number of new individual female grizzly bears captured							Total
	2004	2005	2006	2007	2008	2009	2010	
# New individuals	15	23	12	7	16	22	9	104

again captured for research in 2007. Bear #081600578 was first captured in the North Fork Flathead River in 2008 as a habituated bear. This bear was captured 2 times in 2010, once at a conflict site, and once in a research snare. Female #0107585006 is the sister of #081600578. She was captured at a conflict site in 2008 with her sister. A second management capture occurred in early 2009, followed by a capture in a research snare the same year.

Management and Miscellaneous Grizzly Captures, 2004-2010

Each year grizzly bears were captured in the NCDE for purposes other than trend monitoring. The majority of these captures were for management purposes. Not all of these bears, especially attendant young, were radioed. In 2009, 38 bears were captured in the ecosystem, 13 and 23 of which were females and males, respectively (Table 4). In 2010, 46 bears were captured, 15 and 25 of which were females and males, respectively (Table 4). A list of the bears captured for management reasons is given in Appendix B.

Table 4. Capture of grizzly bears in the NCDE for purposes other than trend monitoring. This includes captures for management, augmentation to the Cabinet-Yaak Ecosystem, or other research efforts, 2004-2010. Not all individuals were radio-collared.

Year	Number of individual bears captured for purposes other than trend (total recaptures)			Total # individuals
	Independent females	Cubs and yearlings	Independent males	
2004	15 (20)	12 (15)	19 (24)	46
2005	8 (8)	4 (4)	12 (12)	24
2006	5 (5)	2 (2)	16 (17)	23
2007	4 (5)	5 (7)	19 (22)	28
2008	9 (12)	0	19 (21)	28
2009	13 (15)	2 (2)	23 (25)	38
2010	15 (17)	6 (6)	25 (27)	46

Number of Bears Radio-Monitored, 2004-2010

Each year, grizzly bears were captured and radio-instrumented for several purposes. These included captures for trend monitoring, for management, and for other research purposes. Sample sizes bears radio-monitored in the NCDE varied each year from 49 to 109 (Table 5).

Table 5. Total radioed sample of grizzly bears in the NCDE, 2004-2010.

Year	Radioed males (mgmt and other research)	Radioed females (mgmt and other research)	Radioed trend females	Total number radioed bears
2004	17	16	16	49
2005	14	10	31	55
2006	22	10	34	66
2007	30	11	36	77
2008	30	12	40	82
2009	47	13	49	109
2010	40	18	40	98

In addition to the 49 female grizzly bears radio-monitored for population trend 2009, the study team also followed the fate of 47 males and 13 females that were radioed for other reasons, for a total of 109 grizzly bears radio-monitored that year (Table 5).

In 2010, we radio-monitored 98 grizzly bears in the NCDE, 40 females of which were used for trend monitoring. An additional 18 females and 40 males were monitored during the year (Table 5).

Survival Rates of Female and Male Grizzly Bears

We followed the fate of 29 radioed subadult females from 2004-2010 for population trend monitoring. We accumulated 293 months of data on subadults, during which 3 subadults died. We could not determine the fate of 1 subadult female (# 036549051). If it is assumed that this female survived, the point estimate for subadult female survival was 0.884 (95% CI = 0.696 - 0.962) (Table 6). If this female did die, the survival estimate was 0.848 (95% CI = 0.658 - 0.942).

We also followed the fate of 72 adult females over the course of 1493 months between 2004 and 2010. Eight of these adults died while the fate of 1 adult could not be resolved (# 071814874). Assuming this 1 bear with an

unresolved fate survived, our estimate of annual survival for adults females was 0.931 (95% CI = 0872 - 0.963) (Table 6). When we assumed this bear died, the survival estimate was 0.923 (95% CI = 0863 - 0.958).

We also monitored the fate of female bears first captured on conflict sites in the NCDE. Between 2004 and 2010, we monitored 25 adult and 20 subadult females. Adults were monitored for 425 months and subadults for 136 months.

Three management adults died during the period, and the fate of 2 adults was unresolved. One adult death was a management removal (#038047294), one bear was killed after being struck by a train (#084383870), and the cause of the third death (#037605609) could not be determined. Assuming the females of the 2 unresolved cases were alive, the mean survival estimate for management adult females was 0.918 (Table 6). If the 2 females are assumed to have died, the estimated survival rate was 0.867.

We documented the death of 7 management subadult females during the period, and the fate of 1 individual was unresolved. Four subadults were management removals (#081580095, #051561278, #084528778, and #084626296), 2 deaths of subadults were illegal (#036585060, # 038051794), and 1 natural death was recorded (#0107789555). Assuming 1 unresolved subadult lived, the mean survival estimate for management subadult females was 0.530 (Table 6). When it is assumed that this bear died, the estimate of subadult female survival was 0.483. A summary of trend female mortalities is given in Table 7.

We have monitored the fate of 48 individual male bears for 341 months that were captured as a part of trend monitoring activities or for other research purposes. These bears had not been previously captured at conflict sites. Our estimate of survival for research males was 0.838 (95% CI = 0.664 – 0.931) (Table 8). We observed 5 mortalities of research males (Table 9).

Between 2004 and 2010, we followed 56 radio-instrumented management males for 353 months. Our survival estimate for management males was 0.615 (95% CI = 0.452 – 0.756). Fourteen management males died. Most deaths were from management removals (Table 9).

Grizzly Bear Reproduction

The number of adult females radioed for trend monitoring has varied each year from 11 in 2004 to 32 in 2009 (Table 10). In 2009, 4 adult females had no attendant offspring. A minimum of 44 attendant young from ages 0.5 to 3 years were monitored in 2009. In 2010, a minimum of 40 attendant offspring were monitored for survival (Table 10). The reproductive history of each adult female is given in Appendix D

Home Range Size of Females

We estimated the 50, 90, 95% fixed kernel home range sizes for 39 females having 56 annual ranges. Home range size (95% isopleth) was largest for subadult females ($\bar{x}$ = 242 km^2) followed by solitary adults ($\bar{x}$ = 164 km^2) (Table 11). Home ranges became progressively larger as family composition

Table 6. Survival rates of female grizzly bears in the NCDE, 2004-2010.

Female type and age class	Survival parameter			
	Estimate	SE	-95% CI	+95% CI
Research:				
Subadult 1 unresolved assumed alive 1 unresolved assumed dead	0.884 0.848	0.063 0.069	0.696 0.658	0.962 0.942
Adult 1 unresolved assumed alive 1 unresolved assumed dead	0.931 0.923	0.022 0.023	0.872 0.863	0.963 0.958
Combined Age classes: 2 unresolved assumed alive 2 unresolved assumed dead	0.923 0.910	0.0214 0.023	0.869 0.855	0.956 0.946
Management:				
Subadult: 1 Unresolved assumed alive 1 Unresolved assumed dead	0.530 0.483	0.127 0.124	0.293 0.260	0.754 0.712
Adult: 2 Unresolved assumed alive 2 Unresolved assumed dead	0.918 0.867	0.045 0.055	0.775 0.718	0.973 0.944

Table 7. Summary of 11 trend monitoring female grizzly bears that have died, 2004-2010.

Bear number	Date of death	Geographic area	Cause of death
37885843	5/26/2004	Swan Valley	Probable mistaken identification. Bullet found.
76589366	9/28/2006	South Fork Flathead	Undetermined. No carcass found. Lots of hair on ground, and radio found.
81577636	8/18/2007	North Fork Flathead	Undetermined. Near forest road. No bullet found. Broken pelvis.
84624383	Late Nov. 2007	North Fork Flathead	Unknown cause. Bear found 150 m from road. No bullet found.
84523288	09/25/2009	North Fork Flathead	Natural. Killed by another bear.
93585538	07/27/2009	Two Medicine	Defense-of-Life.
36327521	10/14/2009	East Front	Defense-of-Life.
107576882	10/03/2009	North Fork Flathead	Illegal. Bear shot on forest road. Bullet found.
93639873	Nov. 2009	Glacier Park	Probably natural.
63604357	9/14/2010	Seeley Lake	Management removal
81280264	Oct. 2010	Blackfeet Reservation	Bear found dead in daybed, close to homes. No bullet found with metal detector. Unresolved.

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progressed from females with COY to females with 2+ year old young (Table 11, Fig. 2).

We compared home range size for females living within Glacier National Park to those outside the Park. Home range sizes were nearly twice the size outside of the Park than inside (Table 12, Fig. 3). For example, 95% kernel isopleths averaged 213 km^2 outside the Park, compared to 108 km^2 within.

Table 8. Survival rates of male grizzly bears in the NCDE; 2004-2010.

Type of male bear	Survival parameter			
	Estimate	**SE**	**-95% CI**	**+95% CI**
Research (*n*=48)	0.838	0.066	0.664	0.931
Management (*n*=56)	0.615	0.079	0.452	0.756

Table 9. Cause of death of male grizzly bears captured for either research or management.

Type of Male	Number of deaths by cause					
	Management removal	**Self defense**	**Illegal**	**Vehicle**	**Train**	**Ukn**
Research	1	0	3	1	0	0
Management	8	1	2	1	1	1

Table 10. The number of attendant young of trend females, 2004-2010.

Year	Number Adult Females	Status	n	Total Young
2004	11	No young 1 cub 2 yearlings 2 3-yr-olds 2 cubs 3 cubs	5 1 0 1 2 1	10
2005	26	No young 1 cub 2 cubs 3 cubs 1 yearling 2 yearlings 2 2-yr-olds unk, but cubs	16 0 1 1 4 2 1 1	Minimum of 16
2006	25	No young 1 cub 2 cubs 3 cubs 2 yearlings unk	14 2 4 1 3 1	Minimum of 19
2007	28	No young 1 cub 2 cubs 3 cubs 1 yearling 2 yearlings 3 yearlings 2 2-yr-olds unk	9 1 7 1 1 3 1 2 3	Minimum of 32
2008	30	No young 1 cub 2 cubs 3 cubs 1 yearling 2 yearlings 3 yearlings 2 2-yr-olds unk	11 2 4 2 2 2 1 0 6	Minimum of 23
2009	32	No young 1 cub 2 cubs 3 cubs 1 yearling 2 yearlings 3 yearlings 1 2-yr-olds unk	4 1 12 2 2 2 2 1	Minimum of 44
2010	31	No young 1 cub 2 cubs 3 cubs 1 yearling 2 yearlings 3 yearlings 1 2-yr-olds unk	8 4 4 1 1 9 1 1	Minimum of 40

Table 11. Fixed kernel annual home range size for female grizzly bears in the NCDE.

Female Class (*n*)	**Size (km^2) of Fixed Kernel Home Range Isopleth (%) (-95% CI – mean - +95% CI)**		
	50	**90**	**95**
Subadult (12)	35-48-62	138-187-236	180-242-304
Solitary Adult (15)	25-34-42	92-128-163	118-164-210
Adult with COY (12)	19-27-35	63-98-134	80-127-175
Adult with Yrlings (12)	23-32-42	85-118-151	111-151-191
Adult with 2+ yr old young (5)	19-35-50	86-129-172	109-166-222

Fig. 2. Home range size of female grizzly bears in the NCDE.

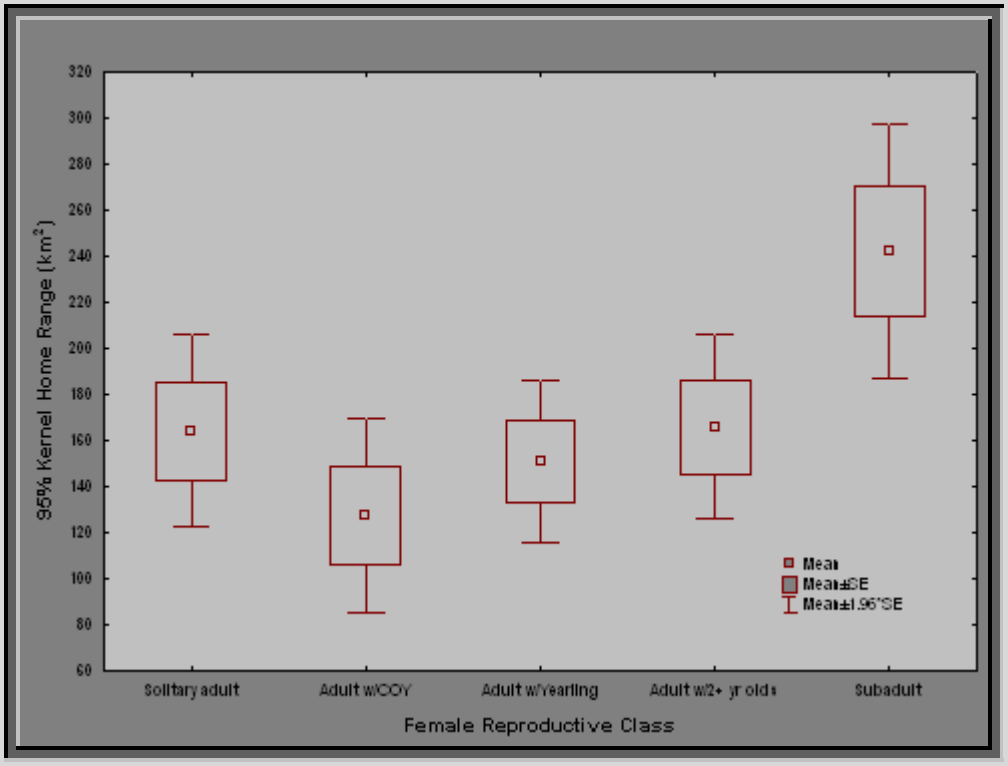
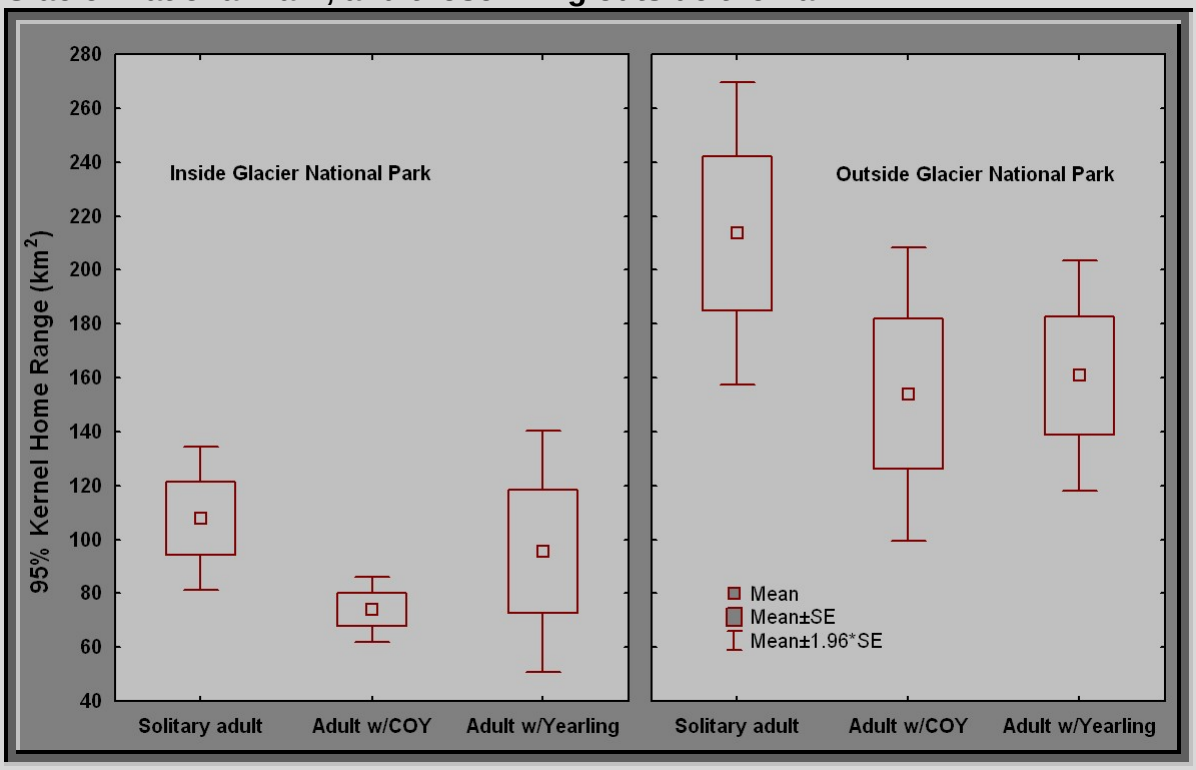


Table 12. Size of 95% fixed kernel home ranges for females residing in Glacier National Park, and those living outside the Park.

Female Class	Mean Size (km^2) of 95% Fixed Kernel Home Range Isopleth (%) (n)	
	Glacier Park	Non-Glacier Park
Solitary Adult	108 (7)	213 (8)
Adult with COY	74 (4)	154 (8)
Adult with Yrlings	95 (2)	160 (9)

Fig. 3. Size of 95% fixed Kernel home ranges for females residing in Glacier National Park, and those living outside the Park.



Grizzly Bear Distribution in the NCDE

Between 1989 and 2010, grizzly bears were documented outside of the NCDE recovery zone boundary in all cardinal directions (Fig. 4). We obtained grizzly bear distribution information for 257 cells **(**25,700 km^2) that either intersected the NCDE recovery zone boundary or were outside of the boundary. The number 10 km x 10 km cells outside the NCDE used by males only, or by females only were 56 (5,600 km^2) and 49 (4,900 km^2) respectively. We documented both Males and females in 99 cells (9,900 km^2). Females that were

moved from the NCDE to the CYE for population augmentation constituted 37 unique cells (3,700 km^2). Cells occupied by both males and females constituted 99 cells (9,900 km^2). In general, male grizzly bears were observed further from the NCDE boundary than females. This map (Fig. 4) does not include all 3miscellaneous sighting, as such databases are not completed.

We evaluated the extent to which radioed-instrumented female grizzly bears utilized the bear management units (BMU) in the NCDE. Occupancy of these BMU's by females may be used as an index to bear distribution within the NCDE. Telemetry locations of research and management bears were superimposed on both a 10km^2 in relation to BMU boundaries. Using telemetry data from 2004 through 2010 (with the exception some missing 2010 data from the east side of the Continental Divide), we determined that all 23 BMU's were occupied by female grizzly bears (Fig. 5). Further, all BMU's were occupied by adult females, 21 of 23 were occupied by subadult females, and females with dependent young also occupied 21 BMU's.

Grizzly Bear Stable Isotopes

To date, we have analyzed 54 hair samples from the NCDE for stable isotope signatures. Thirty-eight samples have come from bears residing east of the Continental Divide, and 16 samples were obtained west of the Divide (Table 13). Hair from males and females comprised 27 and 21 of the samples.
Using reference samples for deer and elk from the Cabinet-Yaak area, we determined that a nitrogen signature of $\pm$ 3 would represent values of a

Fig 4. Distribution of grizzly bears in and adjacent to the NCDE federal recovery zone based on telemetry data, mortality data, and DNA detections in 2004 (from Kendall et al. 2009). Occupancy was based on presence within 10 km^2 grid cells. Note: 2010 telemetry data from Rocky Mountain Front not available at time of printing.

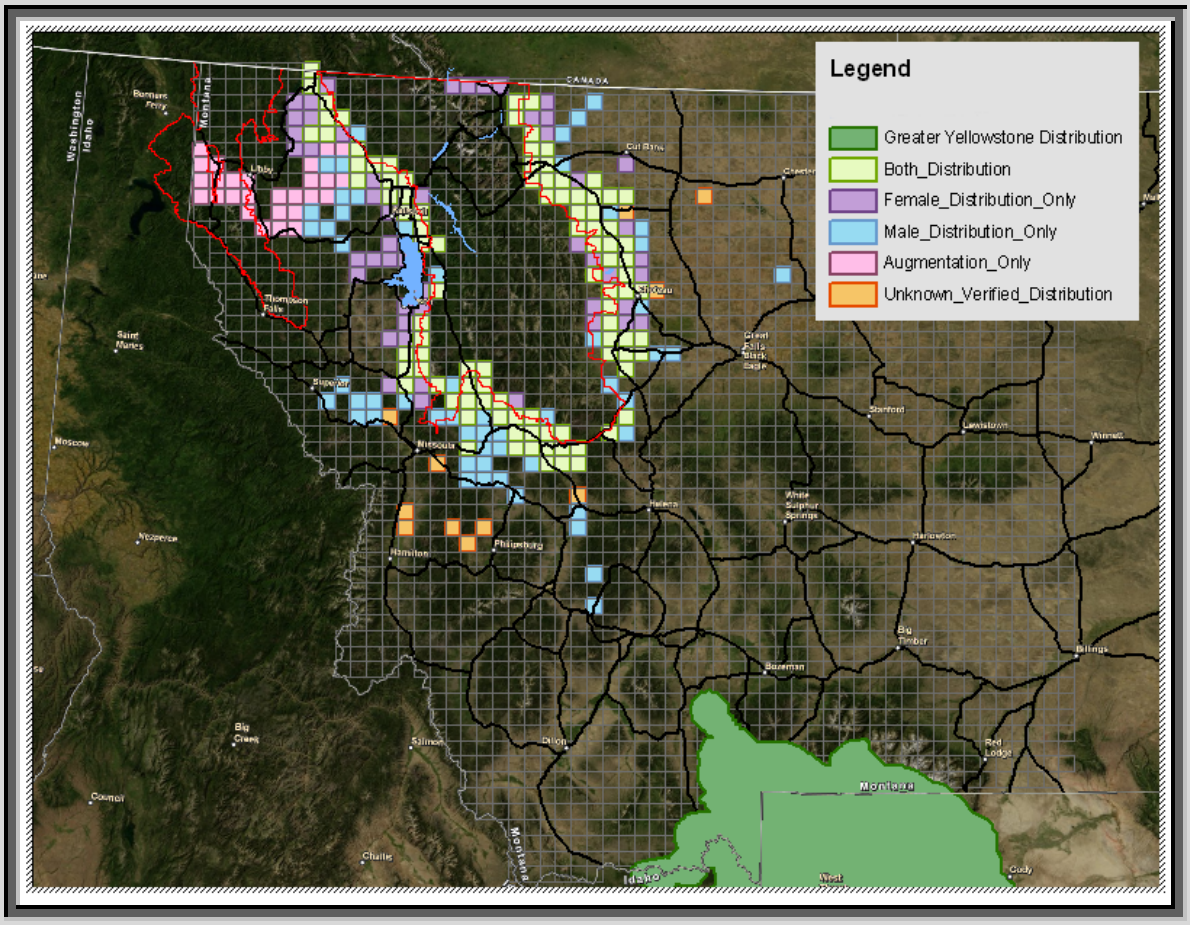
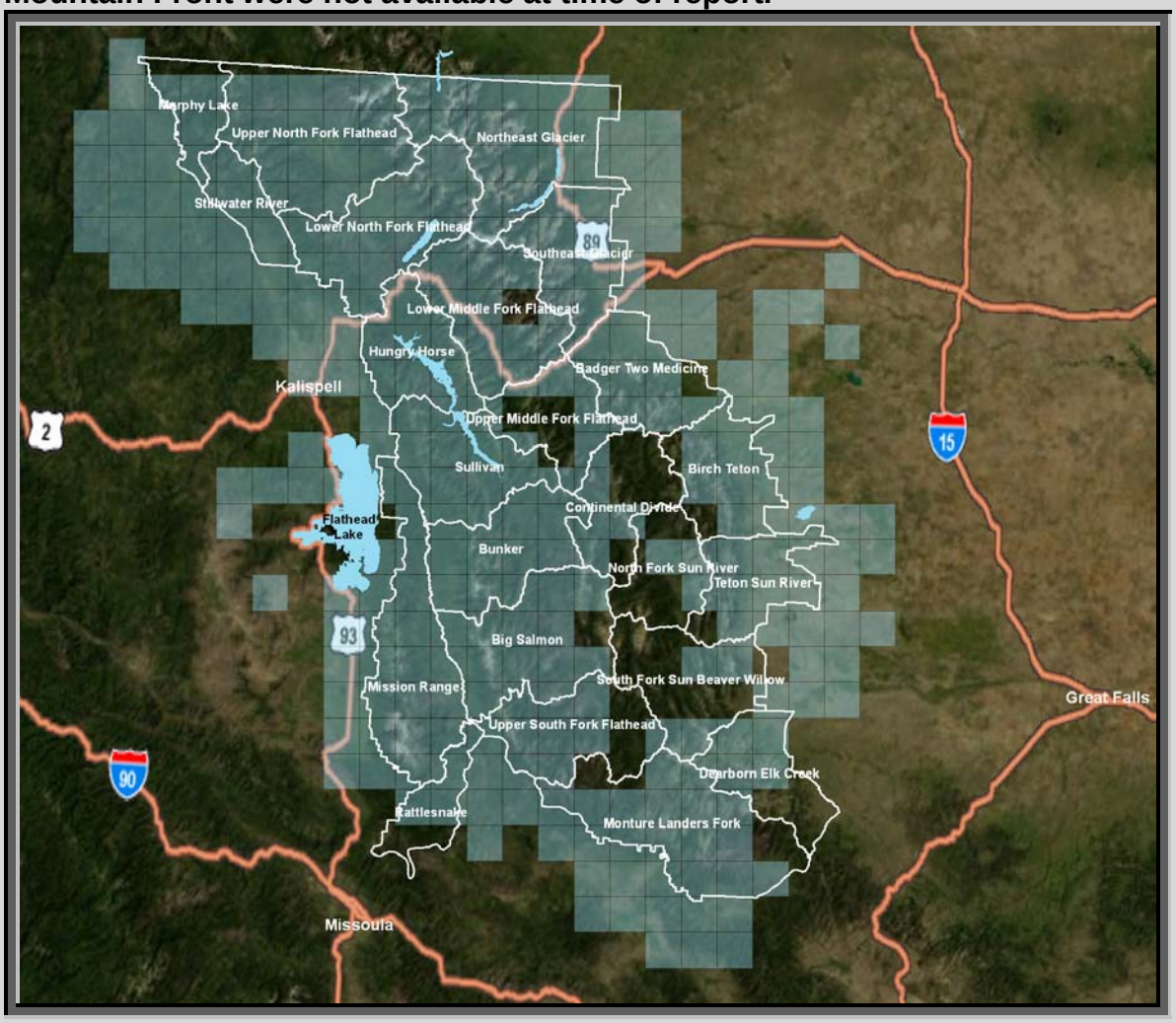


Fig. 5. Distribution of female telemetry data by Bear Management Units; 2004-2010. Research and management female telemetry points (shaded blue) placed on a 10 km^2 grid. Note: 2010 data from Eastern Rocky Mountain Front were not available at time of report.



vegetarian bear (Fig. 6). Nitrogen signatures above this value indicate an increasing amount of meat in the assimilated diet. In general, we observed a higher incidence of meat in samples from the east side of the Continental Divide (Fig. 6). This is in keeping with our knowledge of food habits of bears in this area. Along the Rocky Mountain East Front, numerous livestock carcasses are available to bears, especially during spring months. In fact, FWP maintains a 20-year-old livestock carcass redistribution program, wherein managers move carcasses from populated areas to more remote areas.

Body Condition Index Values

In 2010, we obtained BIA readings and actual weights on 44 grizzly bears in the NCDE at time of capture. BIA readings were obtained from male and female bears for most of the active foraging months (Table14). Although samples sizes are low for each month and sex, mean % body fate estimates were >8% for both sexes each month (Fig. 7). Further, % body fat nearly doubled from August through October.

Table 13. Origin of hair samples used to estimate the assimilated diet of grizzly bears in the NCDE.

Origin of hair sample	Sample sizes for location and sex of hair sample					
	West of Continental Divide			East of Continental Divide		
	Male	Female	Ukn	Male	Female	Ukn
Research	2	6	0	12	6	2
Management	3	3	0	10	5	2
Mortality	0	0	1	0	1	0
Opportunistic	0	0	1	0	0	0

Fig. 6. Carbon and nitrogen stable isotope signatures for bears captured east and west of the Continental Divide, NCDE.

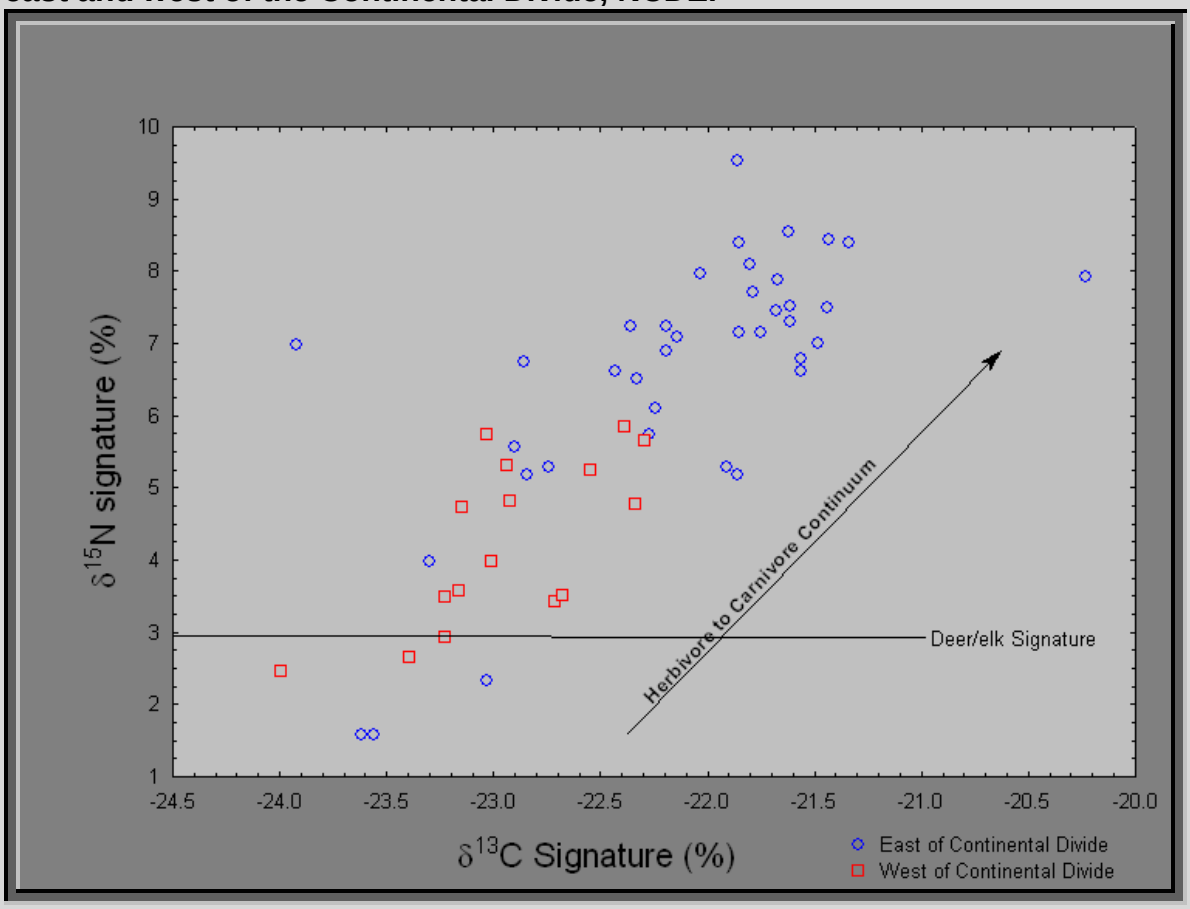
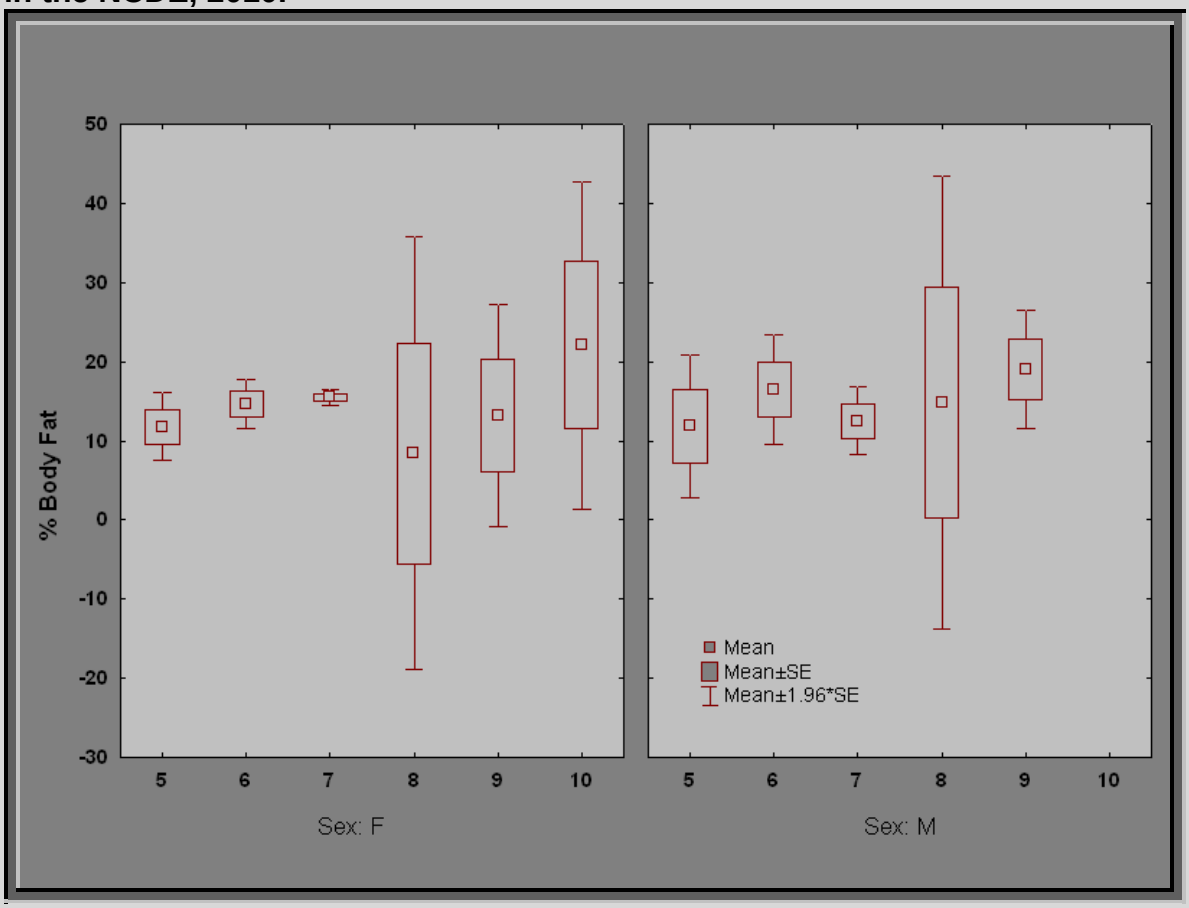


Table 14. Summary of % body fat in male and female grizzly bears in the NCDE by month in 2010.

Month	Mean % body fat by sex (*n*)	
	Male	Female
5	11.85 (4)	11.83(5)
6	16.46(5)	14.65(4)
7	12.51(2)	15.48(3)
8	14.80(2)	8.42(2)
9	19.06(8)	13.22(5)
10	n/a	22.10(4)

Fig. 7. Monthy % body fat readings for male and female grizzly bears in the NCDE, 2010.



Miscellaneous Grizzly Bear Observations Outside the NCDE Boundary

Observations of grizzly bears that occur substantially outside of the boundary of the NCDE are recorded each year. For 2010, these observations are summarized in Fig. 8, and descriptions are given below.

Observation 1: A bear was photographed in the Georgetown Lake area at the south end of the Flint Creek Range (Fig. 9). This observation was approximately 65 miles south of the NCDE Recovery Zone boundary and 100 miles NW of the Yellowstone Recovery Zone boundary. The photo was circulated to bear biologists for confirmation of species.

Observation 2: On 11 June 2010, a male grizzly bear was killed by the public east of Butte Montana at a livestock depredation. The case is ongoing. The bear was estimated to be approximately 5 years old. The UTM coordinates were: 387149 x 5099359 (NAD 83). Genetic analyses confirmed that it was a grizzly bear and was linked to the NCDE population (Fig. 10).

Observation 3: On 4 June, 2010 an unmarked female grizzly bear with two yearlings was observed from the air while radio tracking. The bear was observed by Tim Manley and pilot Dave Hoerner in the Forrey Creek drainage, southwest of Lakeside Montana (UTMs ,zone 11) = 704718 x 5314293).

Observation 4: In early August, 2010, a pair of young grizzly bears was spotted near Brady Montana, 50 miles north of Great Falls. Approximate UTMs = 438794 x 5321632.

Observation 5: A female grizzly bear with two young were observed walking across a grain field in Collins Montana. Approximate UTMs = 438575 x 5307748.

Observation 6: Male grizzly bear #036324093 was captured at a livestock depredation on 1 July 2009 near Fort Benton (UTMs = 536118 x 5309727). This bear was relocated to the Middle Fork Flathead River area the following day. In July 2010, this bear was again implicated in a livestock depredation 12 miles north of Carter Montana (UTMs= 508129 x 5308755) and was removed from the population on 13 July 2010.

Observation 7: On 7 May 2010, a subadult male grizzly bear (#036564057) was captured in the Flathead Valley and moved to the Spotted Bear area. On 24 June 2010, the bear was located south of Avon Montana on the Spotted Dog Wildlife Management Area (UTMs, zone 12, 378425 x 5155763). The bear subsequently returned to the NCDE area. On 11 September 2010 he was captured and removed from the population due to habituated behavior.

Observation 8: A subadult female grizzly bear (avid #097771828), who was a management capture in the Flathead Valley in 2009, was recaptured on the west side of Flathead Lake at church camp in 2010. The female was radioed, and moved to an area west of Blacktail Mountain. This female made extensive use of the area termed the "Island Unit" throughout the summer (Fig. 11). There are very few historical observations of grizzly bears in this area.

Observation 9: Efforts are underway to augment the population in the Cabinet-Yaak Ecosystem with bears from the NCDE. One female was moved in 2009 (#036577520), and a second in 2010 (#095636784). Both of these females returned to the NCDE through the Salish Range, and provided information on bear movements between these 2 ecosystems (Fig. 12).

Fig. 8. Observations of grizzly bears outside the boundary of the NCDE, 2010.

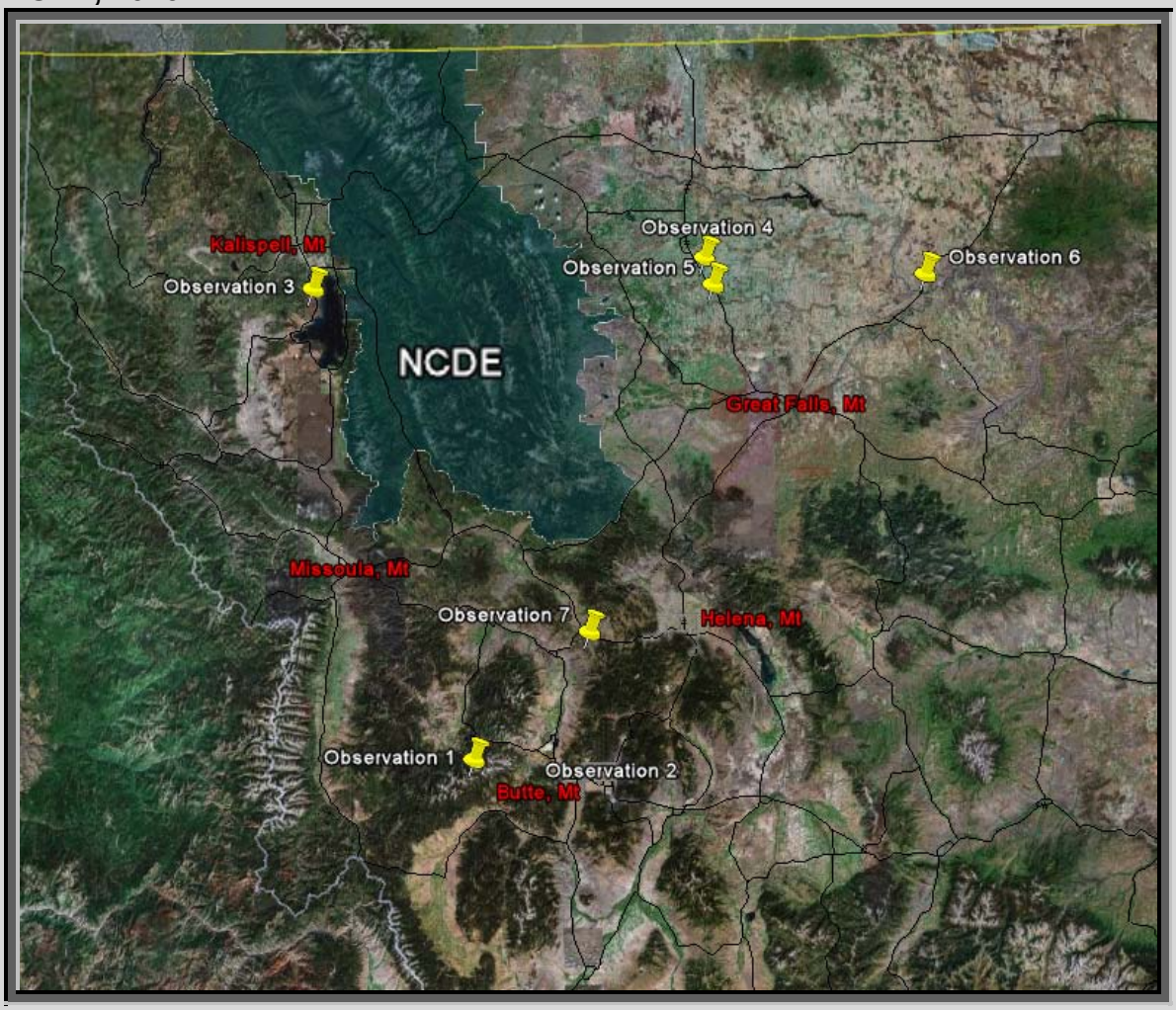


Fig. 9. Photograph of bear presumed to be a grizzly bear in the Flint Creek Range, Montana.

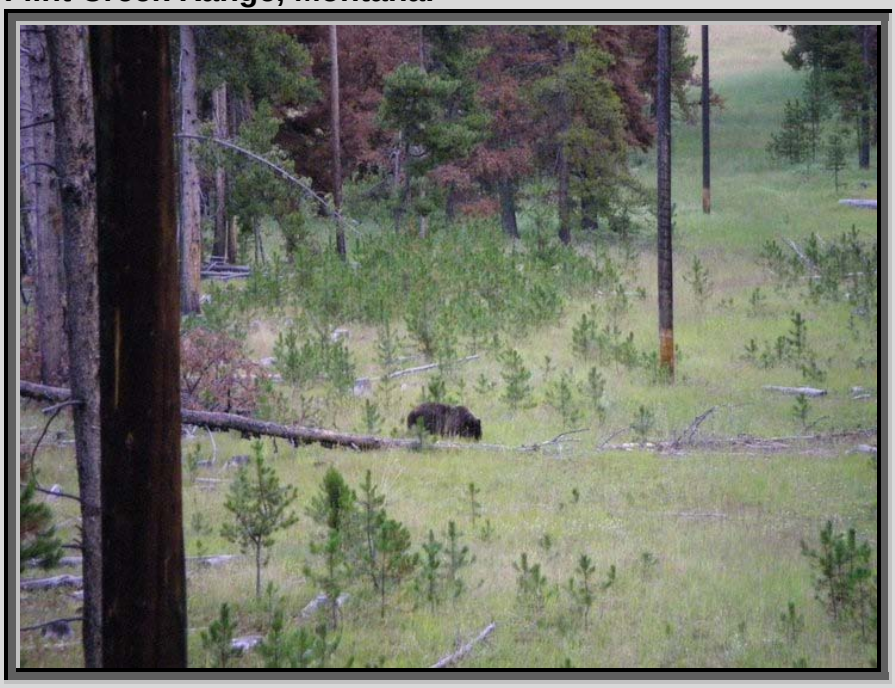


Fig. 10. Clustering results for the Butte Bear (blue) and reference animals from the NCDE (yellow) and GYE (white). The white and yellow outliers are known translocations or captive animals whose records are in a data set that does not correspond to their ancestry, including 3 known GYE/NCDE hybrids from a captive facility.

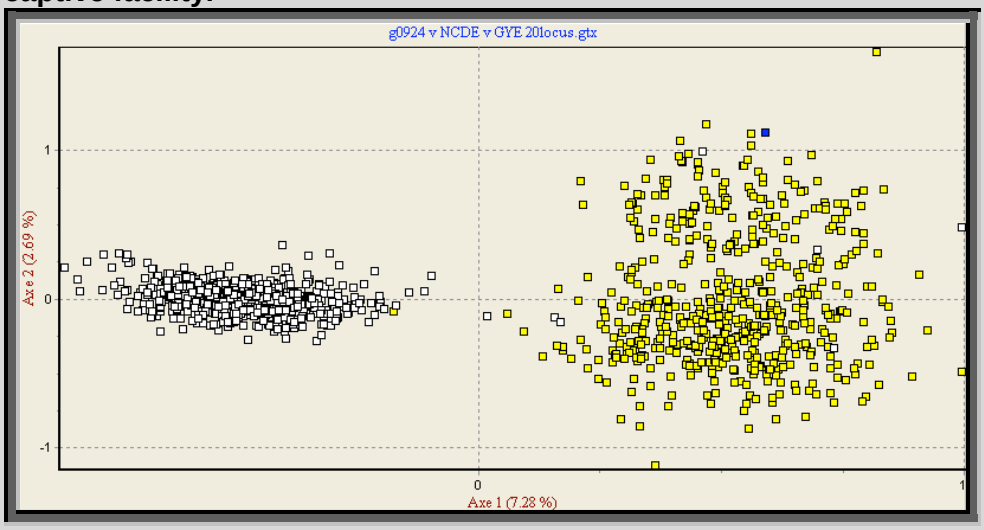
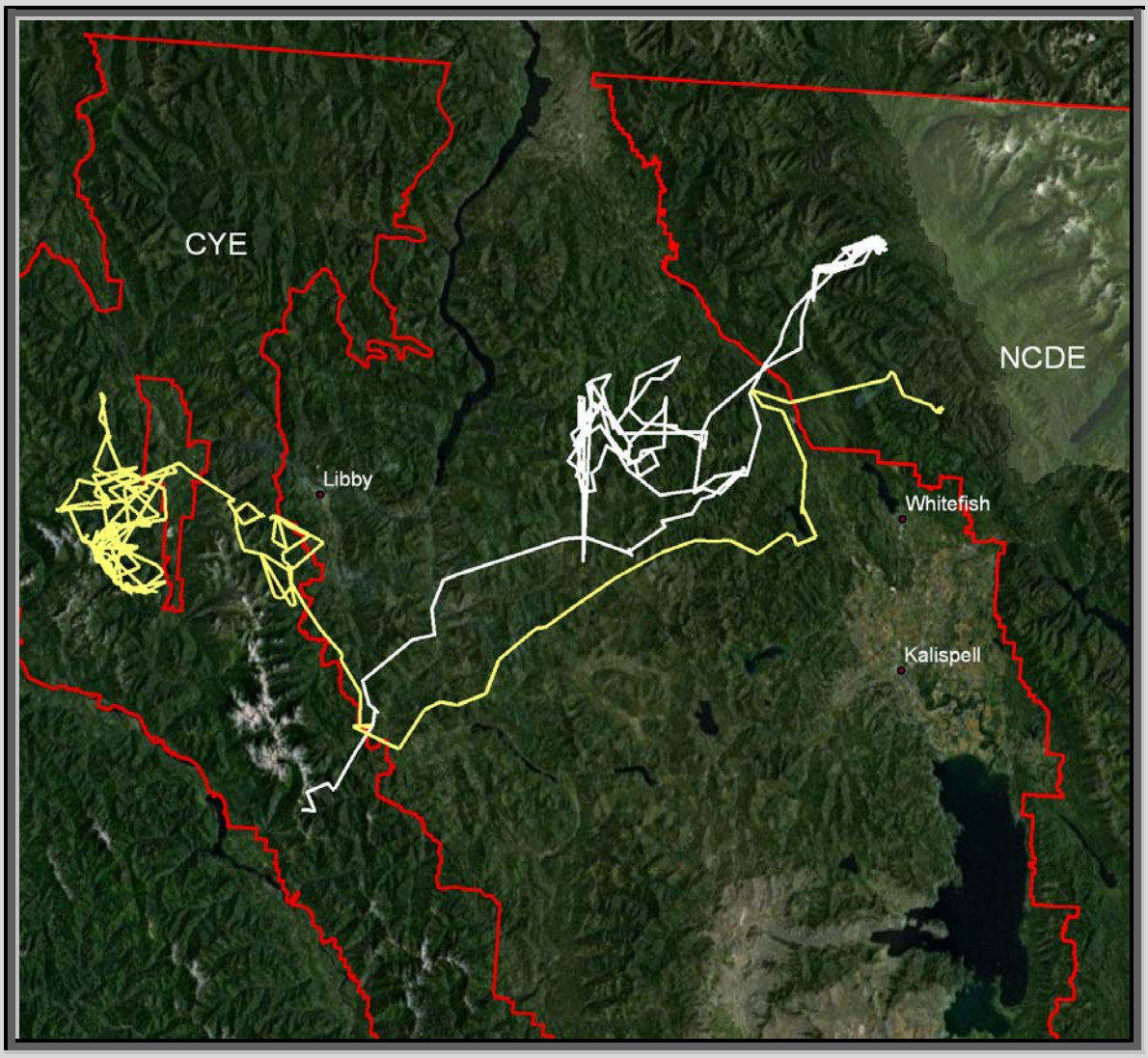


Fig. 11. Movements of subadult female #097771828 in 2010 relative to Flathead Lake.

Fig. 12. Movements of 2 females subsequent to augmentation attempts from the NCDE to the CYE. The yellow line is for female # 036577520 in 2009-2010. The white line is for female #095636784 in 2010.



Grizzly Bear Mortalities in the NCDE, 2009-2010

In 2009, we tallied 21 known or probable grizzly bear mortalities in the NCDE (Table 15). One of these mortalities was natural, and we could not determine the cause of death in one instance. One illegal death of an adult female occurred >10 miles from the recovery zone boundary on the Blackfeet Indian Reservation. Therefore, we tallied 19 known or probable man-caused deaths within 10 miles of the recovery zone. Twelve marked grizzly bears died in 2009. Grizzly bear mortalities in the NCDE during 2009 are listed in Appendix E.

One adult female (# 036577520) was moved from the NCDE (North Fork Flathead River) to the Cabinet-Yaak Ecosystem to augment that population. This bear denned in the CYE but returned to the NCDE on 5/17/2010 (Fig. 13). This bear did not count as mortality in either ecosystem.

In 2010 we tallied 23 grizzly bear known or probable mortalities in the NCDE (Table 16). Two natural mortalities were reported for the year; one of each sex. Two deaths occurred for which the cause could not be determined. Two deaths occurred outside the 10 mile recovery zone buffer, both of which were management removals of males. Therefore, there were 19 known or probable man-caused deaths within 10 miles of the recovery zone in 2010. Fourteen marked grizzly bears died in 2010.

One adult female (#095636784) was moved from the NCDE (North Fork Flathead River) to the Cabinet-Yaak Ecosystem in2010 to augment that population. This female returned to the NCDE and therefore did not count as mortality. One subadult male (# 038025353) was also moved the CYE and

stayed the remainder of the year. Grizzly bear mortalities in the NCDE during 2010 are listed in Appendix F.

Table 15. Summary of known or probable grizzly bear mortalities in the NCDE, 2009.

Sex	Age class	Mortality cause	Number mortalities
Female	adult	Mgmt Removal	1
	yearling	Mgmt Removal	1
	adult	Mistaken Id	1
	adult	Natural	1
	adult	Undetermined	1
	adult	Defense-of-life	2
	adult	Illegal	2[a]
Total Female:			9
Male	adult	Mgmt Removal	1
	subadult	Train	1
	adult	Train	1
	yearling	Capture Related	1
	adult	Illegal	2
	yearling	Illegal	1
	subadult	Mistaken Id	2
Total Male:			9
Ukn Sex	coy	Orphaned	3
Total Ukn:			3
Total Deaths			21

[a] One death was > 10 miles from the recovery zone.

Table 16. Summary of known or probable grizzly bear mortalities in the NCDE, 2010.

Sex	Age class	Mortality cause	Number Mortalities
Female	coy	Mgmt Removal	1
	subadult	Illegal	1
	subadult	Natural	1
	adult	Undetermined	1
	adult	Mgmt Removal	2
Total Female			6
Male	subadult	Illegal	1
	subadult	Augmentation	1
	yearling	Natural	1
	adult	Mgmt Removal	2[a]
	coy	Mgmt Removal	2
	subadult	Automobile	2
	coy	Automobile	3
	subadult	Mgmt Removal	4[a]
Total Male			16
Ukn Sex	Undetermined	Undetermined	1
Total Deaths			23

[a] One death in each category was > 10 miles from the recovery zone.

Estimation of Unreported Mortality

Thirty-two independent-aged grizzly bears died between 1999 and 2010 in the NCDE while wearing functional radio collars. Thirteen and 19 of these dead bears were males and females, respectively. Most (37.5%) deaths were classified as illegal (Table 17).

During the study period 59.4% and 40.6% of the deaths were classified as unreported and reported, respectively. The ratio of unreported to reported deaths suggest that for every 1 reported death there are 1.46 deaths not reported to management authorities. Given the unreported reporting rate of 1.46, the estimated number of deaths that go unreported is given in Table 18.

Total Mortality of Independent aged Grizzly Bears; 1999-2010

Total mortality levels of independent aged grizzly bears in the NCDE each year from 1999-2010, incorporating unreported mortality, are given in Table 19. Total annual mortality is the sum of sanctioned management removals, deaths discovered via radio telemetry, mortalities reported by the public, and unreported mortalities.

Table 17. Cause of death for 32 radio-collared grizzly bears in the NCDE that were used to judge the level of unreported mortality in the NCDE; 1999-2010.

Cause of death	Reporting of Mortality		Total
	Reported by Public	Unreported by Public (due to telemetry)	
Train collision	5	0	5
Automobile collision	2	0	2
Defense-of-life	1	0	1
Illegal	5	7	12
Undetermined	0	9	9
Natural	0	3	3
Total	13	19	32

Table 18. Estimated number of unreported deaths each year based on the ratio of unreported to reported deaths (1.46) using a test sample of radioed bears that died. The estimate of unreported deaths should be applied separately to male and females.

Number of Publicly Reported Deaths per year[a]	Estimated Number of Unreported Deaths per year	Total Reported and Unreported Deaths per year[b]
0	1	1
1	1	2
2	2	4
3	4	7
4	5	9
5	7	12
6	8	14
7	9	16
8	11	19
9	12	21
10	14	24

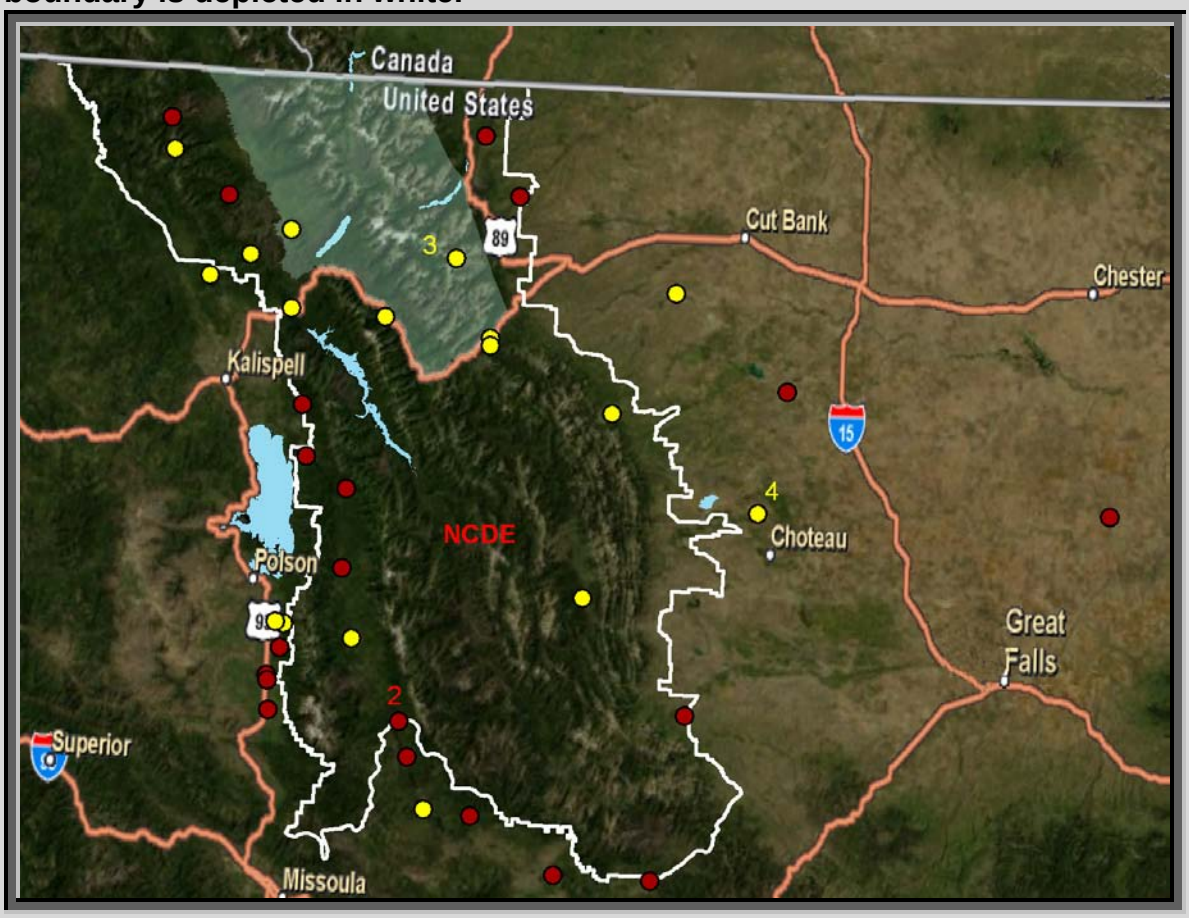
[a] the number of deaths in the official mortality records reported by the public.
[b] the median of the credible interval for reported and unreported mortalities (Cherry et al. 2002).

Table 19. Documented mortality of independent-aged (≥2 years old) grizzly bears in the NCDE from 1999 through 2010 where the sex of the bear was known. Table includes only known and probable mortalities within 10 miles of recovery zone boundary.

Year	Sex	Type of Mortality				Total
		Management Removal[a]	Public Reporting[b]	Unreported[c]	Telemetry[d]	
1999	F	0	4	5	0	9
1999	M	5	2	2	2	11
2000	F	2	6	8	1	17
2000	M	3	1	1	0	5
2001	F	2	5	7	0	14
2001	M	4	5	7	2	18
2002	F	1	4	5	0	10
2002	M	3	4	5	0	12
2003	F	1	1	1	0	3
2003	M	3	1	1	0	5
2004	F	2	3	4	4	13
2004	M	1	6	8	0	15
2005	F	5	1	1	1	8
2005	M	2	8	11	1	22
2006	F	1	0	1	2	4
2006	M	3	1	1	1	6
2007	F	0	6	8	1	15
2007	M	2	10	14	0	26
2008	F	3	2	2	0	7
2008	M	1	3	4	0	8
2009	F	1	4	5	2	12
2009	M	1	6	8	0	15
2010	F	2	0	1	3	6
2010	M	5	3	4	0	12

[a] removal of a bear from the NCDE by management authorities, including bears that were radio-marked at time of removal.
[b] mortalities reported to authorities by the public. May or may not have been radio-marked at death.
[c] estimated number of deaths that were unreported using the method of Cherry et al. (2002).
[d] number of radio-marked bears whose death was determined through telemetry, except those removed by management authorities.

Fig. 13. Locations of grizzly bear mortalities within and near NCDE during 2009 (yellow) and 2010 (red). Several natural mortalities, those where the cause of death was undetermined, and those > 10 mi from the recovery boundary are also depicted on this map. Duplicate mortalities at the same location are shown next to the coordinate. The federal Recovery Zone boundary is depicted in white.



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Appendix A. Fate of trend monitoring females in the NCDE; 2004-2010.

Bear Id	Area	Annual Fate						
		2004	2005	2006	2007	2008	2008	2010
205	East Front	alive	alive	alive	censor			
233	N.F.Flathead	alive	alive	alive	censor			
84625525	Glacier Park	alive	alive	alive	collar_failed			
238	BC	alive	alive	censor			alive	alive
132335546	Alberta	alive	alive			alive	censor	
48366019	Salish	alive	censor					
84525082	Glacier Park	alive	censor					
84528858	N.F.Flathead	alive	censor					
84529290	Swan Valley	alive	censor					
132353547	Alberta	alive	censor					
84623110	N.F.Flathead	alive	Probable_DEAD					
51072381	East Front	censor					alive	censor
37885843, 84628512	Swan Valley	DEAD						
79050043	S.F.Flathead		alive	alive	alive	alive	alive	alive
67006850	N.F.Flathead		alive	alive	alive	alive	alive	censor
71814874	BIR		alive	alive	alive	alive	alive	unresolved
84524018	Middle Fork		alive	alive	alive	alive	censor	
84523288	N.F.Flathead		alive	alive	alive	alive	DEAD	
51561597	Scapegoat		alive	alive	alive	censor		
76553865	East Front		alive	alive	alive	censor		
76615038	Glacier Park		alive	alive	alive	unresolved		
76361015	Glacier Park		alive	alive	censor			alive
51586884	Ovando		alive	alive	censor			
51071845	East Front		alive	alive	collar failed			
84623066	East Front		alive	alive	collar failed			
72023614	BIR		alive	censor				
51605816	East Front		alive	collar failed				
72113035	BIR		censor	alive	alive	censor	unresolved	
72113035	BIR		censor	alive	alive	censor		
23813296	Glacier Park		censor					
71816812	BIR		censor					
76560093	Glacier Park		censor					
76613125	S.F.Flathead			alive	alive	alive	censor	
81886333	S.F.Flathead			alive	alive	alive	unresolved	
263	flathead			alive	alive	censor		alive
81602889	Bob Marshall			alive	alive	censor		alive
71868109	BIR			alive	alive	censor		
76600783	S.F.Flathead			alive	alive	censor		
79110541	Glacier Park			alive	alive	censor		
81603277	Bob Marshall			alive	alive	censor		
76584107	CSKT			alive	censor			
81577636	N.F.Flathead			alive	DEAD			
84624383	N.F.Flathead			alive	DEAD			
82024327	N.F.Flathead			censor	DEAD			
76589366	S.F.Flathead			DEAD				
76570875	Middle Fork				alive	alive	alive	censor
51571800, 64028820	Ovando				alive	alive	censor	
93619344	Glacier Park				alive	alive	censor	
93639873	Glacier Park				alive	alive	DEAD	
81605772	Glacier Park				alive	censor		
64054290	Ovando				alive		alive	alive
93585538	BIR				censor	alive	DEAD	
51597096, 39851084	East Front				censor			alive
97637608, 39851057	East Front					alive	alive	alive
81289085	BIR					alive	censor	alive
81600578	N.F. Flathead					alive	censor	alive
63834064	South end					alive	censor	
93571631	Swan Valley					alive	censor	
93586336	CSKT					alive	censor	
97616524	Glacier Park					alive	censor	
97630806	N.F. Flathead					alive	censor	
97559276	East Front					censor		

97605011	East Front					censor		
107581802	Glacier Park					censor		
97631049	East Front					unresolved	unresolved	
Pam	B.C.						alive	alive
36335046	East Front						alive	alive
36548287	East Front						alive	alive
36568375	East Front						alive	alive
81279315	BIR						alive	alive
97609806	Glacier Park						alive	alive
107568286	Flathead Valley						alive	alive
107587034	Glacier Park						alive	alive
36547575	Glacier Park						alive	censor
81280888	BIR						alive	censor
81290065	BIR						alive	censor
107556786	N.F. Flathead						alive	censor
107585006	North Fork						alive	censor
63604357	South end						alive	DEAD
81280264	BIR						alive	DEAD
36549051	East Front						alive	unresolved
28519310	Middle Fork						censor	
107794628	N.F. Flathead						censor	
36327521	East Front						DEAD	
107576882	North Fork						DEAD	
36547826	Glacier Park							alive
36582073	North Fork							alive
39838052	East Front							alive
39842335	East Front							alive
63614632	South end							alive
107561271	South Fork							alive
107794628	N.F. Flathead							alive
36336617	East Front							censor

Appendix B. Fate of management females in the NCDE; 2004-2010.

Bear Id	Annual Fate						
	2004	2005	2006	2007	2008	2009	2010
34375517	censor						
51085276	collar failed						
51593054	collar failed						
37887572, 81630006	alive	alive	alive	alive	censor		alive
84625280	alive	unresolved					
81580095			alive	alive	DEAD		
81639835			alive	alive			
84529806	alive	alive	alive	collar failed			
84624095	dead						
84383813	dead						
53323794		alive				DEAD	
23518519	alive	DEAD					
38051794, 37557822	DEAD						
51566878	alive	DEAD					
37605609	alive	DEAD					
38100864	alive	alive	alive	alive	alive	alive	censor
38047294, 84524096	DEAD						
84381861	dead						
84516308	dead						
84383870	DEAD						
84623527	dead						
34270060							
71552097							
22	dead						
51561278	DEAD						
34259287, 34259592	DEAD						
84626296	dead						
84528778	DEAD						
84626290		dead					
41503d5a16			censor				
81542363			dead				
82018000			alive	alive	collar failed		
72121834			alive	alive	alive	alive	censor
76313032				alive	censor		dead
81567088				censor	unresolved		
93550102				alive	alive	censor	censor
95621534					dead		
18079257					alive	censor	
18076565						alive_not collared	
81781376					unresolved		

23296344	alive	censor				dead	
216	alive	censor					
97773354						alive	censor
107789555						alive	DEAD
67041110						alive	unresolved
97794282						alive	alive
81279795						alive	unresolved
97771828						alive	alive
36577520						dead	
84382811 ,76568302						alive	alive
36585060							DEAD
36547078							censor
36336335							alive
95636784							alive
81288378							alive
18103301							dead
36558792							
18108866							alive
18095786							
36320266							
55585041							
36558355							alive
40001042							unresolved
4077515970		DEAD					
107559301					alive	censor	
36323078							

Appendix C. Fate of male grizzly bears in the NCDE; 2004-2010.

Bear id	Annual fate							
	Type	2004	2005	2006	2007	2008	2009	2010
84374365	research male	alive	alive	alive	censor			
37860849	research male	alive	alive	alive	DEAD			
67296863	research male	alive	censor					
24595039	mgmt male	alive	censor					
84626074	mgmt male	alive	DEAD					
84383560	mgmt male	alive	dead					
51273314	mgmt male	alive	dead					
84525524	research male	alive	unresolved	alive	censor			
191	research male	censor					dead	
191	mgmt male	censor					dead	
193	research male	censor						
84525021	research male	censor						
84626881	mgmt male	DEAD						
84379069	mgmt male	DEAD						
84524536	mgmt male	DEAD						
84623539	mgmt young	dead						
none	mgmt young	dead						
39847528_254	mgmt male	UNRESOLVED						alive
38043533	mgmt male	UNRESOLVED						
76316585	research male		alive	alive	alive	ukn	dead	
79090808	mgmt male		alive	alive	unresolved			
81576580	augmentationmale		alive	censor	alive	alive	censor	
76517578, 415051031	research male		censor					
48324259	otherresearch male		censor					
84629365	mgmt male		DEAD					
51299051	mgmt male		DEAD					
51303813	mgmt male		dead					
72018558	mgmt male		UNRESLOVED					
72098344	mgmt male			alive	alive	unresolved		
53594886	research male			alive	alive			
81552593	augmentationmale			alive	censor			
81631088	augmentationmale			alive	censor			
81580106	augmentationmale			alive	censor			
51589351	research male			alive	DEAD			
82033566, 84629588	mgmt male			alive	DEAD			
76614342	research male			censor	censor			
76600112	research male			censor		alive	alive	alive
63615794	research male			censor				
81596581	mgmt male			DEAD				
81774014	mgmt male			DEAD				
76554835	research male			DEAD				
79046784	research male			dead				
81610591	augmentationmale			dead				
81583847	mgmt male			dead				
34265368	mgmt male				alive	unresolved	alive	

81552264	research male				alive	alive	DEAD	
81552264	mgmt male				alive	alive	DEAD	
51272543	research male				alive	censor	alive	censor
82024836	mgmt male				alive	censor		
51304876	research male				alive	DEAD		
97777564	mgmt male				alive	DEAD		
82024121	mgmt male				alive	unresolved		
93572867	mgmt male				alive	unresolved		
82023820	mgmt male				alive			dead
28582609	mgmt male				censor			
72088084	mgmt male				censor			
51368573	research male				DEAD			
71537785	mgmt male				DEAD			
82025350	mgmt male				DEAD			
81770822	mgmt male				DEAD			
81603078	research male				dead			
28346107	research male					alive	alive	alive
81562048, 37604261	mgmt male					alive	alive	alive
97605021	mgmt male					alive	alive	alive
76590799	mgmt male					alive	alive	alive
925	mgmt male					alive	alive	
97625062	research male					alive	censor	
97637327	research male					alive	censor	
97612565	research male					alive	censor	
38043801	research male					alive	censor	
76598090	mgmt male					alive	dead	
40774D1C07, 36555639	research male					censor	alive	censor
97772635	mgmt male					censor	censor	
63606347	mgmt male					censor	dead	
81623770	Mgmt/research male					censor		alive
97628566	research male					censor		
93550369	mgmt male					censor		
96597530, 81891531	mgmt young					DEAD		
76326263	research male						alive	alive
107553631	otherresearch male						alive	alive
36567786	otherresearch male						alive	alive
93608813	research male						alive	censor
51280805	research male						alive	censor
36336542	research male						alive	censor
51280805	otherresearch male						alive	censor
51280805	otherresearch male						alive	censor
36328065	research male						alive	DEAD
81258126	mgmt male						alive	DEAD
81258126	mgmt male						alive	DEAD
36324093	research male						alive	dead
36324093	mgmt male						alive	dead

81264536	mgmt male						alive	unresolved
36329535	mgmt male						alive	unresolved
36320525,36555327	research male						alive	
623	mgmt male						alive	
	mgmt male						alive	
36310519	mgmt male						censor	DEAD
81605621	research male						censor	
64035775	research male						censor	
36547771	mgmt male						censor	
93618280,93600058	otherresearch male						censor	
81290367	research male						dead	
51259355	research male						dead	
107792310	research male							alive
39847013	research male							alive
76614342,39694581	research male							alive
81258337	research male							Alive
39847528	research male							alive
40001275	research male							alive
36313532	mgmt male							alive
36555039	mgmt male							alive
36558090	mgmt male							alive
55599290	mgmt male							alive
36551608	otherresearch male							alive
63610272	research male							censor
81278605	mgmt male							censor
81290806	mgmt male							censor
18111794	mgmt male							censor
63812800	mgmt male							censor
18119561	mgmt male							censor
36564057	mgmt male							DEAD
38025353	mgmt male							dead
36569027	mgmt male							dead
18107106	mgmt male							dead

Appendix D. Reproductive history of trend monitoring females and management females in the NCDE; 2004-2010.

Bear Id	Type	Reproductive Status						
		2004	2005	2006	2007	2008	2009	2010
38052875	research	2_yrlings	2_2yrolds					
84529290	research	none	Ukn_but cubs					
48366019	research	1_coy	1_yrling					
84625548	research	subadult						
84623296	research	subadult						
84528858	research	unknown	none					
84525082	research	none	none					
51072381	research	subadult	subadult	subadult	unknown	unknown	2_coy	2_yrlings
84623110	research	none	3_coy					
84625525	research	none	none	none				
238	research	none	none	1_coy			none	none
233	research	3_coy	none	none				
132353547	research	2_2yr_olds						
132335546	research	subadult	subadult	subadult	none	2_coy	2_yrlings	
76553865	research		subadult	none	2_coy	2_yearlings_dispersed		
51071845	research		subadult					
51605816	research		2_yrlings	none				
84623066	research		none	2_coy	2_coy			
51586884	research		1_yrling	unknown	unknown			
71814874	research		none	none	unknown	1_cub	1_yrling	1_2yrlold
72023614	research		none	2_coy				
71816812	research		none					
72113035	research			subadult	none	1_coy_lost		
79050043	research		none	none	none	none	2_coy	2_yrlings
84524018	research		none	none	3_coy	unknown	1_yrling	
76361015	research		none	2_coy	2_yrlings			1_coy
76560093	research		none					
51561597	research		none	unknown	unknown	unknown		
84523288	research		2_coy	2_yrlings	2_2yrolds	3_coy	3_yrlings	
84624383	research		subadult	subadult	subadult			
84628889	research		none					
76615038	research		none	none	2_coy	unknown		
23813296	research		1_yrling					
79110541	research			none	1_cub	1_yrling		
4077420c51	research			subadult				
81577636	research			2_yrlings	2_coy			
76553352	research			subadult				
71868109	research			2_yrlings	2_2yrolds	2_coy		
76584107	research			3_coy	3_yrlings			
76589366	research			subadult				
263	research			subadult	none	2_coy		1_coy
76613125	research			none	2_coy_1died	1_yrling_dead		
82024327	research			unknown				
76600783	research			1_coy	1_yrling_dead	none		
81886333	research			subadult	subadult	none	none	
81602889	research			2_coy	2_yrlings_dead	unknown		none

81603277	research			subadult	subadult	subadult		
93585538	research				subadult	none	1_coy	
76570875	research				none	none	2_coy	2_yrlings
51597096,39851084	research				subadult			none
81605772	research				none	unknown		
51571800,64028820	research				2_yrlings	unknown		
93619344	research				none	unknown	2_coy	
93639873	research				2_coy	2_yrlings_1 dead	dispersed 1_ 2yr old	
97616524	research					none	2_coy	
93604815	research					subadult		
97774544	research					subadult	subadult	ukn
93571631	research					subadult	subadult	
97630806	research					none	2_coy	
97559276	research					subadult		
97605011	research					subadult		
97637608,39851057	research					3_yrlings_1dead	3_coy	3_yrlings
97631049	research					subadult		
63834064	research					none	unknown	
81289085	research					none	2_coy	2_yrlings
93586336	research					subadult	subadult	
107581802	research					subadult		
18098036	research					3_coy	unknown	
107568286	research						subadult	1_coy
63604357	research						adult	2_coy, 1 died
107794628	research						subadult	
81280264	research						none	lost 1_coy
36547575	research						subadult	none
107556786	research						2_yrlings	2_2yrolds
36568375	research						1_3 yr old	none
36549051	research						subadult	subadult
36548287	research						2_coy	2_yrlings
36335046	research						unknown	3_coy
36327521	research						3_cubs	
28519310	research						unknown	
97609806	research						2_coy_1died	1_yrling
81290065	research						subadult	subadult
81280888	research						subadult	2_coy
81279315	research						subadult	subadult
107576882	research						3_yrlings	
107587034	research						subadult	none
Pam	research						2_coy	2_yrlings
107561271	research							none
63614632	research							none
39838052	research							subadult
39842335	research							subadult
36336617	research							subadult
36582073	research							subadult
36547826	research							2_yrlings
37885843,84628512	other	subadult						
205	other	2_coy	2_yrlings	2_coy	2_yrlings			
67006850	other			none	none	lost_2_coy	2_coy	2_yrling
93638000	other					none	unknown	2_yrlings
107585006	other					subadult	subadult	subadult
64054290	other				subadult		subadult	2_coy, 1_coy dead

81600578	other						subadult	subadult
4077515970	other		2_cubs,dead					
107559301	other					none		
72113035	mgmt						2_coy	
107794628	mgmt							2_coy
34375517	mgmt	none						
51085276	mgmt	subadult						
51593054	mgmt	subadult						
37887572,81630006	mgmt	2_yrlngs	2_2yrolds	2_coy	2_yrlngs	2_2yrolds		none
84529806	mgmt	3_cubs_died	unknown	2_cubs	2_yrlings			
53323794	mgmt		2_yrlings				2_yrlings	
23518519	mgmt	3_2yrolds	2_coy					
51566878	mgmt	1_coy	unknown					
37605609	mgmt	1_2yrold	none					
38100864	mgmt	none	2_coy	2_yrlings	2_2yrolds_dispersed	2_coy	2_yrlings	2_2 yr olds
38047294,84524096	mgmt	2_coy						
84383870	mgmt	2_coy						
34270060	mgmt							
71552097	mgmt							
22	mgmt							
51561278	mgmt							
84626296	mgmt	orphaned						
84528778	mgmt	subadult						
41503d5a16	mgmt			1_yrling				
81542363	mgmt			subadult				
82018000	mgmt			none	unknown	none		
72121834	mgmt			none	1_coy	unknown	2_coy	2_yrlings
76313032	mgmt				subadult	subadult		2_coy
81567088	mgmt				3_yrlings	2_2yrolds		
93550102	mgmt				dependent	subadult	subadult	subadult
95621534	mgmt					subadult		
18079257	mgmt					none	2_coy	
18076565	mgmt						dependent	
81781376	mgmt					subadult		
23296344	mgmt	2_yrlings						
216	mgmt	none	none					
97773354	mgmt						1_yrling_dispersed	2_coy
107789555	mgmt						dependent	subadult
67041110	mgmt						none	
97794282	mgmt						2_yrlings	none
81279795	mgmt						subadult	
97771828	mgmt						dependent	subadult
84382811,76568302	mgmt						none	2_coy
36585060	mgmt							subadult
36547078	mgmt							2_coy
36336335	mgmt							subadult
81288378	mgmt							ukn
18103301	mgmt							
18108866	mgmt							2_coy
40001042	mgmt							subadult

34259287,34259592	mgmt	2_coy						
36577520	augmentation						none	
95636784	augmentation							subadult
84626290	augmentation		none					

Appendix E. Summary 21 known or probable grizzly bear mortalities in the NCDE; 2009.

Year	Month	Day	tag	Ageclass	Sex	Cause	Certainty
2009	4	30	81290367	subadult	M	Mistaken Id	Known
2009	5	6		subadult	M	Train	Known
2009	5	15		adult	F	Mistaken Id	Known
2009	7	3	76598090	adult	M	Train	Known
2009	7	13	81552264	adult	M	Probable-illegal	Known
2009	7	27	93585538	adult	F	Defense-of-life	Known
2009	8	17	53323794	adult	F	Mgmt Removal	Known
2009	8	17		yearling	M	Capture Related	Known
2009	8	17		yearling	F	Mgmt Removal	Known
2009	7	12	76316585	adult	M	Illegal	Known
2009	9	1	191	adult	M	Mgmt Removal	Known
2009	10	2	107576882	adult	F	Illegal	Known
2009	9	25	84523288	adult	F	Natural	Known
2009	10	12	36327521	adult	F	Defense-of-life	Known
2009	10			coy	unknown	orphaned	Known
2009	10			coy	unknown	orphaned	Known
2009	10			coy	unknown	orphaned	Known
2009[a]	10	12		adult	F	Illegal	Known
2009	10	1		yearling	M	Illegal	Known
2009	10	31	51259355	subadult	M	Mistaken Id	Known
2009	11	3	93639873	adult	F	Undetermined	Known

[a] Mortality >10 miles from federal recovery zone.

Appendix F. Summary of 23 known or probable grizzly bear mortalities in the NCDE; 2010.

Year	Month	Day	Avid #	Ageclass	Sex	Cause	Certainty
2010	4	19	81258126	subadult	M	Mgmt Removal	Known
2010	5	5		subadult	M	Automobile	Known
2010	6	6	36585060	subadult	F	Illegal	Known
2010[a]	6	8	36310519	adult	M	Mgmt Removal	Known
2010	6	10	107789555	subadult	F	Natural	Known
2010	6	21		coy	M	Automobile	Known
2010				ukn	Ukn	Undetermined	Known
2010[a]	7	13	36324093	subadult	M	Mgmt Removal	Known
2010	7	18	38025353	subadult	M	Augmentation	Known
2010	7	29		coy	M	Automobile	Known
2010	8	12	76313032	adult	F	Mgmt Removal	Known
2010	8	12	18103301	coy	F	Mgmt Removal	Known
2010	8	12	18107106	coy	M	Mgmt Removal	Known
2010	8	31		coy	M	Automobile	Known
2010	9	11	36564057	subadult	M	Mgmt Removal	Known
2010	9	11		subadult	M	Automobile	Known
2010	9	14	63604357	adult	F	Mgmt Removal	Known
2010	9	14		coy	M	Mgmt Removal	Known
2010	9	18	82023820	adult	M	Mgmt Removal	Known
2010	9	24	36569027	subadult	M	Mgmt Removal	Known
2010	9	27		subadult	M	Illegal	Known
2010	10	18		yearling	M	Natural	Known
2010	10	28	81280264	adult	F	Undetermined	Known

[a] Mortality >10 miles from federal recovery zone.

Appendix G. Summary of stable isotope information on grizzly bears in the NCDE.

Bear Id	Sex	Bear type	Collection date	Area	^{13}Carbon	^{15}Nitrogen
72098344	M	mgmt male	04/14/2006	BIR/2Med	-22.36	7.24
n/a	M	research male	04/30/2005	East Front	-22.14	7.09
n/a	M	mgmt male	04/22/1998	East Front	-21.85	7.14
84623066	F	research female	04/28/2005	East Front	-21.79	7.7
51072381	F	research female	04/28/2004	East Front	-21.48	7
n/a	ukn	ukn	04/26/2004	Swan/Missions	-22.94	5.3
81774014	M	research male	05/15/2006	BIR/2Med	-23.92	6.98
93585538	F	research female	05/21/2007	BIR/2Med	-22.9	5.56
72023614	F	research female	05/31/2005	BIR/2Med	-22.86	6.75
154	M	research male	05/15/2005	East Front	-23.3	3.97
n/a	M	mgmt male	05/27/1997	East Front	-22.84	5.19
51272543	M	research	05/12/2007	East Front	-22.27	5.74
97605011	F	research female	05/14/2008	East Front	-22.19	6.89
n/a	M	research male	05/04/2005	East Front	-22.03	7.97
76554835	M	research male	05/11/2006	East Front	-21.86	5.17
97628566	M	research male	05/14/2008	East Front	-21.62	8.55
76600112	M	research male	05/17/2006	East Front	-21.61	7.3
76600112	M	research male	05/31/2008	East Front	-21.61	7.51
81567088	F	mgmt female	05/31/2008	Eureka	-23.01	3.97
82024836	M	mgmt male	05/20/2007	Middle fork	-23.23	3.49
81603078	M	research male	05/19/2007	Middle fork	-22.55	5.24
93571631	F	research female	05/17/2008	Swan/Missions	-23.16	3.57
51368573	M	research male	06/04/2007	East Front	-22.43	6.62
site collection	unk	research	06/07/2007	East Front	-22.19	7.24
97631049	F	research female	06/05/2008	East Front	-21.75	7.16
n/a	M	mgmt male	06/12/2000	East Front	-21.43	8.44
51273314	M	mgmt male	06/05/2005	East Front	-20.23	7.93
93607865	M	research male	06/25/2008	Middle fork	-22.34	4.78
n/a	M	mgmt male	07/13/1996	East Front	-21.44	7.5
81610591	M	Augmentation male	07/10/2006	North Fork	-23.15	4.72
96808303	M	Augmentation male	07/13/2006	North Fork	-22.29	5.66
76305807	M	research male	08/16/2006	BIR/2Med	-23.62	1.59
n/a	F	mgmt female	08/15/1998	East Front	-22.33	6.5
n/a	F	mgmt female	08/15/1998	East Front	-22.24	6.1
n/a	F	mgmt female	08/21/1996	East Front	-21.86	9.52
53594886	M	research male	09/01/2006	BIR/2Med	-23.03	2.32
n/a	M	mgmt male	09/06/2005	East Front	-23.56	1.57
n/a	M	mgmt male	09/27/2000	East Front	-21.91	5.28
n/a	F	mgmt female	09/27/1998	East Front	-21.85	8.4
n/a	F	mgmt female	09/28/1998	East Front	-21.8	8.09
site collection	unk	research	09/08/2007	East Front	-21.68	7.46
n/a	M	mgmt male	09/14/1998	East Front	-21.67	7.89
site collection	unk	mgmt	09/13/2007	East Front	-21.56	6.61
81639835	F	mgmt young	09/24/2006	Flathead Valley	-23.23	2.92

82018000	F	mgmt female	09/12/2006	Flathead Valley	-22.92	4.82
84624383	F	research female	09/28/2007	Glacier Park	-23.03	5.74
79110541	F	research female	09/10/2007	Glacier Park	-22.71	3.43
67006850	F	research female	09/02/2007	North Fork	-23.99	2.46
81886333	F	research female	09/23/2006	South Fork	-22.68	3.51
n/a	F	mort	10/24/2007	East Front	-22.74	5.29
site collection	unk	mgmt	10/19/2007	East Front	-21.56	6.78
n/a	M	mgmt male	10/13/2001	East Front	-21.34	8.4
18098036	F	research female	10/01/2008	Swan/Missions	-22.39	5.85
none	ukn	mort	11/09/2004	North Fork	-23.39	2.66