NORTHERN CONTINENTAL DIVIDE ECOSYSTEM

GRIZZLY BEAR POPULATION MONITORING

ANNUAL REPORT – 2011

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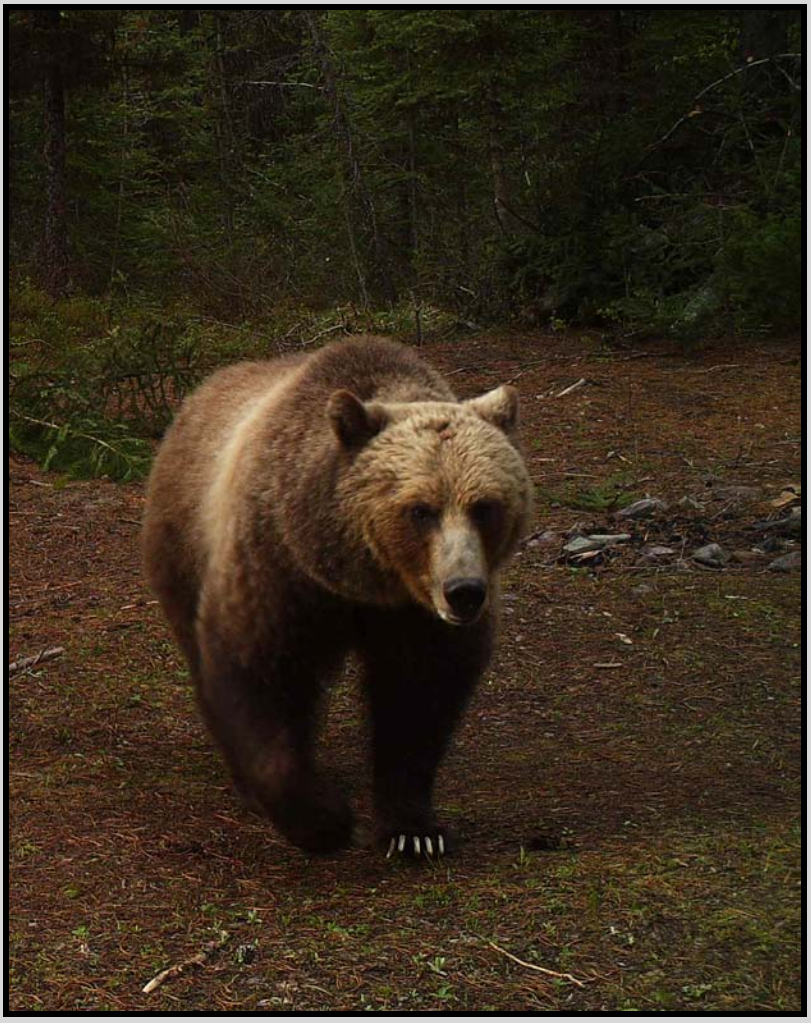

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This annual report summarizes data collection efforts to date. It is not a peer-reviewed document, and data summaries and interpretations are subject to change.

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Cover Photo by FWP: Adult Female Grizzly Bear North Fork of the Flathead

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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 115 female grizzly bears. In 2011, we captured 18 females and 9 males. Including the conflict males and females, we radio-monitored a total of 99 grizzly bears in 2011. 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 0.862. COY survival was estimated to be 0.579 while yearling survival was 0.725. Management subadult and adult female survival averaged 0.664 and 0.931 respectively. Using telemetry data from 2004 through 2011, we determined that all 23 BMU's were occupied by female grizzly bears. We document further expansion of grizzly bear occupancy beyond the federal recovery zone. To date, we have obtained BIA readings and actual weights on 96 grizzly bears in the NCDE at time of capture. Although samples sizes were low, mean % body fate estimates were generally >10% for both sexes each month. There were 31 known/probable mortalities of grizzly bears in the NCDE in 2011, 19 of which were within 10 miles of the NCDE recovery zone boundary. Population trend for the NCDE for the period 2004-2011 was calculated to be approximately 1.03.

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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 survival rates and reproductive rates for population trend. This will be accomplished by radio-monitoring female grizzly bears and their young.

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 unreported mortality.

III. GEOGRAPHIC SCOPE OF THE MONITORING PROGRAM

We monitored the population trend of grizzly bears in the NCDE of western Montana and into the Canadian provinces of British Columbia and Alberta (Fig. 1). Our primary emphasis was within the 23,136 km^2 federal recovery zone in the United States. We also captured and monitored bears up to 16 km north of the United States into Canada, which enlarged the study area to approximately 24,000 km^2. There were 2 national parks in the study area: Glacier National Park in Montana (4,081 km^2) and Waterton Lakes National Park (505 km^2) in Alberta, Canada. Portions of the Blackfeet Indian Reservation and the Confederated Salish and Kootenai Reservation occurred within our study area. Notable roadless regions outside the national parks included the Bob Marshall, Great Bear, Scapegoat, Rattlesnake, and Mission Mountain federal wilderness areas in the US. Non-wilderness areas of the NCDE were characterized by multiple-use lands under public, state, corporate, and tribal ownership. Approximately 17% of the NCDE is private land.

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

IV. METHODS

Survival, Reproduction, and Trend

The methods used to estimate grizzly bear vital rates and population trend are given in Mace et al. (2012). The general study design is further given in Mace (2005).

We estimated the daily and seasonal survival rates of COY and yearlings using the nest survival method of Dinsmore et al. (2002) in Program MARK (White and Burnham 1999). We estimated survival of independent subadult and adult females using the staggered-entry Kaplan-Meier method (Pollock et al. 1989) within Program MARK using the logit scale.

We determined the reproductive status of each adult female visually during aerial telemetry sessions. We conducted observation flights in early spring to ascertain which females had dependent offspring and the number of offspring per litter. We did not know with certainty the exact number of COY in each litter immediately upon their exit from winter dens. Therefore, some COY mortality may have occurred after den emergence and prior to our first observation, which would bias our estimates of litter size low (Schwartz et al. 2006*b*). To account for this, we used a correction factor to estimate litter size at the time of spring den emergence using our DSR_{COY} estimate, the number of COY observed, and the size of each litter (Schwartz et al. 2006*b*). We calculated a 54-day period between our earliest COY litter observation and the mean date of all COY observations. We first calculated the total number of COY (total COY) that could

have been alive at den emergence as: *n* COY observed/ DSR_{COY}[54]. We calculated the mortality-adjusted mean litter size as: total COY/ *n* litters.

We adopted the method of Schwartz and White (2008) to estimate the likelihood that a female ≥3 years old in a given reproductive state in one year would transition to a different state the following year. In a given year, a female may be in 1 of the following states: no young (N), with dependent COY (C), with dependent yearlings (Y), or with dependent 2-year-olds (T). Therefore, we examined 10 biologically possible transitions between states: N→N, N→C, C→N, C→Y, C→C, Y→T, Y→C, Y→N, T→N, and T→C.

Population trend was calculated for this annual report by inputting reproductive and survival rates into Microsoft Excel (Microsoft, Redmond Washington, USA) and the add-in PopTools (G. M. Hood, 2009; PopTools version 3.11).

Grizzly Bear Distribution in the NCDE

Grizzly bear data from males and females were used to assess the distribution of bears in and adjacent to the NCDE recovery zone from 1999-2011. 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 km (SE = 361.83, 95% CI= 9.38 – 10.81 km).

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.

Bear Home Ranges Relative to Glacier National Park

Wildlife managers are in the process of developing a Conservation Strategy for grizzly bears in the NCDE. This document would contain the standards for both habitat and population monitoring. One of the issues that will be addressed in the Strategy is future population management options. Population management options will vary by land designation. Of particular interest is the relationship of bears that live in Glacier National Park to areas outside of the Park. Managers are interested in determining the proportion of bears in the Glacier Park area that spend time outside of the park, in non-preserve habitats.

To address this issue, we scrutinized a sample of radio-instrumented female grizzly bears that live in and adjacent to Glacier National Park. For each individual and year, we determined the radius (km) of their home range. We then buffered the boundary of Glacier Park using that average. Each female was categorized as having a home range that was 1) 100% within Glacier Park, 2) 100% outside of the park but within the buffer, and 3) bears whose home range straddles the park boundary. For those females in category 3, we determined the percentage of telemetry points within and outside Glacier Park. The percentage was assumed to be closely correlated with the amount of time bears spend in and out of the park.

V. RESULTS

Trend Monitoring Captures 2004-2011

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 10 in 2007, to 24 in 2005 (Table 1). In 2011, the team captured 27 individuals of both sexes, 18 of which were females and 9 were males (Table 1).

Eleven new females were added to the total of trend captures, bringing the total to 115 individuals captured since 2004 (Table 2). A list of bears monitored in 2011 is given in Appendix A.

Management and Miscellaneous Grizzly Captures 2004-2011

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 2011, 13 females were captured 17 times (Table 3). Ten dependent COYs or yearlings were captured 20 times, all of which were management captures. Fifteen males were captured 20 times in 2011. A list of bears captured for management reasons in 2011 is given in Appendix B.

Table 1. The number of grizzly bear captures and recaptures in the NCDE for population trend monitoring, 2004-2011. 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
2011	Female	18	0	18
2011	Male	9	0	9
2011	Total	27	0	27

Table 2. 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	2011	
# New individuals	15	23	12	7	16	22	9	11	115

Table 3. 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, 2004-2011. 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
2011	13 (17)	10/20	15(20)	38

Number of Bears Radio-Monitored; 2004-2011

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. Annual sample sizes bears radio-monitored in the NCDE varied each year from 49 in 2004 to 109 in 2009 (Table 4). In 2011, we monitored 99 individuals for varying lengths of time; 41 of which were females for population trend. Twenty-five females were monitored for other reasons, primarily conflict management. In 2011, 33 males were also monitored (Table 4).

Table 4. Total radioed sample of grizzly bears in the NCDE, 2004-2011.

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
2011	33	25	41	99

Vital Rates of Grizzly Bears; 2004-2011

Survival Rates of Independent Male Grizzly Bears

We monitored the fate of male grizzly bears during the period 2004-2011 that were captured at both research (trend) and conflict sites. Annual survival for a sample of 51 research males averaged either 0.844 or 0.862 (Table 5). Most deaths of research males were classified as illegal (Table 6). Survival of management males averaged either 0.606 or 0.663 (Table 5), and most (57%) deaths were due to eventual management removal (Table 6).

Table 5. Survival rates of male grizzly bears in the NCDE; 2004-2011.

Combined age classes	Survival parameter			
Research males: *n* = 51 individuals	**Estimate**	**SE**	**-95% CI**	**+95% CI**
1 unresolved assumed alive	0.862	0.055	0.720	0.944
1 unresolved assumed dead	0.844	0.058	0.694	0.928
Management males *n* = 58 individuals				
3 unresolved assumed alive	0.663	0.073	0.510	0.789
3 unresolved assumed dead	0.606	0.074	0.457	0.740

Table 6. Cause of death for male research and management bears used in the calculation of male survival rates.

Cause of Death	Number of mortalities by bear type	
	Research	**Mgmt**
Management removal	1	8
Defense-life	0	1
Illegal	3	2
Vehicle	1	1
Train	0	1
Unknown	0	1

Survival Rates of Independent Female Grizzly Bears We followed the fate of 33 radioed sub adult females from 2004-2011 for population trend monitoring. We accumulated 321 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 0.893 (95% CI = 0.716 - 0.965) (Table 7). If this female did die, then the survival estimate was reduced to 0.859 (95% CI = 0.681 - 0.946).

We also followed the fate of 84 adult females over the course of 1813 months between 2004 and 2011. Eight of these adults died. No trend females died in 2011. Assuming this 1 bear with an unresolved fate survived, our estimate of annual survival for adults females was 0.948 (95% CI = 0.899 - 0.973) (Table 7). When we assumed this bear died, the survival estimate was 0.941 (95% CI = 0.892 - 0.970).

We also estimated the combined survival rates for subadults and adults. When it is assumed that the 1 unresolved females did not die, our estimate of survival was 0.940 (95% CI = 0.895 - 0.966). If it did die, then survival decreased to 0.934 (95% CI = 0.888 - 0.962) (Table 7). We could not determine the cause of 4 of 7 trend female deaths (Table 8).

Management female survival was generally lower than for trend females (Table 7). Most deaths of management females were due to management removal (Table 8).

Table 7. Survival rates of female grizzly bears in the NCDE, 2004-2011.

Female type and age class	Survival parameter			
	Estimate	SE	-95% CI	+95% CI
Trend:				
Subadult: *n* = 33 individuals				
1 unresolved assumed alive	0.893	0.058	0.716	0.965
1 unresolved assumed dead	0.859	0.065	0.681	0.946
Adult: n = 84 individuals	0.948	0.018	0.900	0.974
Combined Age classes: *n* = 103 individuals				
1 unresolved assumed alive	0.940	0.018	0.895	0.966
1 unresolved assumed dead	0.934	0.018	0.888	0.962
Management:				
Subadult: *n* = 27 individuals				
4 Unresolved assumed alive	0.664	0.103	0.445	0.830
4 Unresolved assumed dead	0.522	0.102	0.329	0.709
Adult: *n* = 30 individuals				
2 Unresolved assumed alive	0.931	0.039	0.806	0.977
2 Unresolved assumed dead	0.887	0.047	0.756	0.952

Table 8. Cause of death for female trend and management bears used in the calculation of female survival rates.

Cause of death	Number of mortalities by bear type	
	Trend	Management
Management removal	1	4
Defense-of-life	2	0
Illegal	2	2
Vehicle	0	0
Train	0	1
Natural	2	1
unknown	4	1

Survival Rates of COY and Yearling Grizzly Bears Survival of dependent young was calculated using the nest survival routine in Program MARK (White and Burnham 1999) following the methods of Dinsmore et al. (2002). To accomplish this, one has to ascertain the first and last dates that COYs and yearlings of each litter were observed. From these dates, 3 survival periods are determined; that of COYs, the denning period, and the period when young were

yearlings. From Mace et al. (2012) these 3 periods were 188, 161, and 213 days in length. Using 2 additional years of data (2010 and 2011), the length of the COY period changed to 211 days, that of the denning period to 154 days, and that of yearlings to 212 days (Table 9). The length of these periods changed because of earlier spring observations of COY and yearling litters.

The daily and period survival rate for COYs and yearlings changed somewhat with the addition of 2 years of data (Table 10). We followed the fate of 73 COYs and 48 yearlings. We documented the death of 18 COYs and 8 yearlings during the period 2004-2011. Seven of the dead COYs were born to 4 mothers who died. Six yearlings were assumed to have lived following the death of their mother.

The survival rate for COYs was estimated to be 0.579 (95% CI = 0.429-0.703) (Table 10). The survival rate for yearlings was estimated to be 0.726 (95% CI = 0.510-0.858) (Table 10).

Table 9. Calendar of events for trend female COY and yearling nest survival analyses; 2004-2011.

	COY		DEN		YRLING	
	Start day	**Stop day**	**Start day**	**Stop day**	**Start day**	**Stop day**
Julian Day	109	320	321	108	109	320
Date	19-Apr	16-Nov	17-Nov	18-Apr	19-Apr	16-Nov
Cumulative Days	1	211	212	365	366	577
Period Length	211 days		154 days		211 days	

Table 10. Daily survival rate estimates and survival rates during the active period for grizzly bear dependent COY of year (COY) and yearlings in the Northern Continental Divide Ecosystem.

	Daily survival rate (DSR)						Active period survival rate			
Age	*n*	Estimate	SE	−95% CI	+95% CI		Estimate	SE	−95% CI	+95% CI
COY										
2004-2009[a]	60	0.99739	0.00093	0.99363	0.99893		0.61193	0.10765	0.3007	0.8182
2004-2011	73	0.99750	0.00058	0.99604	0.99843		0.57929	0.00059	0.42861	0.70348
Yearling										
2004-2009[a]	34	0.99820	0.00090	0.99365	0.99949		0.68199	0.13222	0.25769	0.8977
2004-2011	48	0.99849	0.00057	0.99683	0.99928		0.72565	0.00059	0.510240	0.85833

[a] From Mace et al. (2012).

Grizzly Bear Reproduction

We followed the reproductive performance of 34 adult female grizzly bears in 2011. Fifteen (44.1%) of these adults did not have dependent young. A minimum of 26 dependent young were observed within family groups (Table 11). The reproductive history of each adult female is given in Appendix D.

Table 11. The number of attendant young of trend females, 2011.

Year	Number adult females	Number of young	N litters	Total young
2011	34	No young 1 cub 2 cubs 3 cubs 1 yearling 2 yearlings 3 yearlings 1 2-yr-olds 2 2-yr-olds Unknown	15 1 3 1 5 2 1 0 2 2	Minimum of 26

Litter Size and Reproductive Rate Since 2004, we have documented the litter sizes of trend females. We have observed 54 COY litters (*n* = 106 individuals) and 18 yearling litters (*n* = 34 individuals) (Table 12). Mean COY litter size at time of first observation was 1.96 COY/litter. Yearling litters averaged 1.89 yearlings/litter.

We were able to adjust the litter size for mortality of COY's prior to the first visual observation. The mean day of COY litter observations was Julian date 163 (12 June), and the earliest date was day 109 (19 April). Therefore there was as 54 day difference between these 2 dates where COY mortality could have occurred. The COY survival rate for this 54 day period was calculated as: $0.99750^{54} = 0.874$. The adjusted number of individual COY was then calculated as: (106 COY/0.874) = 121 COY. The adjusted COY litter size was then calculated as: 121/54 (litters) = 2.241 (COY/litter/year for both sexes of COY or 1.121 for female cubs.

Reproductive transition probabilities for 2004-2011 are given in Table 12. From our reproductive transitions, we estimate the probability of a COY litter in the female population was 0.278 (Table 13). This probability multiplied times the adjusted COY litter size of 1.121 gives and estimated reproductive rate of 0.3115.

Table 12. Reproductive state transition probabilities for females (≥ 3 years old) in the NCDE; 2004-2011.

Current reproductive state[a]	Sample sizes (%) for transitions from current state to next years' reproductive state							
	N[a]		C		Y		T	
	Mace et al. 2012	Updated	Mace et al. 2012	Updated	Mace et al. 2012	Updated	Mace et al. 2012	Updated
N	26 (27.4)	42(31.1)	24 (25.3)	30 (22.2)	0[b]	0	0	0
C	2 (1.5)	2 (1.4)	3 (3.2)	3 (2.2)	23 (24.2)	39 (28.9)	0	0
Y	4 (4.2)	5 (3.7)	3 (3.2)	2 (1.5)	0	0	6 (6.3)	8 (5.9)
T	1 (1.1)	2 (1.5)	4 (4.2)	2 (1.5)	0	0	0	0

[a] N = lone female, C = female with a cub of year (COY) litter, Y = female with a yearling litter, and T = female with a 2-year-old litter.
[b] A transition that was not biologically possible.

Table 13. Stable state probabilities that the female grizzly bear population (≥ 3 years old) was composed of no young, COY litters, yearling litters, or two-year-old litters. Northern Continental Divide Ecosystem, 2004-2011.

	Reproductive state parameter estimate				
Reproductive state	None	COY	Yrling	2-yr-old	Dep. young
Estimate	0.371	0.278	0.234	0.117	0.512
S.E.	0.073	0.031	0.026	0.041	0.051
-95% CI	0.227	0.218	0.184	0.036	0.412
+ 95% CI	0.515	0.338	0.285	0.198	0.612

Population Trend

Two estimates of population trend for the NCDE for the period 2004-2011 were made, and depended on whether 1 bear whose fate was unresolved died or not. If this bear did not die, the point estimate for lambda was 1.0336 (Table 14). If the bear did in fact die, the point estimate for lambda was 1.0288).

Table 14. Point estimate of population trend in the NCDE from 2004-2011.

Vital Rate	*Point Estimate*	
Independent female survival	*0.940*[a]	*0.934*[b]
COY survival	*0.579*	*0.579*
Yearling survival	*0.726*	*0.726*
Reproductive rate	*0.3115*	*0.3115*
Trend (lambda)	1.0336	1.0288

[a] *assumes 1 bear with unresolved fate lived*
[b] *assumes 1 bear with unresolved fate died*

Grizzly Bear Distribution

Bear Occupancy by Management Unit 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 and surrounding areas. Telemetry locations of research and management bears were superimposed on a 10km^2 in relation to BMU boundaries. Using telemetry data from 2004 through 2011, we determined that all 23 BMU's were occupied by female grizzly bears (Fig. 2).

Bear Distribution Outside the NCDE Between 1989 and 2011, grizzly bears were documented outside of the NCDE recovery zone boundary in all cardinal directions (Fig. 3). We obtained grizzly bear distribution information for 283 cells

(28,300 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 60 (6,000 km^2) and 65 (6,500 km^2) respectively. We documented both males and females in 119 cells (11,900 km^2). Females that were moved from the NCDE to the CYE for population augmentation constituted 29 unique cells (2,900 km^2). Cells occupied by both males and females constituted 99 cells (9,900 km^2). Thirty-three cells occupied by unknown sexes of bears. In general, male grizzly bears were observed further from the NCDE boundary than females.

In 2011, several observations were made that helped understand the expanded distribution of grizzly bears. Observation #1 was a grizzly bear photographed in the Browns Meadow area south and west of Kalispell (Fig. 4). The 2rd observation (Fig. 5) was of a grizzly bear photographed between 4 Corners and Lockhart Meadow.

Fig. 2. Distribution of female telemetry data by Bear Management Units; 2004-2011. Research and management female telemetry points (shaded grid cells) placed on a 10 km^2 grid.

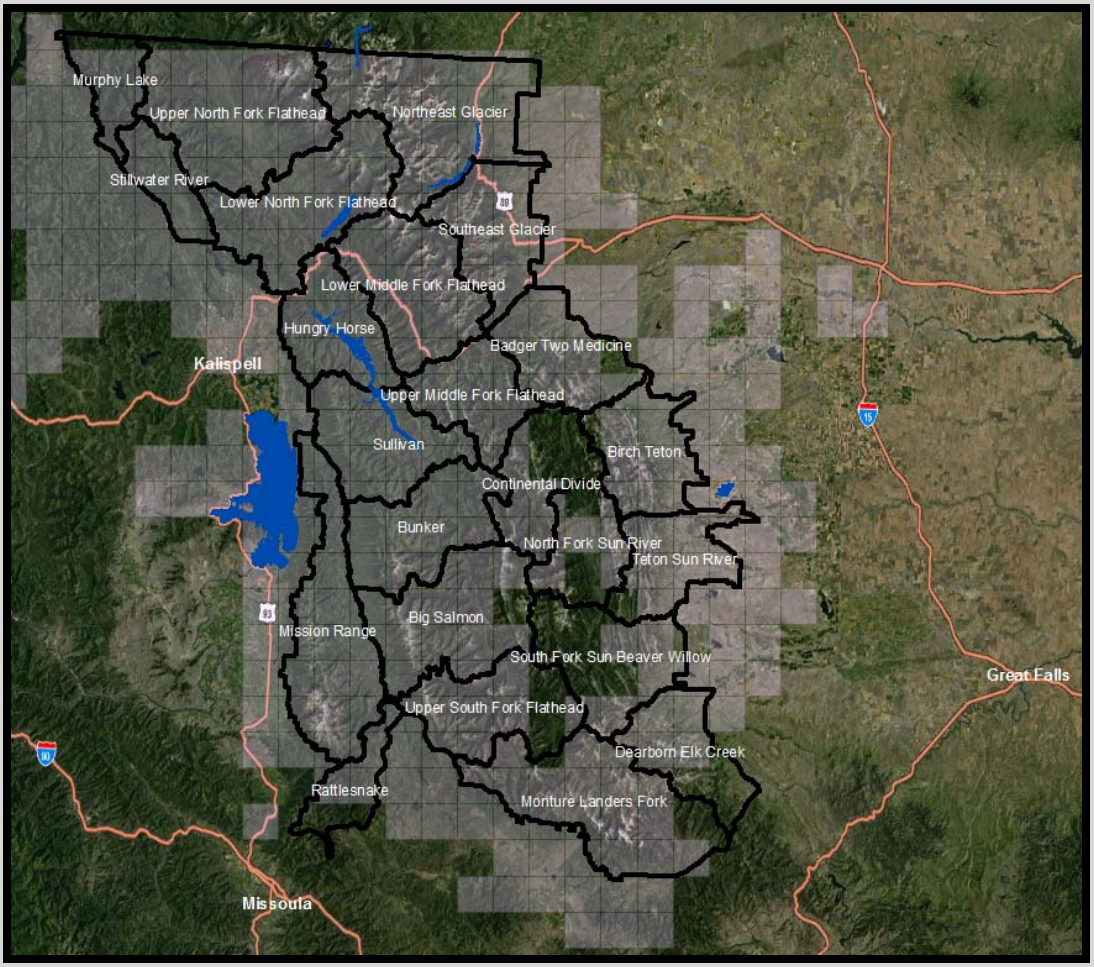


Fig. 3. Distribution of grizzly bears adjacent to the NCDE federal recovery zone (1989-2011) based on telemetry data, mortality data, and DNA detections in 2004 (from Kendall et al. 2009). Occupancy was based on presence within 10 km^2 grid cells.

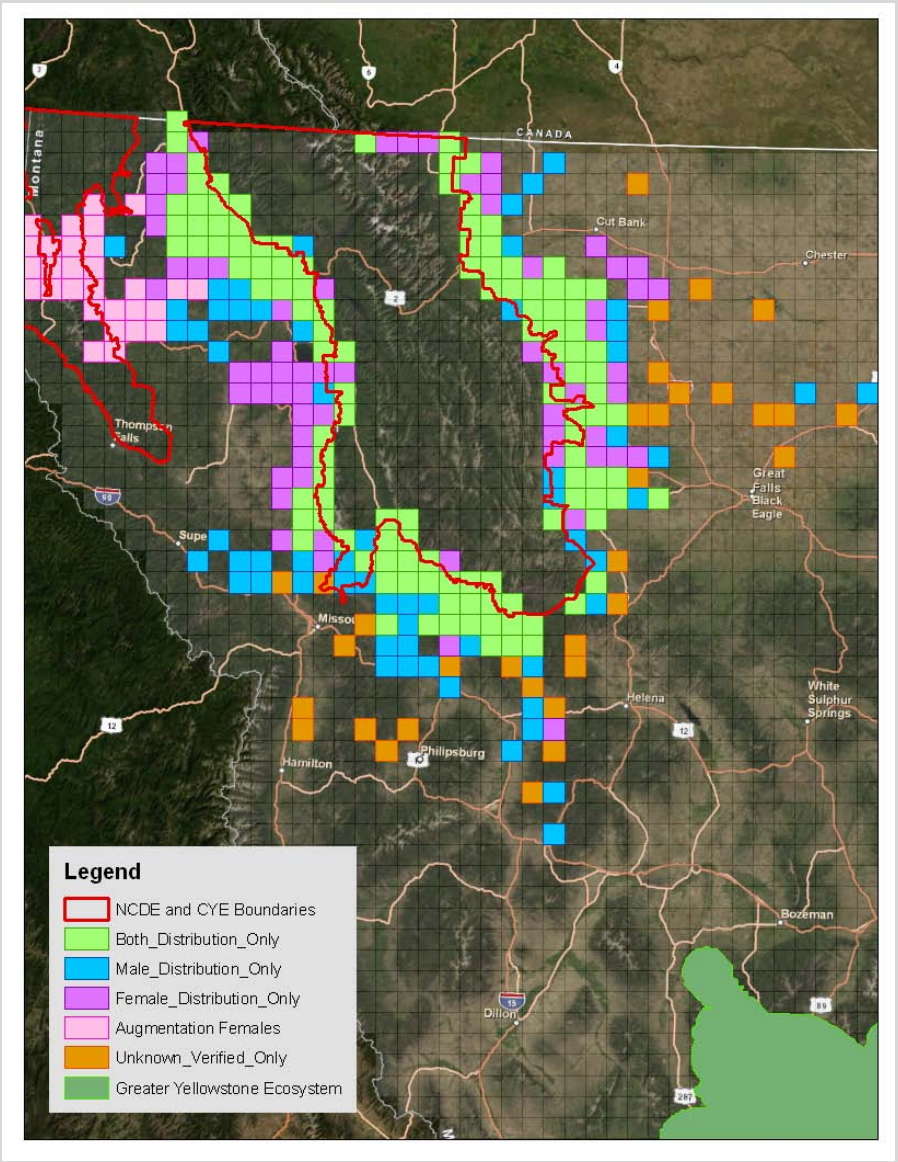


Fig. 4. Grizzly bear photographed in the Browns Meadow area in 2011.

Fig. 5. Photograph of grizzly bear through a scope north of the Elk Park/Bernice area.

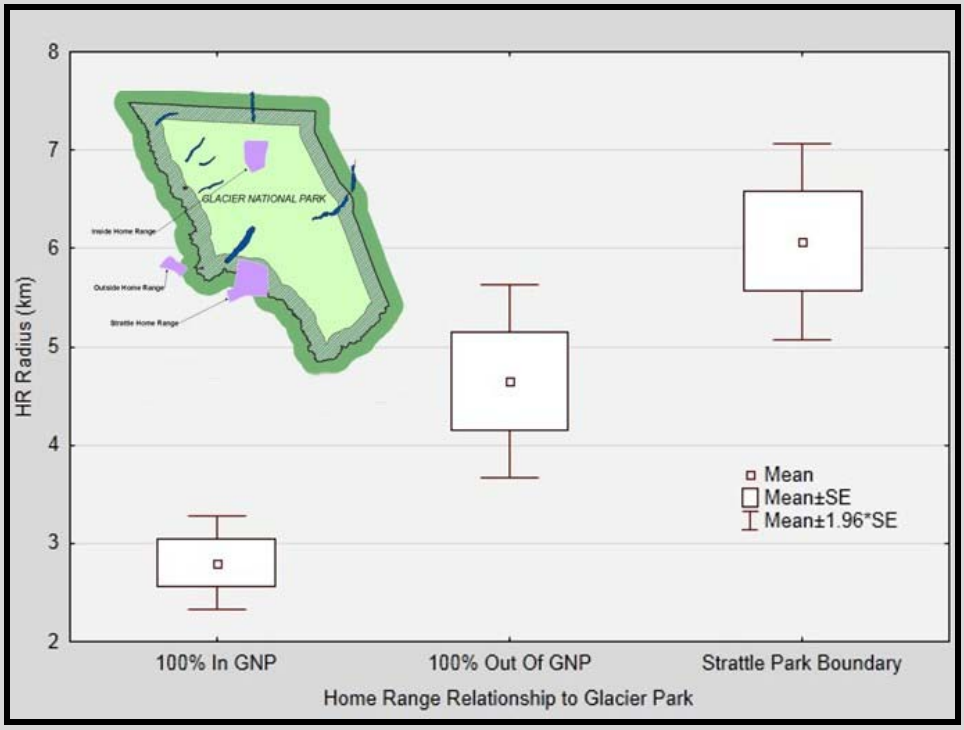
Bear Home Ranges Relative to Glacier National Park

We evaluated 76 home ranges of 34 females that lived in or adjacent to Glacier Park. Home ranges were developed for the period 2004-2011, and individual females had between 1 and 6 annual home ranges within the sample. Most home ranges (59%) straddled the Park boundary. Home ranges were, on average, smallest for bear that lived 100% within the Park, and largest (mean = 6.07 km) for females that straddled the Park (Table 15, Fig. 6). For the pooled sample, the average radius was approximately 5 km. For these bears that straddled the Park, an average of 57.02% of their locations were within the Park (Table 15), while 43.98% were outside the Park.

Table 15. Home range relationship of grizzly bears relative to Glacier National Park.

Home Range Relationship Relative to Glacier Park	Radius of Home Range (km)				
	Mean	**-95% CI**	**+95% CI**	***n***	**SE**
100% in GNP	2.799	2.289	3.308	21	0.244
100% out of GNP	4.645	3.515	5.775	10	0.499
Straddle Park boundary	6.070	5.044	7.096	45	0.509
All Groups	4.979	4.273	5.684	76	0.354
% of Locations within GNP	57.02	46.38	67.66		5.26

Fig. 6. Home range radius size (km) for grizzly bears residing in and adjacent to Glacier National Park.



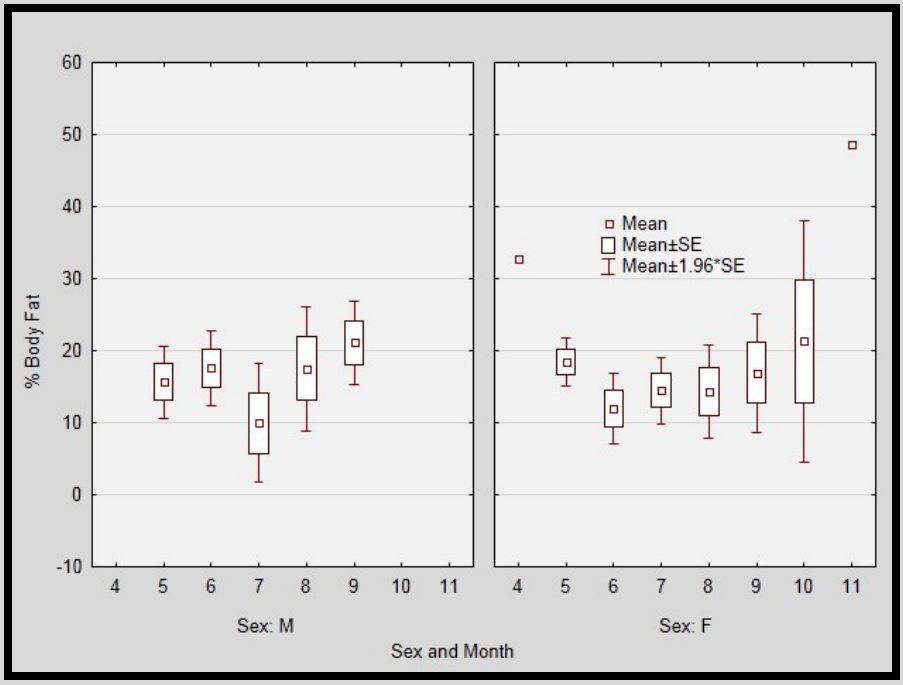
Body Condition Index Values

In 2010 and 2011, we obtained BIA readings and actual weights on 96 (54 f, 42 m) grizzly bears in the NCDE at time of capture. Sample size was greatest for management females (*n* = 30), and smallest for research males (*n* = 15) (Table 16). Although samples sizes are low for each month and sex, mean % body fate estimates were >10% for both sexes throughout the active season (Fig. 7).

Table 16. Summary of monthly sample sizes of BIA readings for grizzly bears in the NCDE during 2010 and 2011.

Sex	Month	Area								
		East Front/ BIR	Swan Valley/ FIR	Flathead Valley	South End	Glacier Park	Middle Fork	North Fork	South Fork	Total
Male	Apr	0	0	0	0	0	0	0	0	0
	May	2	0	2	2	0	2	0	0	8
	June	4	1	2	1	1	0	1	0	10
	July	0	1	2	1	3	0	2	0	9
	Aug	0	2	1	0	0	0	2	0	5
	Sept	0	2	2	0	2	2	2	0	10
	Oct	0	0	0	0	0	0	0	0	0
	Nov	0	0	0	0	0	0	0	0	0
Female	Apr	1	0	0	0	0	0	0	0	1
	May	1	1	1	1	0	3	2	0	9
	June	5	0	1	1	0	3	4	1	15
	July	0	1	0	0	1	3	3	0	8
	Aug	0	4	0	0	1	0	2	0	7
	Sept	0	4	2	0	0	2	0	0	8
	Oct	0	0	1	0	0	0	4	0	5
	Nov	0	0	0	0	0	0	1	0	1
Total		13	16	14	6	8	15	23	1	96

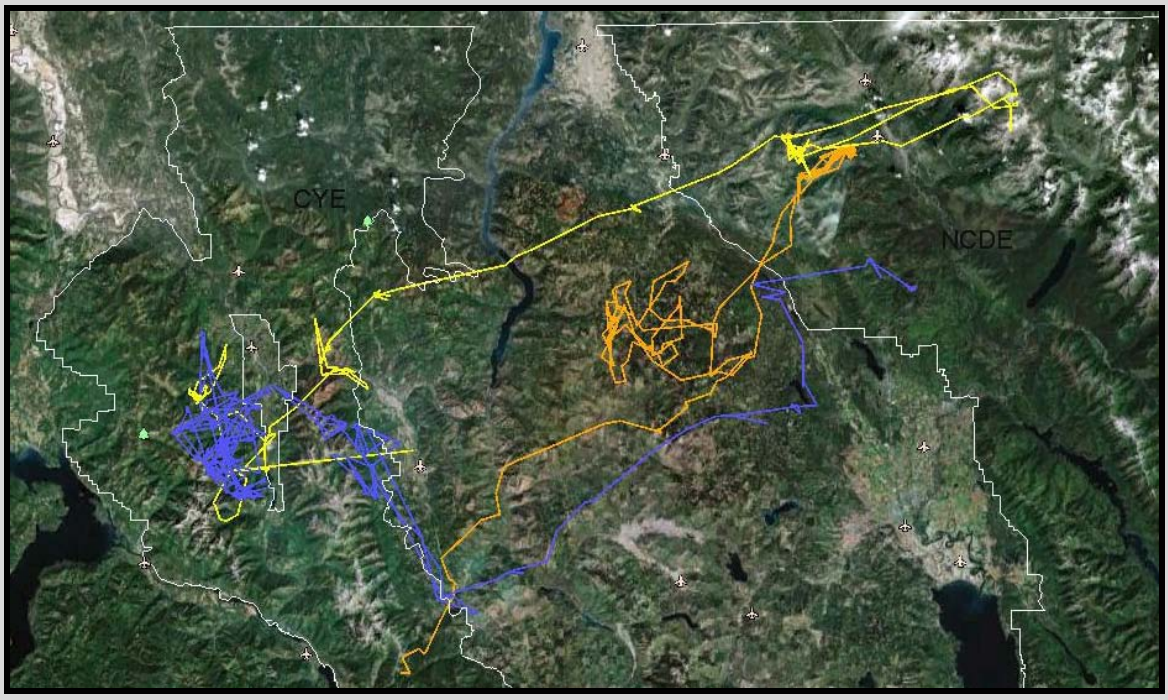
Fig. 7. Monthy % body fat readings for male and female grizzly bears In the NCDE; 2010-2011.



Movements of Augmentation Females

Since 2009, 5 grizzly bears (2 males, 3 females) were moved from the NCDE to the CYE for population augmentation. Males #038025353, and #0107562870 were moved in 2010 and 2011 respectively. Both of these males have remained in the CYE. All 3 females returned to the NCDE following augmentation (Fig. 8).

Fig. 8. Movements of 3 females subsequent to augmentation attempts from the NCDE to the CYE. The blue line is for female # 036577520 in 2009-2010. The orange line is for female #095636784 in 2010, and the yellow line is for female # 36554875 in 2011.



Grizzly Bear Mortalities in the NCDE, 2011

In 2011 we tallied 31 grizzly bear known or probable mortalities in the NCDE (Table 17) (Fig. 10). 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 2011.

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 17. Grizzly bear known and probable mortalities in the NCDE, 2011. One natural mortality was omitted.

Sex	Age class	Cause of Mortality								Total
		Mgmt removal	Mistaken Id	Train collision	Defense-Life	Orphaned	Illegal	Aug-mentaion	Vehicle	
F	subad	0	0	0	0	0	1	0	0	1
	coy	3	0	0	0	0	0	0	0	3
	adult	2	0	0	4	0	1	0	0	7
M	coy	1	0	0	2	1	0	0	0	4
	adult	3	1	1	1	0	0	0	0	6
	subad	3	0	1	1	0	2	1	1	9
Ukn	subad	0	0	1	0	0	0	0	0	1
Total		12	1	3	8	1	4	1	1	31
% Total		38.7	3.2	9.6	35.8	3.2	12.9	3.2	3.2	

Fig. 10. Locations of grizzly bear mortalities within and near NCDE during 2011. Duplicate mortalities at the same location are shown next to the coordinate. The federal Recovery Zone boundary is depicted in white.

Trends in Grizzly Bear Mortalities Outside Glacier National Park; 1999-2011

Most known grizzly bear mortalities come from areas out NCDE outside of Glacier National Park. Few recorded man-caused mortalities have occurred within the Park, and natural mortalities are not often found. It is of importance for population management to understand the levels and causes of mortalities outside of the Park. We are most interested in the proportion of independent-aged bears in the population that die each year. To estimate this proportion, we estimated the number of independent males and females annually in the population outside of the Park, given a population growth of 1.03 (Mace et al. 2012). We estimated, for example, that there were 241 independent females in 2011 (Table 18), of which 18 (7.47%) individuals died. Percent mortality of independent females averaged 5.3% since 1999. This proportion is very close to the 6% mortality rate obtained from radioed trend females.

For independent males, we estimated, for example, that there were 130 individuals outside of the Park 2011 (Table 19), of which 23 (17.7%) individuals died. Percent mortality of independent males averaged 12.7% since 1999. This proportion is very close to the 14% mortality rate obtained from radioed males.

Table 18. Independent female mortality records for that portion of the NCDE recovery zone outside of Glacier Park.

Year	# Independent Females outside of GNP[ab]	Mgmt removals	Public discovery	Unreported estimate	Telemetry discovery	Total	% Mortality[c]
1999	170	0	4	5	0	9	5.31
2000	174	2	6	8	1	17	9.74
2001	179	2	5	7	0	14	7.81
2002	185	1	4	5	0	10	5.41
2003	190	1	1	1	0	3	1.58
2004	196	3	3	4	4	14	7.13
2005	202	5	1	1	1	8	3.96
2006	208	1	0	1	2	4	1.92
2007	214	0	6	8	1	15	7.01
2008	221	3	2	2	0	7	3.17
2009	228	0	5	7	2	14	6.14
2010	234	2	0	1	2	5	2.13
2011	241	2	7	9	0	18	7.47
Mean		1.77	3.38	4.54	1.08	10.77	5.3%

[a] Estimated number of females derived from Kendall et al.'s (2009) estimate in 2004.

Population projections each year given a lambda of 1.03 (Mace et al. 2012).

Independent females are assumed to be 58.9 % of total using stable state probabilities from program RISKMAN.

[b] Proportion of males outside GNP estimated to be 61% (Mace et al. 2012).

[C] Total mortality/population size.

Table 19. Independent male mortality records for that portion of NCDE recovery zone outside of Glacier Park.

Year	*Independent male pop outside of GNP[ab]*	*Mgmt removals*	*Public discovery*	*Unreported estimate*	*Telemetry discovery*	*Total mortality*	*% Mortality[c]*
1999	*91*	*5*	*2*	*2*	*2*	*11*	*12.1*
2000	*94*	*3*	*1*	*1*	*0*	*5*	*5.3*
2001	*97*	*5*	*5*	*7*	*2*	*19*	*19.6*
2002	*100*	*3*	*4*	*5*	*0*	*12*	*12.0*
2003	*103*	*3*	*1*	*1*	*0*	*5*	*4.9*
2004	*106*	*1*	*6*	*8*	*0*	*15*	*14.2*
2005	*109*	*2*	*8*	*11*	*1*	*22*	*20.2*
2006	*112*	*2*	*1*	*1*	*1*	*5*	*4.5*
2007	*115*	*2*	*10*	*14*	*0*	*26*	*22.6*
2008	*119*	*1*	*4*	*5*	*0*	*10*	*8.4*
2009	*123*	*1*	*6*	*8*	*0*	*15*	*12.2*
2010	*126*	*7*	*3*	*4*	*0*	*14*	*11.1*
2011	*130*	*7*	*6*	*9*	*1*	*23*	*17.7*
Mean		*3.2*	*2.3*	*4.0*	*5.4*	*14*	*12.7%*

[a] Estimated number of males derived from Kendall et al.'s (2009) estimate of 294 total males in 2004.

Population grew at at a lambda of 1.03 (Mace et al. 2012).

Independent males are assumed to be 58% of total using stable state probabilities from program RISKMAN.

[b] Proportion of males outside GNP estimated to be 61% (Mace et al. 2012).

[C] Total mortality/population size.

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Appendix A. Fate of trend monitoring females in the NCDE; 2011.

Bear Id	Fate
238	alive
76553865	alive
79050043	alive
263	alive
81602889	alive
39851084	alive
97630806	alive
81289085	alive
36335046	alive
64054290	alive
107587034	alive
Pam	alive
107561271	alive
81600578	alive
36582073	alive
36547826	alive
39893282	alive
97632856	alive
55601314	alive
36311260	alive
81278277	alive
36553583	alive
97636103	alive
28288097	alive
107565854	alive
93612012	alive
76361015	censor
107568286	censor
107794628	censor
107556786	censor
97609806	censor
107585006	censor
81279315	censor
63614632	censor
39838052	censor
39842335	censor
81289074	censor
36548287	censor
39851057	censor
28519310	non-radioed death
72023614	non-radioed_death

Appendix B. Fate of management females in the NCDE; 2011.

Bear Id	Fate
93638000	alive
81279261	alive
55586851	alive
93550102	alive
97794282	alive
97771828	alive
36336335	alive
95636784	alive
81288378	alive
18095786	alive
36558355	alive
40001042	alive
39841558	alive
39886018	alive
55583567	alive
55596108	alive
18112314	alive
14592298	alive
55580075	alive
55598849	alive
55574892	alive
36554875	alive
55577095	alive
39890026	alive
637	alive
176568302	censor
18108866	censor
81630006	dead
55584532	non-radioed_death
55584337	non-radioed_death
55590775	non-radioed_death

Appendix C. Fate of male grizzly bears in the NCDE; 2011.

Bear Id	Bear type	Fate 2011
81552593	mgmt male	non-radioed_death
39847528_254	mgmt male	alive
97605021	mgmt male	alive
81264536	mgmt male	alive
97772298	mgmt male	alive
36555039	mgmt male	alive
36558090	mgmt male	alive
55599290	mgmt male	alive
181245600	mgmt male	alive
55589362	mgmt male	alive
81290853	mgmt male	alive
81279597	mgmt male	alive
97768563	mgmt male	alive
39893281	mgmt male	censor
55585291	mgmt male	censor
36313532	mgmt male	dead
18120261	mgmt male	dead
55576035	mgmt male	dead
7604261	mgmt male	non-radioed_death
63812800	mgmt male	non-radioed_death
18119561	mgmt male	non-radioed_death
76590799	mgmt male	unresolved
18087605	mgmt young	alive
55579327	mgmt young	alive
55593380	mgmt young	alive
81623770	mgmt_research male	censor
107553631	research male	censor
36567786	research male	censor
36551608	research male	unresolved
84525524	research male	alive
93580317	research male	alive
39694580	research male	alive
39847528	research male	alive
55586863	research male	alive
97628566	research male	censor
39847013	research male	censor
40001275	research male	censor
39885302	research male	censor
51573784	research male	non-radioed_death
107562870	research male	non-radioed_death
76326263	research male	possible collar fail
28346107	research male	unresolved

Appendix D. Reproductive history of trend monitoring females and management females in the NCDE; 2011.

Bear	Annual Reproduction							
	2004	2005	2006	2007	2008	2009	2010	2011
84529290	none	cubs						
48366019	1_coy	1_yrling						
37885843,84628512	subad							
84528858	unknown	none						
84525082	none	none						
51072381	subad					2_coy	2_yrlings	
84623110	none	3_coy						
84625525	none	none	none	unknown				
238	none	none	1_coy			none	none	none
233	3_coy	none	none	unknown				
132353547	2_2yr_olds	unknown						
132335546	subad				2_coy	2_yrlings		
76553865		subad	none	2_coy	2_yrlngs			ukn
205	2_coy	2_yrlings	2_coy	2_yrlings				
51071845		subad	none	none				
51605816		2_yrlings	none					
84623066		none	2_coy	2_coy				
51586884		1_yrling	unknown	unknown				
67006850	subad	subad	subad	none	lost_2_coy	2_coy	lost 2_yrlings	
71814874, 81279261		none	none	unknown	1_cub	1_yrling	ukn	
72023614		none	2_coy					
71816812		none						
72113035			subad	none	1_coy_lost	2_coy		
79050043		none	none	none	none	2_coy	2_yrlings	
84524018		none	none	3_coy	unknown	1_yrling		
76361015		none	2_coy	2_yrlings			1_coy	ukn
76560093		none						
51561597		none	unknown	unknown	unknown			
84523288		2_coy	2_yrlings	2_2yrolds	3_coy	3_yrlings		
84624383			subad	subad				
76615038		none	none	2_coy	unknown			
23813296		1_yrling						
79110541			none	1_cub	1_yrling			
81577636			2_yrlings, mgmt removal	2_coy				

71868109			2_yrlings	2_2yrolds	2_coy			
76584107			3_coy	3_yrlings				
76589366			subad					
263			subad	none	2_coy		1_coy	1_yrling
76613125			none	2_coy_1died	1_yrling_ dead	unknown		
82024327			unknown					
76600783			1_coy	1_yrling_dead	none			
81886333			subad	subad	none	none		
81602889			2_coy	2_yrlingsdead	unknown		3_coy	3_yrlings
81603277			subad	subad	subad			
93585538				subad	none	1_coy		
76570875				none	none	2_coy	2_yrlings	
51597096,398 51084				subad			none	2_coy
81605772				none	unknown			
51571800,640 28820				2_yrlings	unknown	unknown		
93619344				none	unknown	2_coy		
93639873				2_coy	2_yrlings_1 dead	dispersed 1_ 2yr old		
97616524					none	2_coy		
93571631					subad	subad		
97630806					none	2_coy		none
97559276					subad			
97605011					subad			
97637608,398 51057					3_yrlings_1d ead_2disper sed	3_coy	3_yrlings	
97631049					subad			
63834064					none	unknown		
81289085					none	2_coy	2_yrlings	unknown
93586336					subad	subad		
107581802					subad			
107568286						subad	1_coy	1_yrling
63604357						adult	2_coy, 1 died,vehicle, 1 to zoo	
107794628						subad	2_coy	2_yrlings
81280264						none	lost 1_coy	
36547575						subad	none	
107556786						2_yrlings	2_2yrolds	none
36568375						1_3 yr old	none	
36549051						subad	subad	
36548287						2_coy	2_yrlings	none
36335046						unknown	3_coy	none

36327521						3_cubs		
28519310						unknown_lact ating		
97609806						2_coy	1_yrling	none?
107585006					subad	subad	subad	none
81290065						subad	subad	
81280888						subad	2_coy	
64054290						none	2_coy, 1_coy dead	1_yrling_ dispersed
81279315						subad	subad	unknown
107576882						3_yrlings		
107587034						subad	none	none
Pam						2_coy	2_yrlings	none
107561271							none	none
81600578						subad	subad	none
63614632							none	2_coy_dead
39838052							subad	subad
39842335							subad	subad
36336617							subad	subad
36582073							subad	none
36547826							2_yrlings	2_2yr olds
39893282								none
97632856								none
55601314								subad
36311260								subad
81289074								subad
81278277								1_yrling
36553583								2_coy
97636103								none
28288097								3_coy_1dead
107565854								subad
93612012								2_yrlings

Appendix E. Summary of 32 known or probable grizzly bear mortalities in the NCDE during 2011. All mortalities were within 10 miles of the federal recovery zone.

Date	Avid #	Ageclass	Sex	Cause
5/9/11	72023614	adult	F	Illegal
5/10/11	none	subadult	M	Illegal
5/12/11	81552593	adult	M	Train
5/14/11	none	subadult	M	Defense-of-life
5/15/11	none	adult	F	Defense-of-life
5/15/11	none	coy	M	Defense-of-life
5/15/11	none	coy	M	Defense-of-life
5/21/11	28579260	adult	M	Mistaken Id
5/23/11	none	subadult	F	Illegal
6/1/11	none	adult	F	Natural
6/16/11	18120261	subadult	M	Mgmt Removal
6/24/11	none	coy	M	orphaned
6/29/11	18124600	subadult	M	Illegal
7/8/11	81562048,37604261	adult	M	Mgmt Removal
8/19/11	1078562870	subadult	M	Augmentation
9/3/11	36313532	subadult	M	Mgmt Removal
9/14/11	55576035	subadult	M	Mgmt Removal
9/19/11	51573784	adult	M	Mgmt Removal
9/27/11	18119561	adult	M	Mgmt Removal
10/7/11	none	adult	F	Defense-of-life
10/11/11	none	adult	M	Defense-of-life
10/13/11	none	subadult	Ukn	Train
10/13/11	none	subadult	M	Train
10/15/11	none	subadult	M	vehicle
10/22/11	none	adult	F	Defense-of-life
11/9/11	28519310	adult	F	Defense-of-life
11/16/11	55584532	adult	F	Mgmt Removal
11/17/11	55584337	coy	F	Mgmt Removal
11/17/11	55590775	coy	F	Mgmt Removal
11/21/11	37887572,81630006	adult	F	Mgmt Removal
11/21/11	55574892	coy	F	Mgmt Removal
11/21/11	55593380	coy	M	Mgmt Removal

Appendix F. Transition's from one reproductive state to the next for trend females 3+ years old in the NCDE; 2004-2011. (C=coy litter, Y = yrling litter, T= 2 yr. old litter, N=no litter). These data can be used in Program MARK to ascertain the probability of transitioning from one reproductive state to the next. Zero's denote missing years.

Bear Id	Start Year	Transitions from 2004-2011
97637608	2007	000CYC00
51597096	2010	000000NC
51571800	2006	00CY0000
Pam	2009	00000CYN
205	2004	CYNC0000
233	2004	CNN00000
238	2004	NNC00000
238	2009	00000NNN
263	2006	00NNC000
23813296	2004	CY000000
36335046	2010	000000CN
36547575	2009	00000NN0
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36548287	2009	00000CYN
36549051	2009	00000NN0
36568375	2009	00000NN0
36582073	2010	000000NN
38052875	2004	YT000000
48366019	2004	CY000000
51071845	2005	0NN00000
51072381	2005	0NN00000
51586884	2004	CY000000
51605816	2004	CYN00000
63604357	2009	00000NC0
63614632	2010	000000NC
64054290	2009	00000NCY
67006850	2006	00NNCC00
71814874	2005	0NNCY000
71868109	2006	00YTC000
72023614	2005	0NC00000
72113035	2006	00NNCC00
76361015	2005	0NCY0000
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76570875	2007	000NNC00
76584107	2006	00CY0000
76600783	2006	00CYN000
76613125	2006	00NCY000
76615038	2005	0NNC0000
79050043	2005	0NNNNC00
79110541	2006	00NCY000
81279315	2009	00000NN0
81280888	2009	00000NC0
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81600578	2009	00000NN0
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81602889	2006	00CY0000
81603277	2007	000NN000
81886333	2006	00NNNN00
84523288	2005	0CYTCY00
84524018	2005	0NNC0000
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84625548	2004	NN000000
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93585538	2007	000NC000
93619344	2008	0000CY00
93638000	2009	0000NCYT
93639873	2007	000CYT00
97609806	2009	00000CY0
97616524	2008	000NC000
97630806	2008	000NC000
97774544	2008	000NN000
107556786	2008	0000CYTN
107561271	2010	000000NN
107568286	2009	00000CCY
107576882	2008	0000CY00
107587034	2009	00000NNN
107794628	2009	00000NCY
132335546	2004	NNNNCY00
132353547	2004	TN000000