

**NORTHERN CONTINENTAL DIVIDE ECOSYSTEM**  
**GRIZZLY BEAR POPULATION MONITORING TEAM**  
**ANNUAL REPORT – 2018**



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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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## 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-marked grizzly bears with the Demographic Monitoring Area (DMA). The DMA is composed of the Primary Conservation Area (PCA; equivalent to the Recovery Zone) and Zone 1 (a buffer area around the PCA). This report summarizes field accomplishments during 2018. During 2018, we captured 28 grizzly bears (13F, 15M) for trend monitoring. An additional 38 bears (14F, 24M) were captured for management or other purposes. Including bears captured in previous years, we monitored 75 bears (52F, 23M) with radio-telemetry. We documented the deaths of 10 radio-marked bears (6F, 4M) among the radio-monitored sample. Reproductive status was documented for 34 radio-marked adult females and included 13 with cubs, 11 with yearlings, 2 with 2-year-old offspring, and 8 with no offspring. Survival of accompanying dependent offspring was monitored for 13 females. We documented 2 known or presumed mortalities among 4 cub litters and 6 known or presumed mortalities among 9 yearling litters. Including unmarked bears, 52 known or probable mortalities of grizzly bears were documented within the NCDE population. We evaluated various demographic parameters relative to thresholds set forth in the 2018 Conservation Strategy. During 2018, we verified presence of reproductive females within 18 of 23 Bear Management Units (BMUs) in the PCA (78%) and within 7 of 7 occupancy units (OUs) in Zone 1 (100%). During the 6-year period of 2013–2018, all BMUs and OUs within the DMA were occupied by females with offspring during at least one year, which surpasses the minimum threshold 21 BMUs and 6 OUs. For the 6-year period 2013–2018, we estimated an annual survival rate of 0.93 ( $\pm 0.01$  SE) for independent females within the DMA, which meets the minimum threshold rate of 0.93. Among known and probable mortalities, we counted 11 independent ( $\geq 2$  years old) females and 16 independent males that died within the DMA. We estimated the number of total reported and unreported (TRU) mortalities of independent female and male bears using these numbers and the reporting rates observed among radio-marked bears. We estimated 19 TRU mortalities of independent females and 25 TRU mortalities of independent males within the DMA. During 2013–2018, the 6-year average of TRU mortalities for independent females within the DMA was 15, which fell below the maximum threshold of 22. The 6-year average for independent males was 20, which fell below the maximum threshold of 28. Using all verified grizzly bear locations during 2009–2018, we estimated occupied range of the NCDE grizzly bear population at

approximately 63,800 km<sup>2</sup> (24,600 mi<sup>2</sup>) of which 36% of occurred outside of the DMA. Occupied range slightly overlapped the eastern boundary of the Recovery Zone for the Cabinet-Yaak Ecosystem (CYE) population. Minimum distance between the occupied ranges of the NCDE and Greater Yellowstone Ecosystem (GYE) populations was estimated at 74 km (45 mi). Based on radio-monitoring or genotypes for bears sampled through 2017, we found no new evidence of natural movements among the NCDE, CYE, and Selkirk Ecosystem populations. To date, we have not detected evidence of immigration into the NCDE from the GYE or emigration from the NCDE into the GYE.

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## **1. INTRODUCTION AND STATEMENT OF NEED**

The grizzly bear (*Ursus arctos horribilis*) was 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; population size during 2004 was estimated to be 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 (MFWP), 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 grizzly bear survival rates, reproductive rates, and population trend primarily by radio-monitoring grizzly bears, particularly females.

## **2. PROGRAM OBJECTIVES**

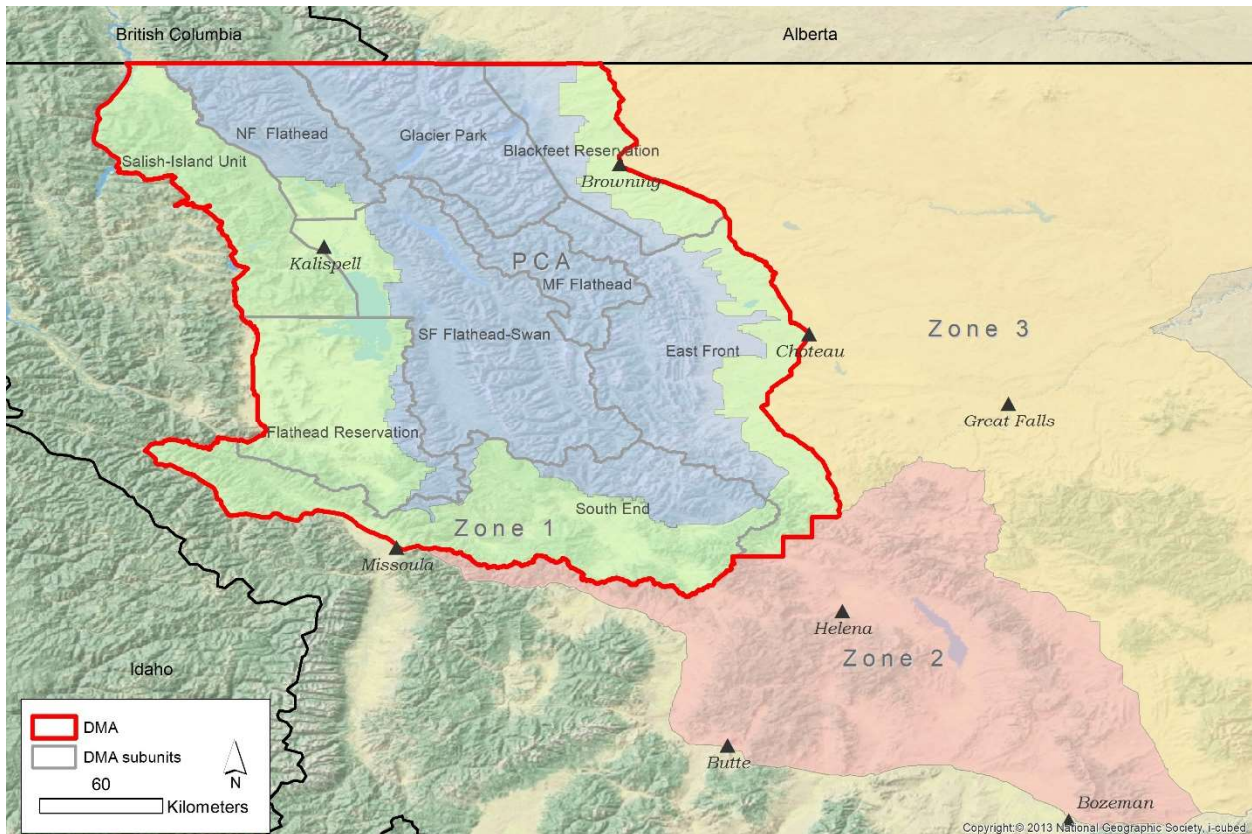
The primary objective of this program is to monitor the population trend of grizzly bears in the NCDE using known-fate estimators of survival and documentation of reproductive rates of radio-transmitted grizzly bears. The ultimate responsibility of the monitoring team is to collect life history data on grizzly bears in western Montana and summarize findings in a comprehensive annual report. Major population monitoring categories will initially include:

- population trend,
- grizzly bear survival rates,
- grizzly bear reproductive rates,
- grizzly bear movements and habitat selection,
- grizzly bear distribution in western Montana,
- mortality levels in the NCDE, and
- levels of unreported mortality.

The 2018 Conservation Strategy detailed demographic monitoring protocols and management objectives developed by an interagency team to maintain and enhance a recovered grizzly bear population in the NCDE. It set forth 3 demographic objectives and associated thresholds. Although the Conservation Strategy is intended to take effect upon removal of the NCDE grizzly bear population from threatened status under the Endangered Species Act, the objectives and thresholds represent the most recent monitoring methodologies, therefore we report on these objectives using field data obtained through 2018.

### 3. GEOGRAPHIC SCOPE OF THE MONITORING PROGRAM

Our trend monitoring program is focused within the Demographic Monitoring Area (DMA; Fig. 1), which encompasses the 23,119-km<sup>2</sup> Primary Conservation Area (PCA: equivalent to the Federal Recovery Zone) and the 19,460-km<sup>2</sup> Zone 1, which roughly correlates to a 10-mile buffer surrounding the PCA (USFWS 1993, NCDE Subcommittee 2018). The DMA includes Glacier National Park, parts of five National Forests (Flathead, Helena, Kootenai, Lewis and Clark, and Lolo); parts of the Blackfeet and Flathead Reservations; Bureau of Land Management lands; state lands, and private lands. The NCDE grizzly bear population is also contiguous with those in the Canadian provinces of British Columbia and Alberta, therefore some captures and monitoring occur north of the United States in Canada. Within the DMA, we designated 9 subunits for localized analyses, based on distinct land ownerships and grizzly bear population management authorities.



**Fig. 1. The Demographic Monitoring Area (DMA; red line), where our grizzly bear population monitoring is conducted, consists of the Primary Conservation Area (PCA; blue) and Zone 1 (green). The DMA is divided into subunits (gray lines) for localized population analyses. Zone 2 (pink) is the area of potential genetic connectivity between the NCDE and the Greater Yellowstone Ecosystem. Zone 3 (orange) is an area occupied by grizzly bears which does not provide habitat linkage to other populations.**



Although our focus for trend monitoring is the DMA, we also document mortalities and other observations outside of the DMA. Notable areas include: Zone 2, an area of potential connectivity between the NCDE and the Greater Yellowstone Ecosystem (GYE); and Zone 3, an area occupied by grizzly bears which does not provide habitat linkage to other grizzly bear populations (NCDE Subcommittee 2018).

## **4. FIELD ACTIVITIES**

### **Methods**

Each year, we capture grizzly bears primarily using leg-hold snares and culvert traps. We follow the handling and immobilization procedures found in the Montana Animal Care and Use Committee protocols for grizzly bears and black bears (Montana Fish, Wildlife and Parks 2004). We tag all bears subcutaneously with passive transponder tags and pull a pre-molar tooth for age determination (Stoneberg and Jonkel 1966). We radio-mark most females and a sample of males using a variety of transmitters, including: very high frequency (VHF) neck-mounted collars (Telonics, Inc., Mesa, AZ); VHF ear-tag transmitters (Advanced Telemetry Systems, Inc., Isanti, MN); store-on-board global positioning system (GPS) collars (TGW-4500; Telonics, Inc.); Argos GPS collars (Models TGW-3580 and TGW-3583; Telonics, Inc.); spread-spectrum GPS collars (TGW-3690; Telonics, Inc.), and Iridium GPS collars (TGW-4570-3; Telonics, Inc.). We capture research bears throughout the study area. We attempt to distribute our sample of research females in proportion to relative grizzly bear density, based on the distribution of female bears detected at DNA hair traps in 2004 (Kendall et al. 2009). Grizzly bears are also captured and radio-marked for management purposes. Individual bears are classified as either research bears or management bears using the terminology of Mace et al. (2012).

We monitor survival and reproduction using aerial telemetry flights conducted monthly and by remote downloads of GPS data. We attempt to investigate mortality signals within 2 weeks to ascertain whether the bear died or shed its collar. If a dead bear is found, we conduct preliminary necropsies in the field and collect relevant samples for laboratory analyses. In early spring, when bears are beginning to emerge from dens, we conduct observation flights for adult female bears to ascertain reproductive status, and age of offspring and litter size (if present). We continue to conduct monthly telemetry flights throughout the active season, when possible, to document survival of dependent offspring.

We record and report known and probable mortalities of marked and unmarked grizzly bears each year. Known mortalities involve a carcass or parts which substantiate death; probable mortalities lack a carcass but involve strong evidence that a bear died (e.g., blood loss).



## Results

In 2018, we captured 68 individuals during 74 capture occasions (6 recaptures). We captured 28 individuals for trend monitoring purposes (Table 1), including 13 females and 15 males. All 13 females and 6 of the males were fitted with radio-transmitters. In addition to research captures, bears were captured in association with management actions, although some were non-target individuals. These captures included 14 females and 24 males, and 10 females and 15 males were fitted with radio-transmitters. Trapping for individuals to augment the population in the Cabinet-Yaak Ecosystem (CYE) was also conducted during 2018. Two males were captured, and one was translocated to the CYE. The other bear was not radio-marked.

Including bears collared during previous years, we radio-monitored 52 independent female grizzly bears during all or part of 2018: 32 females monitored solely for trend and 20 females monitored for conflict management and trend. We also radio-monitored 1 cub for management. We radio-monitored 23 independent males during 2018: 6 for trend research and 17 for conflict management and trend. We documented the deaths of 6 radio-marked females during 2018: 2 automobile collisions, 1 poaching/malicious kill, and 3 undetermined (although no evidence of a human cause). We documented the deaths of 4 radio-marked males during 2018: 3 agency removals and 1 train collision. A summary of the fates of radio-marked bears during 2018 are presented in Appendix A.

We recorded the reproductive status of 34 adult females during 2018, including 13 with cubs, 11 with yearlings, 2 with 2-year-old offspring, and 8 with no offspring. First observations for reproductive status ranged from April 3 (flight observation) to October 16 (new capture) and averaged June 22. We documented 2 litters with 1 cub, 6 litters with 2 cubs, and 3 litters with 3 cubs. First observations for these litters ranged from 3 April (flight observation) to October 16 (new capture). Mean date of first verified litter size was July 9. Litter size was not verified for 2 cub litters. We monitored survival of 4 cub litters (9 cubs) and 9 yearling litters (21 yearlings) through repeated observations during the year. We documented 2 presumed cub mortalities and 6 known or presumed yearling mortalities. A summary of the reproductive observations of radio-marked females are presented in Appendix B.

Fifty-two known or probable grizzly bear mortalities were documented in the NCDE during 2018 (Table 2). Forty-five occurred within the DMA: 24 inside the PCA and 21 within Zone 1 (Fig. 2). Seven mortalities occurred outside the DMA in Zone 3. Among 31 mortalities of independent bears, causes of death were: agency removal due to conflict (5); agency removal for augmentation of the Cabinet-Yaak populations (1); agency humane removal (2); agency handling mortality (1); defense of life kill (4); automobile collision (5); poaching/malicious kill (3); illegal defense of property kill (3); illegal hunting due

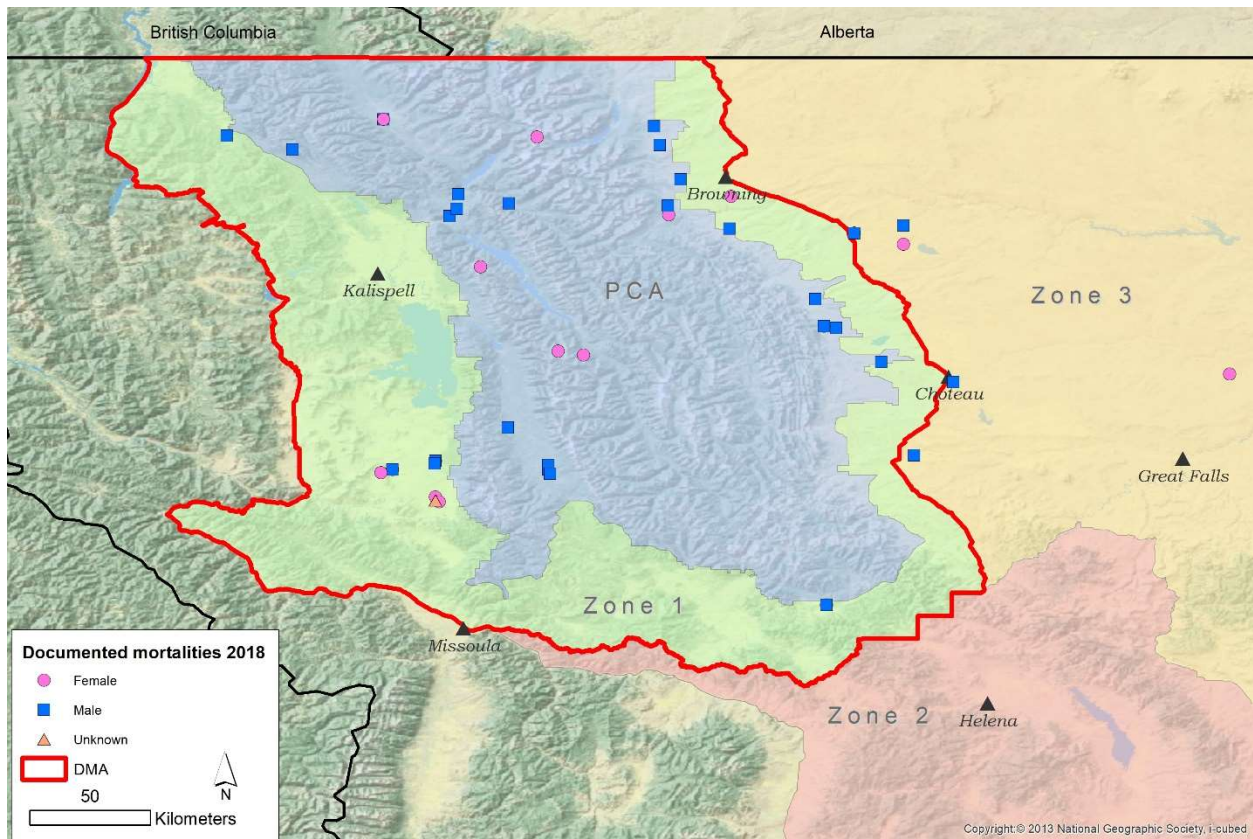
to mistaken identification (1); train collision (1); natural (1); and undetermined (4). Twenty-one dependent bear mortalities included individuals that died, individuals that were orphaned and then captured and moved to zoos, or cubs that were orphaned and assumed dead (if fate is unknown, cubs are assumed dead). Causes of death were: automobile collision (8); agency removal due to orphaning (4); agency removal due to conflict (2); assumed dead due to orphaning (2); defense of life (2); illegal defense of property (1); train collision (1); and accidental poisoning (1). A summary of all documented mortalities in the NCDE during 2018 is reported in Appendix C.

**Table 1. Number of individual grizzly bears captured and fitted with radio-transmitters in the NCDE, 2018.**

Type	Captured			Radio-marked		
	Female	Male	Total	Female	Male	Total
Research	13	15	28	13	6	19
Management	14	24	38	10	15	25
Augmentation	0	2	2	0	1	1
Total	27	41	68	23	25	45

**Table 2. Number of documented known or probable mortalities of grizzly bears in the NCDE, 2018.**

	Ageclass	Sex			Total
		Female	Male	Unknown	
Inside DMA	Dependent	4	11	3	18
	Independent	11	16	0	27
	Total	15	27	3	45
Outside DMA	Dependent	2	1	0	3
	Independent	1	3	0	4
	Total	3	4	0	7



**Fig. 2.** Location of known and probable grizzly bear mortalities in the NCDE, 2018. Zones as described in Fig. 1.

## 5. CONSERVATION STRATEGY OBJECTIVES AND THRESHOLDS

The NCDE Conservation Strategy (NCDE Subcommittee 2018) articulated an overarching management goal to maintain a recovered, genetically diverse grizzly bear population throughout the DMA while maintaining demographic and genetic connections with Canadian populations and providing the opportunity for demographic and/or genetic connectivity with other ecosystems, with the following objectives and thresholds:

### **Objective 1: Maintain a well-distributed grizzly bear population within the DMA**

- Occupancy threshold: Maintain the documented presence of females with offspring in at least 21 of 23 BMUs of the PCA and in at least 6 of 7 occupancy units of Zone 1 at least every 6 years.

**Objective 2: Manage mortalities from all sources to support a  $\geq 90\%$  estimated probability that the grizzly bear population within the DMA remains above 800 bears, considering the uncertainty associated with all the demographic parameters.**

- Independent female survival threshold: Using a 6-year running average, maintain estimated annual survival of independent females within the DMA to: (a) a rate of  $\geq 0.90$ ; and (b) a rate at or above the minimum level consistent with a projected  $\geq 90\%$  probability that the population within the DMA will remain above 800 bears based on population modeling.
- Independent female mortality threshold: Using a 6-year running average, limit annual estimated number of total reported and unreported (TRU) mortalities of independent females within the DMA to: (a) a number that is  $\leq 10\%$  of the number of independent females estimated within the DMA based on population modeling; and (b) a number that is at or below the maximum level consistent with a projected  $\geq 90\%$  probability that the population within the DMA will remain above 800 bears based on population modeling.
- Independent male mortality threshold: Using a 6-year running average, limit annual estimated number of TRU mortalities of independent males within the DMA to a number that is  $\leq 15\%$  of the number of independent males estimated within the DMA based on population modeling.

**Objective 3: Monitor demographic and genetic connectivity among populations**

- Estimate spatial distribution of the NCDE grizzly bear population biennially.
- Identify the population of origin for individuals sampled inside and outside of the DMA to detect movements of individuals to and from other populations or recovery areas.

### **Methods**

Each year, we document presence of females with cub, yearling, or 2-year-old offspring within units, based on visual observations obtained from radio-marked females; verified remote camera photos; other verified visual observations; known or probable mortalities of family units (death of the mother, dependent young, or both); and telemetry or GPS locations of radio-marked females known to have offspring. The PCA component of the threshold represents a continuation of the occupancy targets established within the Recovery Zone prior to delisting (USFWS 1993) and utilizes the same BMUs (Fig. 3). The Zone 1 component utilizes Occupancy Units (OUs) demarcated using established political boundaries

(i.e., state/tribal boundaries and FWP regional boundaries) and the boundaries of the two Demographic Connectivity Areas (NCDE Subcommittee 2018).

We estimate survival of independent females within the DMA based on known-fate analysis of data collected from radio-marked female bears within the DMA (Costello et al. 2016). Analysis incorporates the time series of survival data from known-fate monitoring since 2004 and differentiates the most recent 6 years of data to compare to the threshold. Based on the number of known and probable mortalities recorded each year, and the human reporting rate observed among radio-marked bears (Costello et al. 2016), we estimate numbers of TRU mortalities of independent female and male grizzly bears within the DMA and assess the female and male mortality thresholds using an average for the last 6 years. We previously developed thresholds for a 6-year management period during 2013–2018 (NCDE Subcommittee 2018). Thresholds were developed by simulating population growth using current estimates of vital rates (Costello et al. 2016) to year 2012 and then projecting another 25 years to predict effects of changing female and male independent bear survival. Under this scenario, and assuming selection of a 6-year management period of 2013–2018, the minimum threshold for independent female survival was 0.93, the maximum threshold for the number of independent female mortalities was 22, and the maximum threshold for the number of independent male mortalities was 28.

We estimate the distribution of the NCDE grizzly bear population biennially, by applying zonal analysis and ordinary kriging (Bjornlie et al. 2014) to 7-km x 7-km cells with verified grizzly bear locations documented during a 10-year window up to the current year. Verified locations are collected from GPS transmitters; VHF telemetry flights; capture and mortality locations; grizzly bear-human conflict sites; observations (sightings or tracks) or remote camera photos confirmed by agency personnel; and opportunistic samples of grizzly bear hair, blood, scat, or tissue confirmed by DNA analysis. DNA samples obtained during captures or at any of verified grizzly bear sites are analyzed for population of origin to document movement of individuals to and from other populations or recovery areas (Haroldson et al. 2010). Genetic samples are not submitted until the end of each field season and take some time to analyze, therefore there is typically a 1-year lag in reporting results for population of origin.

## **Results**

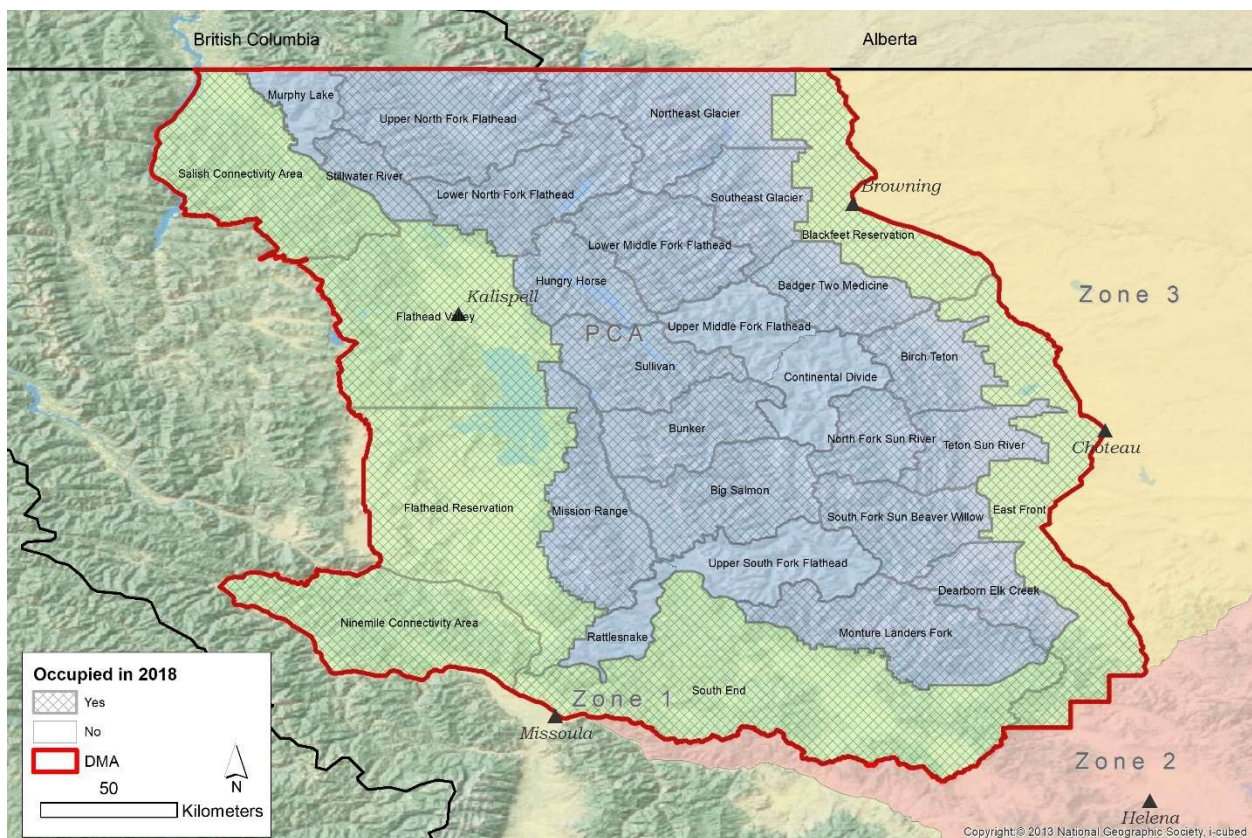
During 2018, we verified presence of reproductive females within 18 of 23 BMUs (78%) and within 7 of 7 supplementary BMUs (100%; Fig. 3). For the 6-year period 2013–2018, all BMUs were occupied by females with offspring, thus exceeding the objective of 21 of 23 BMUs occupied. Similarly, all OUs were occupied during the last 6 years, exceeding the objective of 6 of 7 OUs occupied. Using the 6-year tally,



full occupancy of the PCA has been documented each year since 2010 and full occupancy of Zone 1 has been documented each year since 2013 (Costello et al. 2016, Appendix D).

For the 6-year period 2013–2018, we estimated an annual survival rate of 0.93 ( $\pm$  0.01 SE) for independent females within the DMA, which meets the minimum threshold rate of 0.93 (Fig. 2; NCDE Subcommittee 2018).

Within the DMA, there were 11 and 16 known mortalities reported for independent females and independent males, respectively (Fig. 2). We estimated the number of total reported and unreported (TRU) mortalities of independent bears within the DMA using these numbers and the reporting rates observed among radio-marked bears. We estimated 19 TRU mortalities of independent females and 25 TRU mortalities of independent males within the DMA (Table 3). During 2013–2018, the 6-year average of TRU mortalities for independent females within the DMA was 15, which falls below the maximum threshold of 22 (NCDE Subcommittee 2018). The 6-year average for independent males was 20, falling below the maximum threshold of 28 (NCDE Subcommittee 2018).



**Fig. 3. Documented occupancy of female grizzly bears with offspring in 23 BMUs of the PCA and 7 OU of Zone 1 during 2018. All units have been occupied during the last 6 years. Zones as described in Fig. 1.**

**Table 3. Summary of independent grizzly bear mortalities within the DMA, NCDE, 2018.**

Sex	Documented mortalities by method of discovery				Estimated reported and unreported <sup>e</sup> (C)	Estimated total mortality (A + B + C)
	Agency removal <sup>a</sup> (A)	Telemetry <sup>b</sup> (B)	Reported <sup>c</sup> (high)	Reported <sup>d</sup> (low)		
Female	1	6	2	2	12	19
Male	7	1	6	2	17	25
Total	8	7	8	4	29	44

<sup>a</sup> Count of agency-sanctioned removals, including those involving radio-marked bears

<sup>b</sup> Count of deaths for bears wearing functional radio-transmitters, except for agency removals

<sup>c</sup> Count of non-radioed bear deaths reported by the public or discovered by agency personnel with high reporting rates (illegal defense-of-property, defense-of-life, train collision, automobile collisions, illegal hunting-misidentification)

<sup>d</sup> Count of non-radioed bear deaths reported by the public or discovered by agency personnel with low reporting rates (poaching/malicious, natural, undetermined)

<sup>e</sup> Bayesian estimate of the total number of reported and unreported deaths of non-radioed bears, predicted from the number of reported deaths of non-radioed bears in the high- and low-reporting rate categories (as per Cherry et al. 2002 and Costello et al. 2016).

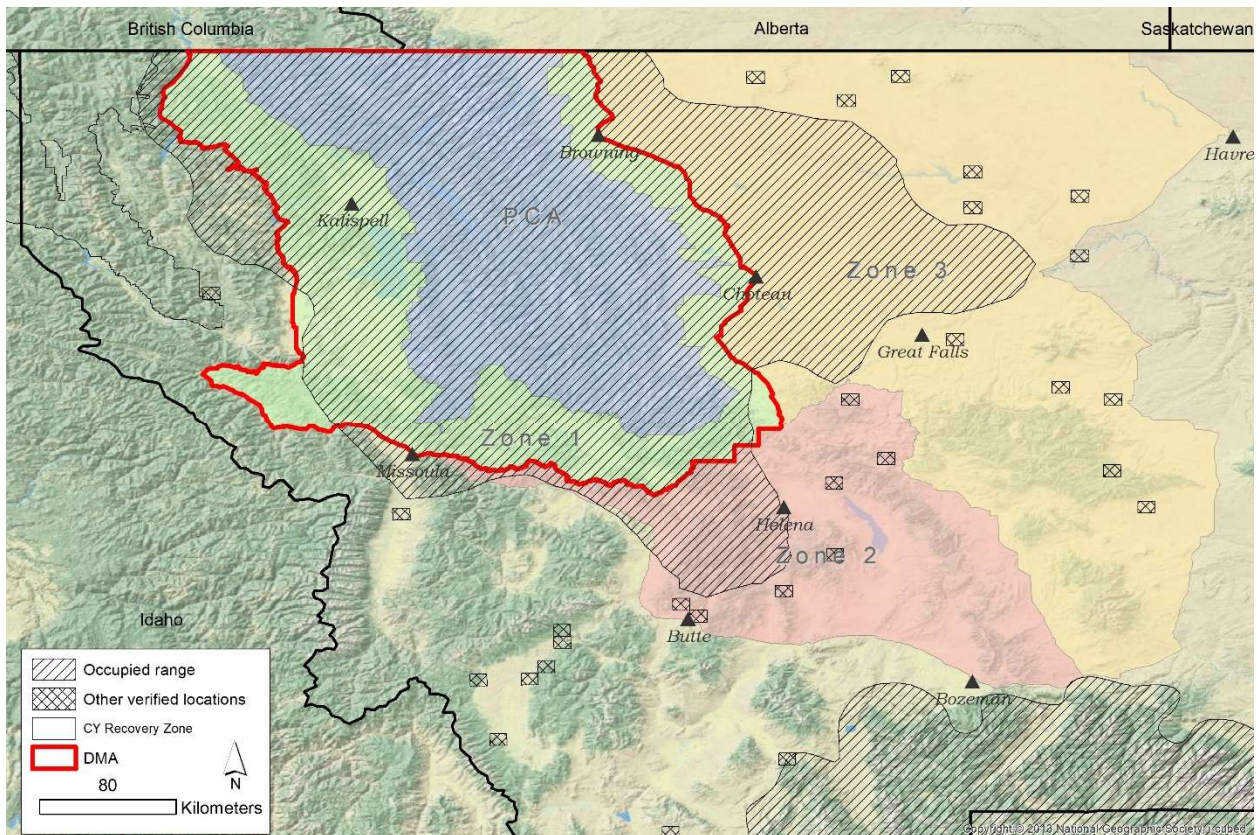
Using all verified grizzly bear locations during 2009–2018, we estimated the area of occupied range for the NCDE grizzly bear population as approximately 63,800 km<sup>2</sup> (24,600 mi<sup>2</sup>), of which 36% occurred outside of the DMA (Fig. 4). Using the same methods to estimate occupied range during previous years, we found that this current distribution represents a 42% increase from 2004 (~45,000 km<sup>2</sup>) and a 25% increase from 2010 (~51,000 km<sup>2</sup>).

Occupied range of the NCDE population slightly overlaps the eastern boundary of the CY Recovery Zone. Limited movements of male grizzly bears among the NCDE, CYE, and Selkirk Ecosystem were reported previously (Kendall et al. 2016), but we found no new evidence of natural movements among these ecosystems based on radio-monitoring or genotypes for bears sampled through 2017 (samples collected during 2018 are not yet analyzed).

Based on 2018 distribution estimates, minimum distance between the occupied ranges of the NCDE and GYE populations (Interagency Grizzly Bear Study Team [IGBST] 2018) was estimated at 74 km (45 mi). This is a 32% decrease from the distance estimated for 2014 (110 km) and a 13% decrease from the distance estimated for 2016 (85 km). There were several verified observations of grizzly bears between the NCDE and GYE populations during 2009–2018, mostly during the last 3 years (Fig. 4). Distance from occupied range for several of these outlier observations was larger than the minimum distance between the NCDE and GYE (Fig. 4). Outlier observations occurred in or near the Sapphire, Anaconda, Beaverhead, Pioneer, Boulder, Elkhorn, Adel, Big Belt, and Little Belt Mountain Ranges.



Genetic samples were not available for most outlier locations, prohibiting us from determining the population of origin. Based on genotypes for bears sampled through 2017, we have not detected evidence of immigration into the NCDE from the GYE or emigration from the NCDE into the GYE.



**Fig. 4.** Estimated occupied range of the NCDE grizzly bear populations in the NCDE during 2009–2018, relative to the estimated occupied range of the GYE population during 2004–2018 (IGBST 2018) and the CYE Recovery Zone. Other verified locations documented during 2009–2018 are depicted within corresponding 7×7 km grid cells. Zones as described in Fig. 1.

## 6. LITERATURE CITED

- Cherry, S., M. A. Haroldson, J. Robinson-Cox, and C. C. Schwartz. 2002. Estimating total human-caused mortality from reported mortality using data from radio-instrumented grizzly bears. *Ursus* 13:175–184.
- Costello, C. M., R. D. Mace, and L. Roberts. 2016. Grizzly bear demographics in the Northern Continental Divide Ecosystem, Montana: research results (2004–2014) and suggested techniques for management of mortality. Montana Department of Fish, Wildlife and Parks, Helena.
- Haroldson, M. A., C. C. Schwartz, K. C. Kendall, K. A. Gunther, D. S. Moody, K. Frey, and D. Paetkau. 2010. Genetic analysis of individual origins supports isolation of grizzly bears in the Greater Yellowstone Ecosystem. *Ursus* 21:1–13.
- Interagency Grizzly Bear Study Team. 2018. Download from Northern Rocky Mountain Science Center at <https://www.sciencebase.gov/catalog/folder/52fe7f75e4b0354fef6de4f0>.
- Kendall, K. C., J. B. Stetz, J. Boulanger, A. C. McLeod, D. Paetkau, and G. C. White. 2009. Demography and genetic structure of a recovering grizzly bear population. *Journal of Wildlife Management* 73:3–16.
- Kendall, K. C., A. C. Macleod, K. L. Boyd, J. Boulanger, J. A. Royle, W. F. Kasworm, D. Paetkau, M. F. Proctor, K. Annis, and T. A. Graves. 2016. Density, distribution, and genetics structure of grizzly bears in the Cabinet-Yaak Ecosystem. *Journal of Wildlife Management* 80:314–331.
- Mace, R. D., D. W. Carney, T. Chilton-Radandt, S. A. Courville, M. A. Haroldson, R. B. Harris, J. Jonkel, B. McLellan, M. Madel, T.L. Manley, C. C. Schwartz, C. Servheen, G. Stenhouse, J. S. Waller, and E. Wenum. 2012. Grizzly bear population vital rates and trend in the Northern Continental Divide Ecosystem, Montana. *The Journal of Wildlife Management*, 76: 119–128.
- Montana Fish, Wildlife and Parks. 2004. Biomedical protocol for free-ranging Ursidae in Montana: black bears (*Ursus americanus*) and grizzly bears (*Ursus arctos horribilis*): capture, anesthesia, surgery, tagging, sampling, and necropsy procedures. Helena, Montana, USA.
- NCDE Subcommittee. 2018. Conservation strategy for the grizzly bear in the Northern Continental Divide Ecosystem. (170 pages + appendices)
- Stoneberg, R. P., and C. J. Jonkel. 1966. Age determination in black bears by cementum layers. *Journal of Wildlife Management* 30:411–414.
- U.S. Fish and Wildlife Service. 1993. Grizzly Bear Recovery Plan. U.S. Fish and Wildlife Service, Office of the Grizzly Bear Recovery Coordinator, University Montana, Missoula. 181pp.

**Appendix A. Fate of radio-marked grizzly bears monitored with radio-telemetry in the NCDE, 2018.**

Sex	Capture type	DMA subunit	Bear ID	Fate
Female	Research	Blackfeet Reservation	81289535	Censored
Female	Research	Blackfeet Reservation	41089770	Alive
Female	Research	Blackfeet Reservation	839845540	Alive
Female	Research	Blackfeet Reservation	81278116	Alive
Female	Research	East Front	39088856	Censored
Female	Research	East Front	39036349	Alive
Female	Research	East Front	41375278	Alive
Female	Research	Flathead Reservation	41519364	Alive
Female	Research	Flathead Reservation	79558051	Alive
Female	Research	Flathead Reservation	41299353	Alive
Female	Research	Flathead Reservation	79606840	Dead
Female	Research	Flathead Reservation	79563629	Alive
Female	Research	Flathead Reservation	79558279	Alive
Female	Research	Glacier National Park	55599346	Dead
Female	Research	Glacier National Park	41078883	Alive
Female	Research	Glacier National Park	41515561	Alive
Female	Research	Glacier National Park	76361015	Alive
Female	Research	Glacier National Park	36554783	Alive
Female	Research	Middle Fork Flathead River	601591305	Alive
Female	Research	Middle Fork Flathead River	41580379	Censored
Female	Research	North Fork Flathead River	107565854	Censored
Female	Research	North Fork Flathead River	67006850	Alive
Female	Research	North Fork Flathead River	11052544	Alive
Female	Research	North Fork Flathead River	79570382	Alive
Female	Research	South End	11065603	Alive
Female	Research	South Fork Flathead River-Swan Valley	79050043	Alive
Female	Research	South Fork Flathead River-Swan Valley	839836351	Dead
Female	Research	South Fork Flathead River-Swan Valley	839826876	Alive
Female	Research	South Fork Flathead River-Swan Valley	11077801	Censored
Female	Research	South Fork Flathead River-Swan Valley	839828530	Alive
Female	Research	South Fork Flathead River-Swan Valley	41638009	Dead
Female	Research	South Fork Flathead River-Swan Valley	839828828	Alive
Female	Management	Blackfeet Reservation	41090260	Alive
Female	Management	Blackfeet Reservation	11044088	Alive
Female	Management	Blackfeet Reservation	81279041	Alive
Female	Management	Blackfeet Reservation	839828868	Alive
Female	Management	East Front	41623606	Alive
Female	Management	East Front	41532565	Alive
Female	Management	East Front	39081850	Censored
Female	Management	East Front	41554381	Alive
Female	Management	East Front	39086301	Alive
Female	Management	East Front	39080331	Alive

Sex	Capture type	DMA subunit	Bear ID	Fate
Female	Management	Flathead Reservation	18122873	Dead
Female	Management	Flathead Reservation	18097536	Dead
Female	Management	North Fork Flathead River	601603326	Alive
Female	Management	North Fork Flathead River	79562572	Censored
Female	Management	Outside DMA	839815522	Alive
Female	Management	Salish-Island Unit	601604350	Alive
Female	Management	Salish-Island Unit	55577095	Alive
Female	Management	South Fork Flathead River-Swan Valley	41379363	Alive
Female	Management	South Fork Flathead River-Swan Valley	97771828	Censored
Female	Management	South Fork Flathead River-Swan Valley	36336335	Alive
Female	Management	South Fork Flathead River-Swan Valley	601599568	Dead
Male	Research	East Front	41638038	Alive
Male	Research	East Front	41360823	Alive
Male	Research	Glacier National Park	107588047	Censored
Male	Research	North Fork Flathead River	601622611	Censored
Male	Research	South End	41086114	Alive
Male	Research	South Fork Flathead River-Swan Valley	41382533	Alive
Male	Management	Blackfoot Reservation	11003083	Alive
Male	Management	Blackfoot Reservation	39036887	Censored
Male	Management	East Front	41311617	Alive
Male	Management	North Fork Flathead River	837817818	Alive
Male	Management	North Fork Flathead River	601619778	Alive
Male	Management	North Fork Flathead River	55600592	Dead
Male	Management	North Fork Flathead River	80626085	Alive
Male	Management	Outside DMA	839841348	Alive
Male	Management	Outside DMA	839832101	Alive
Male	Management	Outside DMA	11029050	Alive
Male	Management	Outside DMA	39081555	Dead
Male	Management	Salish-Island Unit	601617115	Dead
Male	Management	South End	55584076	Alive
Male	Management	South End	10889003	Alive
Male	Management	South Fork Flathead River-Swan Valley	839844883	Dead
Male	Management	South Fork Flathead River-Swan Valley	79583879	Censored
Male	Management	South Fork Flathead River-Swan Valley	601599348	Censored

**Appendix B. Observed reproductive status and fate of offspring for adult female grizzly bears monitored with radio-telemetry in the NCDE, 2018.**

Capture type	DMA subunit	Bear ID	Status	Litter size	Offspring mortality
Research	Blackfeet Reservation	81289535	Cubs	2	
Research	East Front	39036349	Yearlings	3	
Research	East Front	39088856	Yearlings	2	1
Research	Flathead Reservation	41299353	Cubs	2	
Research	Flathead Reservation	41519364	Yearlings	3	
Research	Flathead Reservation	79558279	Cubs	3	
Research	Flathead Reservation	79563629	Cubs	1	
Research	Flathead Reservation	79606840	Cubs	2	
Research	Glacier National Park	36554783	None		
Research	Glacier National Park	41515561	None		
Research	Glacier National Park	55599346	Yearlings	2	
Research	Glacier National Park	76361015	Cubs	2	
Research	Middle Fork Flathead River	601591305	None		
Research	North Fork Flathead River	11052544	Yearlings	3	2
Research	North Fork Flathead River	67006850	Yearlings	2	2
Research	North Fork Flathead River	79570382	Yearlings	2	
Research	South End	11065603	None		
Research	South Fork Flathead River-Swan Valley	11077801	Cubs		
Research	South Fork Flathead River-Swan Valley	79050043	None		
Research	South Fork Flathead River-Swan Valley	839826876	None		
Research	South Fork Flathead River-Swan Valley	839836351	Yearlings	2	
Management	Blackfeet Reservation	11044088	Cubs	3	
Management	Blackfeet Reservation	81279041	Cubs		
Management	Blackfeet Reservation	839828868	None		
Management	East Front	39081850	Cubs	1	
Management	East Front	39086301	Yearlings	3	3
Management	East Front	41532565	Yearlings	2	1
Management	East Front	41623606	None		
Management	Flathead Reservation	18097536	Cubs	3	
Management	North Fork Flathead River	601603326	Cubs	2	
Management	Salish-Island Unit	55577095	Cubs	2	
Management	South Fork Flathead River-Swan Valley	36336335	Two-year-olds	2	
Management	South Fork Flathead River-Swan Valley	97771828	Two-year-olds	2	
Management	South Fork Flathead River-Swan Valley	601599568	Yearlings	2	

**Appendix C. Summary of known and probable grizzly bear mortalities in the NCDE, 2018.**

Date	Date accuracy	Certainty of death	DMA <sup>1</sup>	Sex <sup>2</sup>	Age Class <sup>3</sup>	Bear ID	Collared <sup>1</sup>	Cause
4/27/2018	Day	Known	Y	M	SA	41781305	N	Agency (livestock)
5/14/2018	Day	Known	Y	M	SA	839813814	N	Capture mortality
5/21/2018	Day	Known	Y	M	AD	76517578	N	Mistaken ID
5/22/2018	Day	Known	N	M	AD	41260019	N	Automobile
5/29/2018	Day	Known	Y	F	CB		N	Automobile
6/4/2018	Day	Known	Y	M	SA		N	Defense of life
6/6/2018	Day	Known	Y	F	AD	64028820	N	Automobile
6/6/2018	Day	Known	Y	M	CB		N	Agency (orphaned)
6/6/2018	Day	Known	Y	M	CB		N	Agency (orphaned)
6/6/2018	Day	Known	Y	M	CB		N	Agency (orphaned)
6/7/2018	Day	Known	N	M	SA		N	Illegal defense of property
6/9/2018	Day	Known	Y	M	SA	839815046	N	Illegal defense of property
6/11/2018	Day	Known	N	F	YR		N	Accidental
6/24/2018	Day	Known	N	F	CB		N	Automobile
6/26/2018	Day	Known	Y	M	CB		N	Automobile
6/27/2018	Day	Known	N	F	AD		N	Illegal defense of property
6/27/2018	Day	Known	N	M	CB		N	Illegal defense of property
7/3/2018	Day	Known	Y	M	SA	79583879	N	Agency (site conflict)
7/5/2018	Day	Known	Y	M	SA	601617115	Y	Agency (site conflict)
7/14/2018	Day	Known	Y	F	AD		N	Natural
7/19/2018	Day	Known	Y	F	CB		N	Automobile
6/8/2018	Day	Known	Y	F	AD	41638009	Y	Undetermined
7/20/2018	Day	Known	Y	M	SA	601514850	N	Agency (augment)
7/27/2018	Day	Known	Y	F	AD	18097536	Y	Automobile
7/27/2018	Day	Known	Y	F	CB		N	Automobile
7/27/2018	Day	Known	Y	M	CB		N	Automobile
7/29/2018	Day	Known	Y	M	CB		N	Agency (orphaned)
8/13/2018	Day	Known	N	M	AD	39081555	Y	Agency (injury)
7/27/2018	Day	Known	Y	M	AD		N	Automobile
8/23/2018	Day	Known	Y	F	AD	55599346	Y	Automobile
9/2/2018	Day	Known	Y	M	SA	55600592	Y	Agency (site conflict)
6/1/2018	Year	Known	Y	M	AD		N	Poached/Malicious
9/10/2018	Week	Known	Y	M	SA	839844883	Y	Train
9/24/2018	Day	Known	Y	M	AD		N	Defense of life
9/26/2018	Day	Known	Y	F	AD	39088856	N	Defense of life
9/26/2018	Day	Known	Y	M	YR		N	Defense of life
9/26/2018	Day	Known	Y	F	AD	79606840	Y	Poached/Malicious
9/26/2018	Day	Probable	Y	M	CB	41298369	N	Orphaned
9/26/2018	Day	Probable	Y	M	CB	79579003	N	Orphaned
10/10/2018	Day	Known	Y	M	SA	839817818	N	Agency (site conflict)
9/12/2018	Day	Known	Y	F	AD	839836351	Y	Undetermined

Date	Date accuracy	Certainty of death	DMA <sup>1</sup>	Sex <sup>2</sup>	Age Class <sup>3</sup>	Bear ID	Collared <sup>1</sup>	Cause
10/12/2018	Day	Known	Y	F	AD		N	Poached/Malicious
10/15/2018	Month	Known	Y	M	AD	84525524	N	Undetermined
10/21/2018	Day	Known	Y	M	YR		N	Agency (site conflict)
10/21/2018	Day	Known	Y	F	YR	601611778	N	Agency (site conflict)
10/22/2018	Day	Known	Y	F	AD	18078025	N	Agency (injury)
10/18/2018	Day	Probable	Y	U	CB		N	Automobile
10/18/2018	Day	Probable	Y	U	CB		N	Automobile
10/26/2018	Week	Known	Y	F	AD	601599568	Y	Undetermined
11/8/2018	Day	Known	Y	M	CB		N	Train
11/20/2018	Day	Known	Y	M	AD			Defense of life
7/25/2018	Day	Known	Y	M	YR		N	Defense of life

<sup>1</sup> Y = Yes, N = No

<sup>2</sup> F = female, M = Male, U = unknown sex

<sup>3</sup> AD = adult (≥5 years old), SA = subadult (2-4 years old), YR = yearling (1 year old), CB = cub (<1 year old)



**Appendix D. Observed occupancy of 23 Bear Management Units within the PCA and 7 Occupancy Units within Zone 1 by female grizzly bears with offspring, 2013–2018. Units known occupied during a given year are signified by the symbol x. All units were occupied during a 6-year period ending with the given year during 2013–2018.**

Bear Management Unit (PCA)	2013	2014	2015	2016	2017	2018
Murphy Lake	x					
Upper North Fork Flathead	x	x	x	x	x	x
Northeast Glacier	x	x	x	x	x	x
Stillwater River	x	x	x			x
Lower North Fork Flathead	x	x	x	x	x	x
Hungry Horse			x	x	x	x
Lower Middle Fork Flathead	x	x	x	x	x	x
Southeast Glacier	x	x		x	x	x
Sullivan		x		x	x	x
Upper Middle Fork Flathead	x	x	x	x	x	
Badger Two Medicine	x	x		x	x	x
Mission Range	x	x	x	x	x	x
Bunker	x	x	x	x	x	x
Continental Divide	x	x	x			
Birch Teton				x	x	x
Big Salmon						x
North Fork Sun River	x	x	x		x	x
Teton Sun River	x	x	x		x	x
Rattlesnake	x	x		x		
Upper South Fork Flathead	x		x		x	
South Fork Sun Beaver Willow	x	x	x		x	x
Monture Landers Fork	x	x	x	x	x	x
Dearborn Elk Creek					x	x
Occupied during year	18	17	15	14	18	18
Occupied during last 6 years	23	23	23	23	23	23
<b>Occupancy Unit (Zone 1)</b>						
Salish Connectivity Area	x	x		x	x	x
Flathead Valley	x	x	x	x	x	x
Flathead Reservation	x	x	x	x	x	x
Ninemile Connectivity Area	x				x	x
South End	x	x	x	x	x	x
East Front			x	x	x	x
Blackfeet Reservation	x	x	x	x	x	x
Occupied during year	6	5	5	6	7	7
Occupied during last 6 years	7	7	7	7	7	7