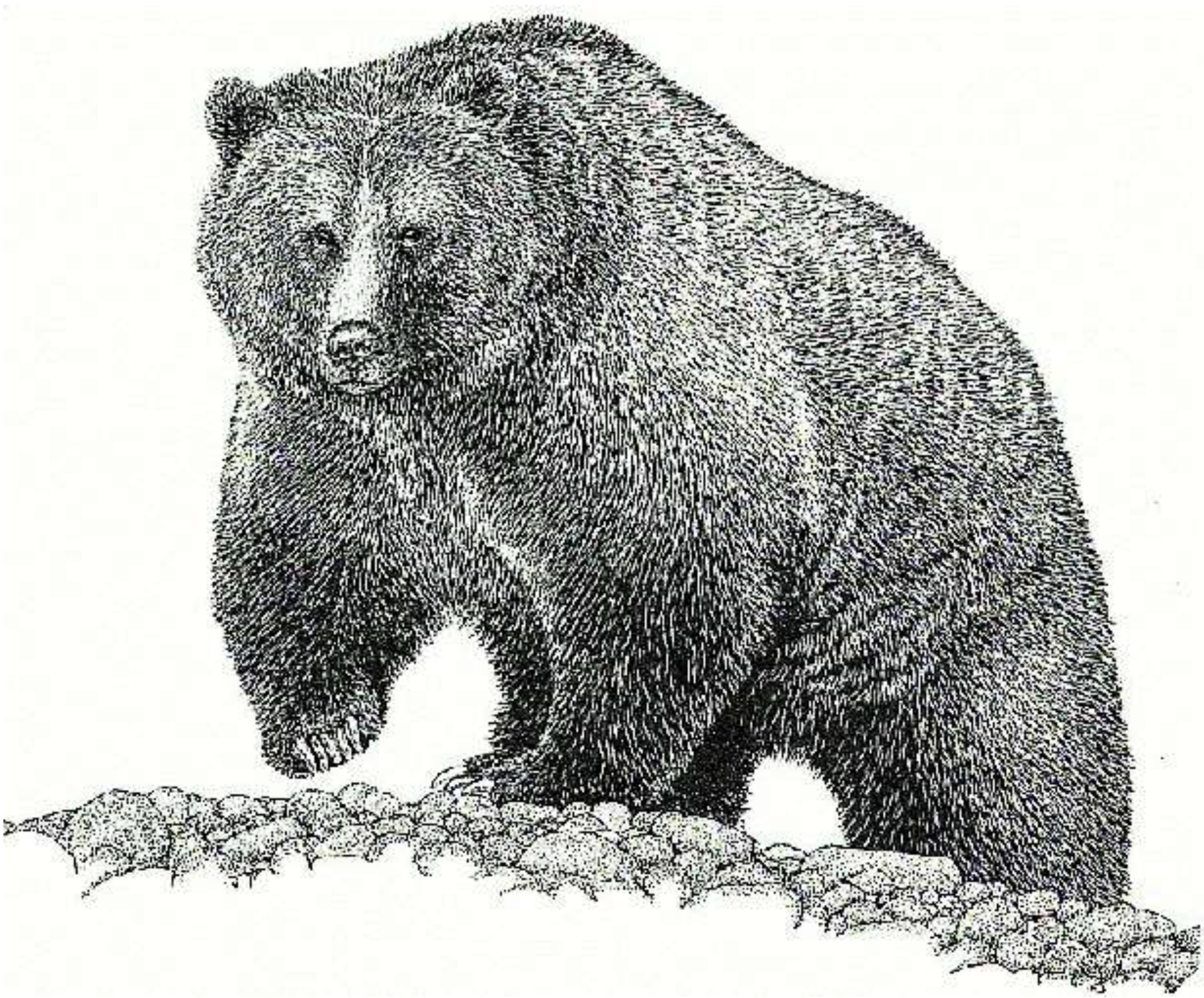
CABINET-YAAK GRIZZLY BEAR RECOVERY AREA 2022 RESEARCH AND MONITORING PROGRESS REPORT



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This annual report has cumulative data collected the inception of this program in 1983. New information collected or available to this study is incorporated and reanalyzed. Information within supersedes previous reports. Please obtain permission and cite as follows: **Kasworm, W. F., T. G. Radandt, J. E. Teisberg, T. Vent, M. Proctor, H. Cooley, and J. K. Fortin-Noreus. 2023. Cabinet-Yaak grizzly bear recovery area 2022 research and monitoring progress report. U.S. Fish and Wildlife Service, Missoula, Montana. 118 pp.**

ABSTRACT

Fifteen grizzly bears were monitored with radio-collars during portions of 2022. Research monitoring included eight females (four adults and four subadult) and seven males (two adult and five subadults) in the Cabinet-Yaak Ecosystem (CYE). Grizzly bear monitoring and research has been ongoing in the Cabinet Mountains since 1983 and in the Yaak River since 1986. Ninety individual resident bears were captured and monitored through telemetry in the two areas from 1983–2022. Research in the Cabinet Mountains indicated that only a small population remained as of 1988. Concern over persistence of grizzly bear populations within this area resulted in a pilot program in 1990 that tested population augmentation techniques. Four subadult female bears with no history of conflicts with humans were captured in southeast British Columbia for release in the Cabinet Mountains during 1990–1994. Three of four transplanted bears remained within the target area for at least one year. Hair snag sampling and DNA analysis during 2000–2004 identified one of the original transplanted bears. Genetic analysis conducted in 2005 identified at least three first-generation offspring and two second-generation offspring from this individual. Success of the augmentation test program prompted additional augmentation in cooperation with Montana Fish, Wildlife, and Parks (MFWP). Ten female bears and eight male bears were moved from the Flathead River to the Cabinet Mountains during 2005–2022. Of 22 bears released through 2022, eight are known to have left the target area (one was recaptured and brought back, two returned in the same year, and one returned a year after leaving). Seven of the 22 bears are known to have died, though one of these individuals was killed 16 years after release. Five individuals are known to have reproduced (3 females and 2 males).

Recovery plan monitoring includes tracking of the number of females with cubs, distribution of females with young, and human caused mortality. Numbers of unduplicated females with cubs in the CYE varied from 2–5 per year and averaged 3.3 per year, 2017–2022. Sixteen of 22 bear management units (BMUs) had sightings of females with young. Human-caused mortality averaged 1.5 bears per year (0.8 female and 0.7 male), 2017–2022. Nine grizzly bears (5 females and 4 males) died due to known or probable human causes during 2017–2022, including four adult females (2 under investigation, 1 vehicle collision, 1 self-defense), one subadult female (management), two adult males (management and property defense), 2 subadult males (1 human under investigation and 1 misidentification).

Sex- and age-specific survival and reproductive rates yielded an estimated finite rate of increase (λ) of 1.016 (95% C.I. = 0.939–1.079, annual rate of increase = 1.6%) for 1983–2022 using Booter software with the unpaired litter size and birth interval option. The probability that the population was stable or increasing was 67%. Subadult female survival and adult female survival accounted for most of the uncertainty in λ, with reproductive rate, yearling survival, cub survival, and age at first parturition contributing much smaller amounts.

Berry counts indicated average production for huckleberry and serviceberry and below average production for mountain ash and buffaloberry during 2022.

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INTRODUCTION

Grizzly bear (*Ursus arctos*) populations south of Canada are currently listed as Threatened under the terms of the 1973 Endangered Species Act (16 U.S.C. 1531-1543). In 1993 a revised Recovery Plan for grizzly bears was adopted to aid the recovery of this species within ecosystems that they or their habitat occupy (USFWS 1993). Six areas were identified in the Recovery Plan, one of which was the Cabinet-Yaak Grizzly Bear Recovery Zone (CYE) of extreme northwestern Montana and northeast Idaho (Fig. 1). This area lies directly south of Canada and encompasses approximately 6,800 km^2. The Kootenai River bisects the CYE, with grizzly bear habitat within the Cabinet Mountains to the south and the Yaak River drainage to the north (Fig. 2). The degree of grizzly bear movement between the two portions was believed to be minimal but several movements by males into the Cabinet Mountains from the Yaak River and the Selkirk Mountains have occurred since 2012.

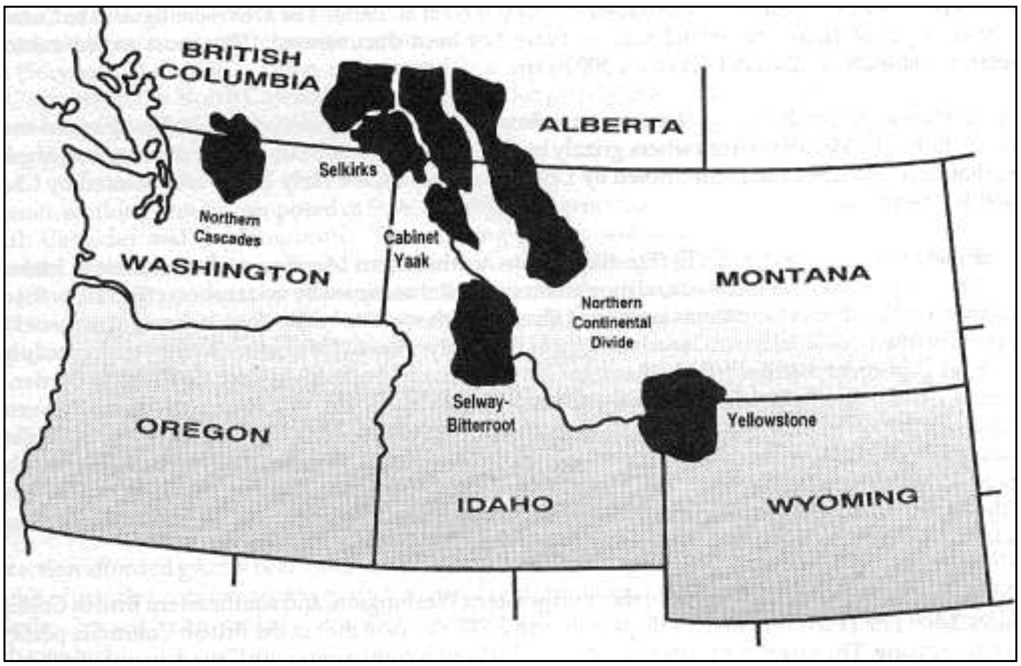

Figure 1. Grizzly bear recovery areas in the U.S., southern British Columbia, and Alberta, Canada.

Research on resident grizzly bears began south of the Kootenai River during the late 1970's. Erickson (1978) reported the results of a survey he conducted for bears and their sign in the Cabinet Mountains and concluded the population consisted of approximately a dozen animals. A trapping effort in 1979 and 1980 in the same area failed to capture a grizzly bear, but a female and yearling were observed (Thier 1981). In 1983 trapping efforts were resumed and intensified (Kasworm and Manley 1988). Three individual grizzly bears were captured and radio-collared during 1983–1987. Minimal reproduction was observed during the period and the population was believed to be declining toward extinction. To reverse this trend, a formal plan was proposed in 1987 to augment the Cabinet Mountains portion of the population with subadult female bears from outside the area (USFWS 1990, Servheen *et al*. 1987).

Two approaches for augmenting grizzly bears were proposed. The first involved transplanting adult or subadult grizzly bears from other areas of similar habitat to the Cabinet Mountains. Transplants would involve bears from remote areas that would have no history of conflict with humans. The use of subadult females was recommended because of their smaller home ranges and potential reproductive contribution. The second approach relied on the cross fostering of grizzly bear cubs to American black bear (*Ursus americanus*) females. Under this approach, grizzly bear cubs from zoos would be placed in the maternal dens of black bear females during March or April. The fostering of orphaned black bear cubs to surrogate black bear females has been used successfully in several areas (Alt and Beecham 1984, Alt 1984).

During public review of the augmentation program, many concerns were expressed which included human safety, conflicts with other land-uses, and long-term grizzly bear population goals. A citizen’s involvement committee was formed to aid information exchange between the public and the agencies. Representatives of several local organizations donated their time to further this purpose. The first product of this group was a question-and-answer brochure regarding grizzly bears in the CYE. This brochure was mailed to all box holders in Lincoln and Sanders counties. In response to concerns expressed by the committee, the augmentation proposal was modified to eliminate cross fostering and to reduce total numbers of transplanted bears to four individuals over five years. The beginning date of augmentation was also postponed for one year to allow additional public information and education programs.

Prior to 1986, little work was conducted on grizzly bears in the Yaak River portion of the CYE. Bears that used the area were thought to be largely transitory from Canada. However, a black bear study in the Yaak River drainage in 1986 and 1987 resulted in the capture and radio-collaring of five individual grizzly bears (Thier 1990). The Yaak River area has traditionally been an important source of timber for area mills, with timber harvesting the dominant use of the area. A pine beetle (*Dendroctonus ponderosae*) epidemic began in the mid 1970's. Large stands of lodgepole pine (*Pinus contorta*) were infected, which resulted in an accelerated timber-harvesting program with clearcutting the dominant silvicultural technique. A concern of environmental degradation, as well as the effects of timber harvesting on the local grizzly bear population, prompted a lawsuit against the Forest Service by a local citizen's group in 1983 (USFS 1989). To obtain additional information on the population status and habitat needs of grizzly bears using the area, the U.S. Forest Service and Montana Fish, Wildlife and Parks (MFWP) cooperated with the U.S. Fish and Wildlife Service (USFWS) initiating a long-term study. Field work began in June of 1989.

A population viability analysis recommended four areas of emphasis in future management for recovery of this population (Proctor *et al*. 2004). Those recommendations included: reducing human-caused mortality, implementing population augmentation in the Cabinet Mountains, enhancing population interchange by improving internal and external population linkage, and motorized access management on public lands to reduce mortality risk and habitat displacement. Recovery efforts have and will continue to emphasize these recommendations.

OBJECTIVES

A. Cabinet Mountains Population Augmentation:

Test grizzly bear augmentation techniques in the Cabinet Mountains to determine if transplanted bears will remain in the target area and ultimately contribute to the population through reproduction.

B. Recovery Zone Research and Monitoring:

1. Document grizzly bear distribution in the CYE.
2. Describe and monitor the grizzly bear population in terms of reproductive success, age structure, mortality causes, population trend, and population estimates and report this information through the grizzly bear recovery plan monitoring process.
3. Determine habitat use and movement patterns of grizzly bears. Determine habitat preference

by season and assess the relationship between human-altered habitats such as logged areas and grizzly bear habitat use. Evaluate grizzly bear movement permeability of the Kootenai River valley between the Cabinet Mountains and the Yaak River drainage and across the Moyie River Valley in British Columbia.

4. Determine the relationship between human activity and grizzly bear habitat use through the identification of areas used more or less than expected in relation to ongoing timber management activities, open and closed roads, and human residences.
5. Identify mortality sources and management techniques to limit human-caused mortality of grizzly bears.
6. Conduct black bear studies incidental to grizzly bear investigations to determine interspecific relations. Data on black bear densities, reproduction, mortality, movements, habitat-use, and food habits relative to grizzly bears will be gathered and analyzed.

STUDY AREA

The CYE (48º N, 116º W) encompasses approximately 6,800 km^2 of northwest Montana and northern Idaho (Fig. 2). The Cabinet Mountains constitute about 58% of the CYE and lie south of the Kootenai River. The Yaak River portion borders Canadian grizzly populations to the north. There are two potential linkage areas between the Yaak and the Cabinets – one between Libby and Troy and one between Troy and the Idaho border. Prior to 2012 we were unable to document any grizzly bear movement between these areas or grizzly bear use within these linkage zones; however, since that time we have documented several instances of male bears moving from the Selkirk Mountains or the Yaak River into the Cabinet Mountains. Approximately 90% of the recovery area is on public land administered by the Kootenai, Lolo, and Panhandle National Forests. Stimson Lumber Company is the main corporation holding a significant amount of land in the area. Individual ownership exists primarily along major rivers, and there are numerous patented mining claims along the Cabinet Mountains Wilderness boundary. The Cabinet Mountains Wilderness encompasses 381 km^2 of higher elevations of the study area in the Cabinet Mountains. Bonners Ferry,

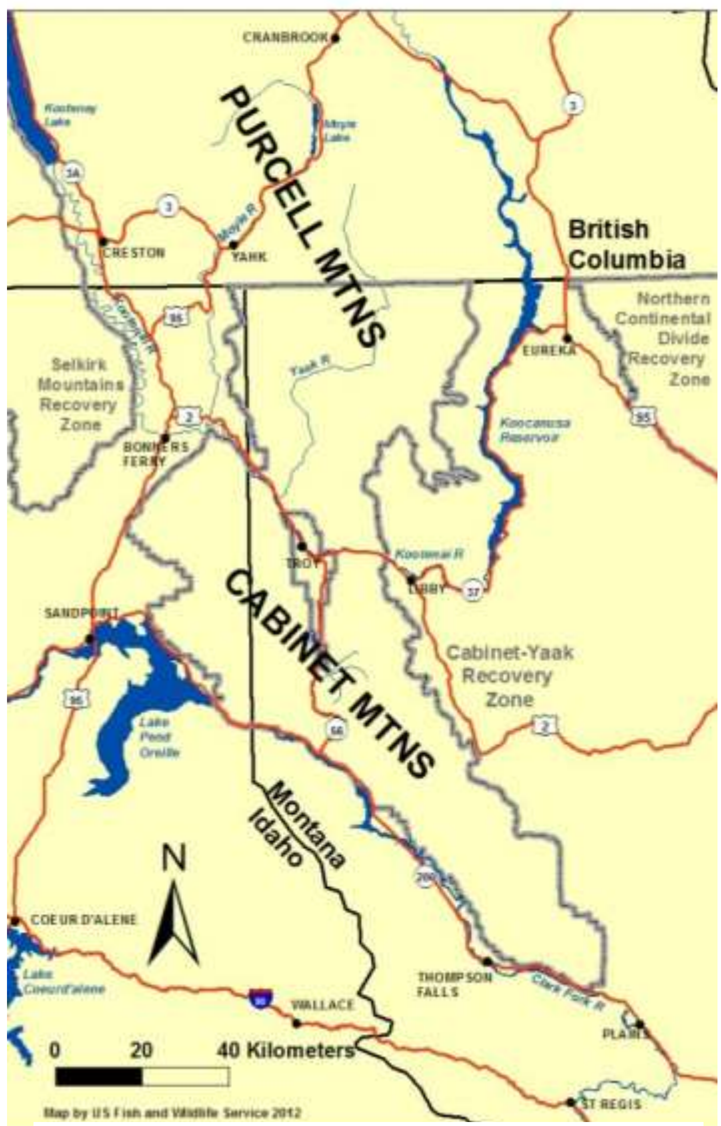

Figure 2. Cabinet-Yaak grizzly bear recovery zone.

Libby, Noxon, Sandpoint, Troy, Thompson Falls, and Trout Creek are the primary communities adjacent to the Cabinet Mountains.

Elevations in the Cabinet Mountains range from 610 m along the Kootenai River to 2,664 m at Snowshoe Peak. The area has a Pacific maritime climate characterized by short, warm summers and heavy, wet winter snowfalls. Lower, drier slopes support stands of ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*), whereas grand fir (*Abies grandis*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*) dominate lower elevation moist sites. Subalpine fir (*Abies lasiocarpa*), spruce (*Picea spp*.), and mountain hemlock (*Tsuga mertensiana*) dominate stands between 1,500 m and timberline. Mixed coniferous and deciduous tree stands are interspersed with riparian shrub fields and wet meadows along major drainages. Huckleberry (*Vaccinium spp.*) and mixed shrub fields are partially a result of wildfires that occurred in 1910 and 1929 and more recent stand replacing fires. Fire suppression has reduced wildfires as a natural force creating or maintaining berry-producing shrub fields.

The Yaak River drainage lies in the extreme northwestern corner of Montana, northeastern Idaho, and southern British Columbia and is bounded on the east and south by Lake Koocanusa and the Kootenai River, to the west by the Moyie River, and to the north by the international boundary. Two north-south trending mountain ranges dominate the landscape - the McGillivray range in the east and the Purcell range to the west. Topography is varied, with rugged, alpine glaciated peaks present in the Northwest Peaks Scenic Area. Rounded peaks and ridges cover most of the remaining area, a result of continental glaciation. Coniferous forests dominate, with cutting units the primary source of diversity. Much of the Yaak River is low gradient and the river tends to meander, creating lush riparian zones and meadows. Elevations range from 550 m at the confluence of the Kootenai and Moyie Rivers to 2,348 m atop Northwest Peak. Vegetation is diverse, with an overstory of western hemlock and western red cedar the indicated climax species on much of the study area. Ponderosa pine and Douglas-fir are common at lower elevations on south and west slopes. Subalpine fir and spruce dominate the upper elevations and cirque basins. Large stands of lodgepole pine and western larch (*Larix occidentalis*) occur at mid and upper elevations and are largely the result of extensive wildfires in the past. In recent decades, several stand altering fires have occurred in the Yaak River. Additionally, the Kootenai and Idaho Panhandle National Forests have implemented prescribed fire to promote grizzly bear habitat in recent years.

Understory and non-forested habitats include graminoid parks consisting primarily of fescue (*Festuca* spp.) and bluebunch wheatgrass (*Agropyron spicatum*), which occur at moderate to high elevations. Riparian shrub fields of red-osier dogwood (*Cornus stolonifera*) and hawthorn (*Crataegus douglasii*) are prevalent along major drainages. Buffaloberry (*Shepherdia canadensis*) is common under stands of open lodgepole pine while serviceberry (*Amelanchier alnifolia*) and chokecherry (*Prunus virginiana*) prevail on drier, rockier sites. Huckleberry shrub fields are often found under open timber canopies adjacent to graminoid parks, in old burns, in cutting units, and intermixed with beargrass (*Xerophyllum tenax*). Recent wildfires at upper elevations have had more influence on habitat in the CYE. An outbreak of pine bark beetles resulted in logging large areas at lower elevations during the 1980's. Large portions of upper elevations had been logged earlier in response to a spruce bark beetle (*Dendroctonus obesus*) epidemic.

During 1990–1994, Cabinet Mountains population augmentation trapping was conducted in the upper North Fork of the Flathead River drainage and the Wigwam River drainage in southeast British Columbia, approximately 10–40 km north of the U.S. border. Trapping was also conducted south of the international border in the North Fork of the Flathead River in 1992. Since 2005, augmentation trapping has occurred south of the international border in the Flathead River drainage.

METHODS

This annual report is cumulative and represents almost all data collected since the inception of this monitoring program since 1983. New information collected or made available to this study was incorporated into summaries and may change previous results.

Grizzly Bear Observations and Mortality

All grizzly bear observations and reports of sign (tracks, digs, etc.) by study personnel and the public were recorded. Grizzly bear sighting forms were sent to a variety of field personnel from different agencies to maximize the number of reports received. Sightings of grizzly bears were rated 1–5 with 5 being the best quality and 1 being the poorest. General definitions of categories are presented below, but it was difficult to describe all circumstances under which sightings were reported. Only sightings receiving ratings of 4 or 5 were judged credible for use in reports. Sightings that rate 1 or 2 may not be recorded in the database.

5 - Highest quality reports typically from study personnel or highly qualified observers. Sightings not obtained by highly qualified observers must have physical evidence such as pictures, track measurements, hair, or sightings of marked bears where marks are accurately described.

4 - Good quality reports that provide credible, convincing descriptions of grizzly bears or their sign. Typically, these reports include a physical description of the animal mentioning several characteristics. Observer had sufficient time and was close enough or had binoculars to aid identification. Observer demonstrates sufficient knowledge of characteristics to be regarded as a credible observer. Background or experience of observer may influence credibility.

3 - Moderate quality reports that do not provide convincing descriptions of grizzly bears. Reports may mention one or two characteristics, but the observer does not demonstrate sufficient knowledge of characteristics to make a reliable identification. Observer may have gotten a quick glimpse of the bear or been too far away for a good quality observation.

2 - Lower quality observations that provide little description of the bear other than the observer's judgment that it was a grizzly bear.

1 - Lowest quality observations of animals that may not have been grizzly bears. This category may also involve secondhand reports from someone other than the observer or location cannot be confirmed from firsthand observer.

Reported grizzly bear mortality includes all bears known to have died within the U.S. and within 10 mi (16 km) of the international border in Canada. Many bears collared in the U.S. have home ranges that extend into Canada. Mortality occurring in this area within Canada can affect calculations for U.S. populations. All radio collared bear mortality was reported regardless of location in the U.S. or Canada. Observations, remote camera photos, genetics data from hair snags, mortalities, and radio telemetry are used to determine numbers of unduplicated females with cubs, distribution of females with young, and mortality levels as directed by the grizzly bear recovery plan (USFWS 1993).

Survival and Mortality Calculations

Survival rates for all age classes except cubs were calculated by use of the Kaplan-Meier procedure as modified for staggered entry of animals (Pollock *et al*. 1989, Wakkinen and Kasworm 2004). Assumptions of this method include: marked individuals were representative of the population, individuals had independent probabilities of survival, capture and radio collaring did not affect future survival, censoring mechanisms were random, a time origin could be defined, and newly collared animals had the same survival function as previously collared animals. Censoring was defined as radio-collared animals lost due to radio failure, radio loss, or emigration of the animal from the study area. Kaplan-Meier estimates may differ slightly from Booter survival estimates used in the trend calculation. Survival rates were calculated separately for native, augmentation, and management bears because of biases associated with the unknown proportion of management bears in the population and known differences in survival functions.

Our time origin for each bear began at capture. If a bear changed age classification while radio-collared (i.e., subadult to adult), the change occurred on the first of February (the assigned birth date of all bears). Weekly intervals were used in the Kaplan-Meier procedure during which survival rates were assumed constant. No mortality was observed during the denning season. Animals were intermittently added to the sample over the study. Mortality dates were established based on radio telemetry, collar retrieval, and mortality site inspection. Radio failure dates were estimated using the last radiolocation date when the animal was alive.

Cub recruitment rates to 1 year of age were estimated as: {1 - (cub mortalities / total cubs observed)}, based on observations of radio-collared females (Hovey and McLellan 1996). Mortality was assumed when a cub disappeared or if the mother died with no other evidence of cub surviving. Cubs were defined as bears < 1.0-year-old.

Use of known human-caused mortality counts probably results in under-estimates of total human-caused mortality. Numerous mortalities were reported only because animals wore a radio-collar at the time of death. The public reporting rate of bears wearing radio-collars can be used to develop a correction factor to estimate unreported mortality (Cherry *et al*. 2002). The correction factor was not applied to natural mortality, management removals, mortality of radio-collared bears, or bears that died of unknown causes. All radioed bears used to develop the unreported mortality correction were >2 years-old and died from human related causes.

Cabinet Mountains augmentation individuals were counted as mortalities when removed from the Northern Continental Divide Ecosystem and are not counted again as mortalities in the CYE if they die during their first year (Appendix Table T1). Mortalities in Canada are not counted toward recovery goals (USFWS 1993) even though bears initially marked within the CYE have died in Canada. Bears originating in Canada that die in the US are counted.

Reproduction

Reproduction data was gathered through observations of radio-collared females with offspring and genetics data analyzed for maternity relationships. Because of possible undocumented neonatal loss of cubs, no determination of litter size was made if an observation occurred in late summer or fall. Inter-birth interval was defined as length of time between subsequent births. Age of first parturition was determined by presence or lack of cubs from observations of aged radio-collared bears and maternity relationships in genetics data from known age individuals.

Population Growth Rate

We used the software program Booter 1.0 (© F. Hovey, Simon Fraser University, Burnaby, B.C.) to estimate the finite rate of increase (λ, or lambda) for the study area's grizzly bear populations. The estimate of λ was based on adult and subadult female survival, yearling and cub survival, age at first parturition, reproductive rate, and maximum age of reproduction.

Booter uses the following revised Lotka equation (Hovey and McLellan 1996), which assumes a stable age distribution:

(1) $0 = \lambda^a - S_a \lambda^{a-1} - S_c S_y S_s^{a-2} m[1 - (S_a / \lambda)^{w-a+1}]$,

where S_a, S_s, S_y, and S_c are adult female, subadult female, yearling, and cub survival rates, respectively, a = age of first parturition, m = rate of reproduction, and w = maximum age. Booter calculates annual survival rates with a seasonal hazard function estimated from censored telemetry collected through all years of monitoring in calculation of λ. This technique was used on adults, subadults, and yearlings. Point estimates and confidence intervals may be slightly different from those produced by Kaplan-Meier techniques (differences in Tables 12 and 15). Survival rate for each class was calculated as:

$$(2) \quad S_i = \prod_{j=1}^{k} e^{-L_j(D_{ij} - T_{ij})}$$

where S_i is survival of age class i, k is the number of seasons, D_{ij} is the number of recorded deaths for age class i in season j, T_{ij} is the number of days observed by radio telemetry, and L_j is the length of season j in days. Cub survival rates were estimated by 1 - (cub mortalities / total cubs born), based on observations of radio-collared females. Intervals were based on the following season definitions: spring (1 April – 31 May), summer (1 June – 31 August), autumn (1 September – 30 November), and winter (1 December – 31 March). Intervals were defined by seasons when survival rates were assumed constant and corresponded with traditional spring and autumn hunting seasons and the denning season.

Booter provides several options to calculate a reproductive rate (m) and we selected three to provide a range of variation (McLellan 1989). The default calculation requires a reproductive rate for each bear based upon the number of cubs produced divided by the number of years monitored. We input this number for each adult female for which we had at least one litter size and at least three successive years of radio monitoring, captures, or observations to determine reproductive data. We ran the model with this data and produced a trend calculation. Among other options, Booter allows use of paired or unpaired litter size and birth interval data with sample size restricted to the number of females. If paired data is selected, only those bears with both a known litter size and associated inter-birth interval are used. The unpaired option allows the use of bears from which accurate counts of cubs were not obtained but interval was known or for instances where litter size was known but radio failure or death limited knowledge of intervals. To calculate reproductive rates under both these options, the following formula was used (from Booter 1.0):

$$(3) \quad m = \frac{\displaystyle\sum_{i=1}^{n} \frac{\sum_{j=1}^{p} L_{ij}}{\sum_{j=1}^{k} B_{ij}}}{n}$$

where n = number of females; j = observations of litter size (L) or inter-birth interval (B) for female i; p = number of observations of L for female i; and k = number of observations of B for female i. Note k and p may or may not be equal. Cub sex ratio was assumed to be 50:50 and maximum age of female reproduction (w) was set at 27 years (Schwartz *et al*. 2003). Average annual exponential rate of increase was calculated as $r = \log_e \lambda$ (Caughley 1977).

Bears captured and relocated to the Cabinet Mountains as part of population augmentation were not included in the population trend calculation (Appendix Table T1). None of these animals had any prior history of nuisance activity. Bears captured initially as objects of conflict captures were not included. Several native bears that were captured as part of a preemptive move to avoid nuisance activity were included. Currently collared bears that became management bears while wearing a collar were included.

Bootstrapping is a statistical procedure that resamples a single data set to create many simulated samples which allows calculation of confidence intervals. In the bootstrapping approach, a sample of size n is drawn from the population (S). The sampling distribution is created by resampling observations with replacement from S m times, with each resampled set having n observations. Increasing the number of resamples, m, will not increase the amount of information in the data. Resampling the original set 10,000 times is <u>not</u> more useful than resampling it 1,000 times. The amount of information within the set is dependent on the sample size, n, which will remain constant throughout each resample. The benefit of more resamples, then, is to derive a better estimate of the sampling distribution. Bootstrapping was run 5,000 times at the maximum allowed in the program. The program was run 10 times at this level. Lambda values in the each of the 10 runs were identical indicating that 5,000 replications were sufficient.

Capture and Marking

Capture and handling of bears followed an approved Animal Use Protocol through the University of Montana, Missoula, MT (061-14CSCFC111714 and 040-20HCCFC-092420). Capture of black bears and grizzly bears was performed under state permits (MT 2020-066-W and ID 140226) and U.S. Fish and Wildlife Service Endangered Species Permit [Section (i) C and D of the grizzly bear 4(d) rule, 50 60 CFR17.40(b)]. Bears were captured with leg-hold snares following the techniques described by Johnson and Pelton (1980) and Jonkel (1993). Snares were manufactured in house following the Aldrich Snare Co. (Clallam Bay, WA) design and consist of 6.5 mm braided steel aircraft cable. Bears were immobilized with either Telazol (tiletamine hydrochloride and zolazepam hydrochloride), a mixture of Ketaset (ketamine hydrochloride) and Rompun (xylazine hydrochloride), a mixture of Telazol and Dexmedetomidine, or a combination of Telazol and Rompun. Yohimbine and Atipamezole were the primary antagonists for Rompun and Dexmedetomidine. Drugs were administered intramuscularly with a syringe mounted on a pole (jab-stick), homemade blowgun, modified air pistol, or cartridge powered dart gun. Immobilized bears were measured, weighed, and a first premolar tooth was extracted for age determination (Stoneberg and Jonkel 1966). Blood, tissue and/or hair samples were taken from most bears for genetic and food use studies. Immobilized bears were given oxygen at a rate of 2–3 liters per minute. Recovering bears were dosed with Atropine and Diazepam.

All grizzly bears (including management bears captured at conflict sites) and some adult black bears (≥ 4.0 years old) were fitted with radio collars or ear tag transmitters when captured. Some bears were collared with Global Positioning System (GPS) radio collars. Collars were manufactured by Telonics® (Mesa, AZ) and ear tag transmitters were manufactured by Advanced Telemetry Systems® (Isanti, MN). To prevent permanent attachment, a canvas spacer was placed in the collars so that they would drop off in 1–3 years (Hellgren *et al*. 1988).

Trapping efforts were typically conducted from May through September. In 1986–1987, snares were placed in areas where black bear captures were maximized on a defined study area of 214 km^2 (Thier 1990). Snares were placed over a broader area during 1989–1994 to maximize grizzly bear captures. Trap sites were usually located within 200 m of an open road to allow vehicle access. Beginning in 1995, an effort was made to capture and re-collar known grizzly bears in the Yaak River and augmentation bears in the Cabinet Mountains. In 2003, trapping was initiated in the Salish Mountains south of Eureka, Montana to investigate bear movements in the intervening area between the Northern Continental Divide and CYE recovery zones. Trapping was conducted along Highway 2 in northwest Montana and along Highway 3 in southeast British Columbia to collar bears with GPS radio collars during 2004–2010. During 2011, trapping was initiated along Highway 95 near McArthur Lake in northern Idaho and along Interstate 90 near Lookout Pass in Montana and Idaho. All four studies were designed to examine bear population connectivity across river valleys with highways and human habitation. Highway 2, 95, and I-90 studies utilized black bears as surrogates for grizzly bears because of the small number of grizzly bears in the valley. The Highway 3 effort in British Columbia collared grizzly bears and black bears. Much of the trapping effort in the Yaak and Cabinet Mountains areas involved the use of horses on backcountry trails and closed logging roads. Traps were checked daily. Bait consisted primarily of road-killed ungulates.

Trapping for population augmentation was conducted in the North Fork of the Flathead River in BC during 1990–1994. Female grizzly bears < 6 years old (or prior to first reproduction) and > 35 kg were deemed suitable for transplant. Other captured grizzly bears were released with collaring to aid an ongoing BC bear study. Capture efforts for bears transplanted in 2005–2021 occurred primarily in the North Fork and South Fork of the Flathead River in the US by MFWP. No suitable bears were captured in 1991, 2007, 2017, 2020, or 2021.

Hair Sampling for DNA Analysis

This project originally sought evidence of grizzly bears in the Cabinet Mountains using DNA to understand the fates of four bears transplanted during 1990–1994. The program used genetic information from hair-snagging with remote-camera photo verification to identify transplanted bears or their offspring living in the Cabinet Mountains. Since then, sampling has expanded into the Yaak drainage and project objectives now include: observations of females with young, sex ratio of captured bears, relatedness as well as genetic diversity measures of captured bears, and evidence of interpopulation movements of individuals.

Sampling occurred from May–October of 2002–2022 in the CYE in Idaho and Montana following standard hair snagging techniques (Woods *et al.* 1999). Sampling sites were established based on location of previous sightings, sign, and radio telemetry from bears in the CYE. A 5 km x 5 km grid (25 km^2) was used to distribute sample sites across the Cabinet Mountains in 2003 (n =184). Each grid cell contained a single sample point near the center of the cell. Actual site location was modified based on access to the site and habitat quality near the site. Sites were baited with 2 liters of a blood and fish mixture to attract bears across a barbwire perimeter placed to snag hair. Sites were deployed for 2 weeks prior to hair collection. One third of sites were sampled during each of the months of June, July, and August. Sample sites were stratified by elevation with lowest elevation sites sampled in June and highest elevation sites sampled in August. Trail cameras were used at some sites. Hair was collected and labeled to indicate: number and color of hairs, site location, date, and barb number. These data aided sorting hair to minimize lab costs. Solid black hairs were judged to be from black bears and not analyzed further. Samples collected as a part of this effort and other hair samples collected in previous years either from known grizzly bears or samples that outwardly appeared to be grizzly bear were sent to Wildlife Genetics International Laboratory in Nelson, British Columbia for DNA extraction and genotyping. Hairs visually identified as black bear hair by technicians at the Laboratory were not processed and hairs processed and determined to be black bear were not genotyped. Dr. Michael Proctor (Birchdale Ecological) is a cooperator on this project and assisted with genetic interpretations. He has previously analyzed genetic samples from the Yaak portion of this recovery zone (Proctor 2003). Hair snag sampling effort during 2012 was altered and reduced to avoid conflicts with a US Geological Survey (USGS) study to estimate CYE grizzly bear population size (Kendall *et al*. 2016). USGS was concerned that our sample sites might influence capture success at their sites.

The USGS study established and sampled 1,373 rub trees across the CYE during 2012.

The study made preliminary data available regarding the success of this effort by providing us coordinates of all trees and those trees that produced grizzly bear samples. Sites that produced grizzly bear hair and adjacent sites that were easily sampled in conjunction with successful sites were resampled 2–4 times during 2013–2022. Collected hairs were evaluated by study personnel and samples not judged to be probable black bear were sent to Wildlife Genetics International Laboratory in Nelson, BC for DNA extraction and genotyping.

Movements of radio-collared bears, multiple locations of genetically marked bears, and maternity/paternity analysis were typically used to identify migrants between various bear populations. In the absence of this type of data, we used methods as applied in Proctor *et al*. (2005) and further used in Proctor *et al*. (2012) where program GeneClass uses an algorithm to assign a probability of being a migrant by translating log ratio of assignment to each population into probabilities with thresholds using realistic Type I error rates (Piry et al. 2004, Paetkau et al. 2004). The use of TYPE I error rate in this algorithm is important as it allows researchers to differentiate true migrants from those who might appear as migrants by chance. A bear is determined to be a migrant when it has a very high probability of being born in a population other than the one it was captured in, but also when it is beyond the number of 'putative migrants' who cross assign by chance (the TYPE I error rate). For more detailed treatment of this process see Proctor *et al*. (2005).

We used bears that were DNA sampled prior to 2006, after which population interchange increased and reduced precision in determining population of origin. More specifically, we used a sample of bears from each population: the South Selkirk (n = 49), Yahk (n = 33, south of Highway 3) and South Purcells (n = 23, north of BC Highway 3) where we were certain of their origin. This contained 2 sets of bears,

- those captured prior to 2005 as this is when we determined inter-population exchange started to increase (Proctor *et al*. 2018) and
- those whose population of origin was known because the offspring were in a perfectly matched triad: mother – father – offspring where the offspring shared an allele at each of 21 loci with each parent and the parents were captured prior to 2005.

Then we added individual bear suspected of being migrants into the analysis dataset, to assess what their probability of origin was, relative to bears of known origin. Migrants we determined to be real had the highest log ratios, of all 'putative' migrants and they were beyond the number of expected 'chance migrants' (the TYPE I error rate). For example, using an alpha value of 0.01 means that 1 in 100 of samples would appear as a migrant by chance alone, and thus would not be real. So, if our analysis identified 4 migrants in a sample of 100 bears, we could then conclude that 3 were likely real migrants as 1 was a migrant by chance (the TYPE I error rate). We would then take the 3 putative migrants with the greatest log ratio and probability of being a migrant and call them real migrants. In practice, the log ratios of these real migrants typically reflect probabilities that are 100–10000 times higher probabilities being a migrant than a resident.

Radio Monitoring

Attempts were made to obtain aerial radiolocations on all instrumented grizzly bears at least once each week during the 7–8 month period in which they were active. GPS collars were programmed to attempt a location fix every 1–4 hours. Collar releases were programmed to drop in early October for retrieval. Expected collar life varied from 1–3 field seasons over the course of the study depending upon model of collar, programming, and size and age-class of the bear. Augmentation bears were monitored daily following release for at least the first two weeks and usually three times per week following. In addition, efforts were made to obtain as many ground locations as possible on all bears, usually by triangulating from a vehicle. Life home ranges (minimum convex polygons; Hayne 1959) were calculated for grizzly bears during the study period. We generated home range polygons using ArcGISPro 2.3.3.

Grizzly and black bears were collared with GPS collars during 2004–2010 to study movements across the Moyie River Valley and Highway 3 in British Columbia. Black bears were tested for their potential to act as surrogates that would predict grizzly bear movements. Collars attempted locations every 1–2 hours depending on configuration and data were stored within the collar. Weekly aircraft radio monitoring was conducted to check for mortality signals and approximate location. From 2004 to 2007, black bears were fitted with similar GPS radio collars to study movements across the Kootenai River Valley and Highway 2 in Montana, as part of linkage monitoring between the Yaak River and Cabinet Mountains. In 2008–2012, black bears were fitted with GPS collars in the Yaak River study area and along the Clark Fork River on the south end of the Cabinet Mountains study area.

Scat analysis

Bear scats were collected, tagged, and either dried or frozen between 1981 and 1992. We only considered scats associated with definite grizzly bear sign (tracks, hair, and radio location of instrumented bear) as from grizzly bears. Food habits analysis was completed by William Callaghan (Florence, MT) and Kevin Frey (Bozeman, MT). Samples were rinsed with hot and cold water over 2 different size mesh screens (0.40 and 0.24 cm). The retained contents were identified to species with the aid of microscopes. Plant part was recorded and percent volume was visually estimated. We corrected scat volumes with correction factors that incorporate different digestibility of various food items (Hewitt and Robbins 1996).

Isotope analysis

Hair samples from known age, captured grizzly bears were collected and analyzed for stable isotopic ratios. Stable isotope signatures indicate source of assimilated (i.e., digested) diet of grizzly bears. Nitrogen stable isotope ratios (^{15}N) indicate trophic level of the animal; an increased amount of ingested animal matter yields higher nitrogen isotope ratios while lower values tie to more plant-based diets. In our ecosystem, carbon isotope signatures vary depending on the amount of native C3 vs. C4 plant matter ingested. Corn, a C4 plant, has elevated $^{13}C/^{12}C$ ratios relative to native C3 plants. Because much of the human food stream is composed of corn, carbon stable isotope signatures allow for verification or identification of human food conditioned bears.

Hair samples were rinsed with a 2:1 chloroform:methanol solution to remove surface contaminants. Samples were then ground in a ball mill to homogenize the sample. Powdered hair was then weighed and sealed in tin boats. Isotope ratios of $\delta^{13}C$ and $\delta^{15}N$ were assessed by continuous flow methods using an elemental analyzer (ECS 4010, Costech Analytical, Valencia, California) and a mass spectrometer (Delta PlusXP, Thermofinnigan, Bremen, Germany) (Brenna *et al*. 1997, Qi *et al*. 2003).

Berry Production

Quantitative comparisons of annual fluctuations and site-specific influences on fruit production of huckleberry and buffaloberry were made using methods similar to those established in Glacier National Park (Kendall 1986). Transect line origins were marked by a painted tree or by surveyors' ribbon. A specific azimuth was followed from the origin through homogenous habitat. At 0.5 m intervals, a 0.04 m^2 frame (2 x 2 decimeter) was placed on the ground or held over shrubs and all fruits and pedicels within the perimeter of the frame were counted. If no portion of a plant was intercepted, the frame was advanced at 0.5 m intervals and empty frames were counted. Fifty frames containing the desired species were counted on each transect. Timbered shrub fields and mixed shrub cutting units were the primary sampling areas to examine the influence of timber harvesting on berry production within a variety of aspects and elevations. Notes on berry phenology, berry size, and plant condition were recorded. Service berry, mountain ash, and buffaloberry production was estimated from 10 marked plants at several sites scattered across the recovery area. Since 1989 several sites have been added or relocated to achieve goals for geographic distribution. Some transects were eliminated because plant succession or fire had affected production. Monitoring goals identified an annual trend of berry production and did not include documenting the effects of succession.

Huckleberry sampling began in 1989 at 11 transect sites. Fifteen sites were sampled in 2022. Buffaloberry sampling began in 1990 at 5 sites. Due to the dioecious (separate male and female plants) nature of buffaloberry, all frame count transects were dropped in 2007 in favor of marking 10 plants per site and counting the berries on marked plants. Two sites were sampled in 2022. Serviceberry productivity was estimated by counting berries on 10 marked plants at 5 sample sites beginning in 1990. Four sites were sampled in 2022. In 2001, three new plots were established to document berry production of mountain ash (*Sorbus scopulina*). Ten plants were permanently marked at each site for berry counts, similar to the serviceberry plots. Production counts occurred at 3 sites in 2022.

Temperature and relative humidity data recorders (LogTag®, Auckland, New Zealand) were placed at sites beginning in 2011. These devices record conditions at 90-minute intervals and will be retrieved, downloaded, and replaced at annual intervals. We used a berries/plot or berries/plant calculation as an index of berry productivity. Transects were treated as the independent observation unit. For each year observed, mean numbers of berries/plant (berries/plot) were used as our transect productivity indices. For each year, we indicate whether berry productivity is above average (annual 95% confidence interval falls above study-wide mean), average (confidence interval encompasses the study-wide mean), or below average (confidence interval falls below study-wide mean).

Body Condition

Field measurements and bioelectric impedance analysis (BIA) of captured bears allows us to estimate body condition of grizzly bears in the Cabinet-Yaak (Farley and Robbins 1994). More specifically, these methods allow for estimation of body fat content, an important indicator of quality of food resources and a predictor of cub production for adult females. We attempted estimation on captured bears, characterized by sex-age class, reproductive status, area of capture, and management status. ANOVA and post-hoc Tukey-HSD tests were performed to test for differences in body fat content across factors (management status, sex, and month of capture). Body condition (primarily, body fat content) of reproductive-aged females offers an *indirect* metric of whether females were of a physiological condition that supports cub production (Robbins *et al.* 2012).

RESULTS AND DISCUSSION

Research and monitoring with telemetry and full-time personnel were present since 1983 and therefore this date represents the most intense period of data collection. All tables and calculations are updated when new information becomes available. For instance, genetic analysis determined the sex of a previously unknown mortality (2012) and a bear originally identified as a probable mortality (2003) was removed when genetic evidence later indicated that the bear survived that incident. Covid-19 protocols reduced the monitoring effort substantially during 2020 and a lesser extent during 2021.

Grizzly Bear Occupied Range Mapping

Grizzly bear occurrence data from telemetry sightings, mortality, and genetics was used to produce a map of occupied range for male and female grizzly bears and females only in the Cabinet-Yaak and Selkirk recovery areas during 2000-2022 (Appendix 1).

Grizzly Bear Observations and Recovery Plan Targets

Grizzly bear observations and mortality from public and agency sightings or records were appended to databases. These databases include information from the U.S. and Canada from 1982-2022. The file includes over 2,100 credible sightings, tracks, scats, digs, genetic detections from hair, and trail camera photographs dating from 1960 and over 140 mortalities dating from 1949 (Table 1, Appendix Table 2, Fig. 3). Credible sightings were those rating 4 or 5 on the 5-point scale (see page 9). Sixty-seven instances of grizzly bear mortality were detected inside or within 10 mi (16 km) of the CYE during 1982–2022 (Table 1). Seventy-five credible sightings were reported to this study that rated 4 or 5 (most credible) during 2022. Sightings of females with young or mortalities that occur outside the recovery zone are counted in the closest BMU.

<u>Recovery Target 1: 6 females with cubs over a running 6-year average both inside the recovery zone and within a 10-mile area immediately surrounding the recovery zone</u>.
Three credible sightings of a female with cubs occurred during 2022 in Bear Management Units (BMUs) 5,12, and 20 (Tables 2, 3, 4, 5, Fig. 4 and 5). There appeared to be 3 unduplicated females with cubs in the recovery area or within 10 miles during 2022. Fourteen credible sightings of a female with yearlings or 2-year-olds occurred in BMUs 4, 5, 6, 11, 12, 13, 14, 15, 16, 17, and 20. Females with young identified in the 10-mile buffer were counted in the nearest BMU. Unduplicated sightings of females with cubs (excluding Canada) varied from 2–5 per year and averaged 3.3 per year from 2017–2022 (Tables 3, 4). This target has not been met.

<u>Recovery Target 2: 18 of 22 BMU's occupied by females with young from a running 6-year sum of verified evidence.</u>

Fourteen of 22 BMUs in the recovery zone had sightings of females with young (cubs, yearlings, or 2-year-olds) during 2017–2022 (Figs. 4, 5, Table 6). Occupied BMUs were: 1, 2, 4, 5, 6, 10, 11, 12, 13, 14, 15, 16, 17, and 19, 20, and 21. This target has not been met.

<u>Recovery Target 3: The running 6-year average of known, human-caused mortality should not exceed 4 percent of the population estimate based on the most recent 3-year sum of females with cubs. No more than 30 percent shall be females. These mortality limits cannot be exceeded during any 2 consecutive years for recovery to be achieved.</u>

There were three known human-caused mortalities during 2022. Nine known or probable human caused mortalities of grizzly bears have occurred in or within 10 miles of the CYE in the U.S. during 2017–2022 (Table 1), including 5 females (BMUs 5, 7, 11) and 4 males (BMUs 2, 13, and 17). These mortalities included four adult females (two under investigation, a self-defense, and a vehicle collision), one subadult female (management), two adult males (management and property defense), and two subadult males (mistaken identity, and human caused under investigation). We estimated minimum population size by dividing observed females with cubs during 2020–2022 (10) minus any human-caused adult female mortality (2) by 0.6 (sightability correction factor as specified in the recovery plan) then divide the resulting dividend by 0.284 (adult female proportion of population, as specified in the recovery plan) (Tables 3, 4) (USFWS 1993). This resulted in a minimum population of 47 individuals. The recovery plan stated, "any attempt to use this parameter to indicate trends or precise population size would be an invalid use of these data". Applying the 4% mortality limit to the minimum calculated population resulted in a total mortality limit of 1.9 bears per year. The female limit is 0.6 females per year (30% of 1.9). Average annual human-caused mortality for 2017–2022 was 1.5 bears/year and 0.8 females/year. The mortality levels for total bears were at or less than the calculated limit but females exceeded the calculated limit during 2017–2022. The recovery plan established a goal of zero human-caused mortality for this recovery zone due to the initial low number of bears, however it also stated, “In reality, this goal may not be realized because human bear conflicts are likely to occur at some level within the ecosystem.” Therefore, even if the goal of zero mortality is not met, it is important to evaluate the targets to determine if we are making progress towards recovery. During the 2017–2022 reporting period, total mortality met the target, but females did not. All tables and calculations were updated as new information becomes available.

Table 1. Known and probable grizzly bear mortality in or within 16 km of the Cabinet-Yaak grizzly bear recovery zone (including Canada). Includes all radio collared bears regardless of location, 1982–2022.

Mortality Date	Tag #	Sex	Age	Mortality Cause	Location	Open Road <500 m	Public Report	Owner[1]
October, 1982	None	M	AD	Human, Poaching	Grouse Creek, ID	No	Yes	USFS
October, 1984	None	Unk	Unk	Human, Mistaken Identity, Black bear	Harvey Creek, ID	Yes	Yes	USFS
9/21/1985	14	M	AD	Human, Self Defense	Lyons Gulch, MT	No	Yes	USFS
7/14/1986	106 cub	Unk	Cub	Natural	Burnt Creek, MT	Unk	No	USFS
10/25/1987	None	F	Cub	Human, Mistaken Identity, Elk	Flattail Creek, MT	No	Yes	USFS
5/29/1988[1]	134	M	AD	Human, Legal Hunter kill	Moyie River, BC	Yes	Yes	BC
10/31/1988	None	F	AD	Human, Self Defense	Seventeen Mile Creek, MT	No	Yes	USFS
7/6/1989	129	F	3	Human, Research	Burnt Creek, MT	Yes	No	USFS
1990	192	M	2	Human, Poaching	Poverty Creek, MT	Yes	Yes	USFS
1992	678	F	37	Unknown	Trail Creek, MT	No	Yes	USFS
7/22/1993	258[2]	F	7	Natural	Libby Creek, MT	No	No	USFS
7/22/1993	258-cub	Unk	Cub	Natural	Libby Creek, MT	No	No	USFS
10/4/1995[1]	None	M	AD	Human, Management	Ryan Creek, BC	Yes	Yes	PRIV
5/6/1996	302	M	3	Human, Undetermined	Dodge Creek, MT	Yes	No	USFS
October, 1996[1]	355	M	AD	Human, Undetermined	Gold Creek, BC	Yes	No	BC
June? 1997	None	M	AD	Human, Poaching	Libby Creek, MT	Unk	Yes	PRIV
6/4/1999	106	F	21	Natural, Conspecific	Seventeen Mile Creek, MT	No	No	USFS
6/4/1999	106-cub	M	Cub	Natural, Conspecific	Seventeen Mile Creek, MT	No	No	USFS
6/4/1999	106-cub	F	Cub	Natural, Conspecific	Seventeen Mile Creek, MT	No	No	USFS
10/12/1999[1]	596	F	2	Human, Self Defense	Hart Creek, BC	Yes	Yes	BC
11/15/1999	358	M	15	Human, Management	Yaak River, MT	Yes	Yes	PRIV
6/1/2000[1]	538-cub	Unk	Cub	Natural	Hawkins Creek, BC	Unk	No	BC
6/1/2000[1]	538-cub	Unk	Cub	Natural	Hawkins Creek, BC	Unk	No	BC
7/1/2000	303-cub	Unk	Cub	Natural	Fowler Creek, MT	Unk	No	USFS
11/15/2000	592	F	3	Human, Undetermined	Pete Creek MT	Yes	No	USFS
5/5/2001	None	F	1	Human, Mistaken Identity, Black Bear	Spread Creek, MT	Yes	Yes	USFS
6/18/2001[1]	538-cub	Unk	Cub	Natural	Cold Creek, BC	Unk	No	BC
6/18/2001[1]	538-cub	Unk	Cub	Natural	Cold Creek, BC	Unk	No	BC
9/6/2001	128	M	18	Human, Undetermined	Swamp Creek, MT[3]	Yes	No	PRIV
October, 2001	None	F	AD	Human, Train collision	Elk Creek, MT	Yes	Yes	MRL
6/24/2002[1]	None	Unk	Unk	Human, Mistaken Identity, Hounds	Bloom Creek, BC	Yes	Yes	BC
7/1/2002	577	F	1	Natural	Marten Creek, MT	Yes	No	USFS
10/28/2002	None	F	4	Human, Undetermined	Porcupine Creek, MT	Yes	Yes	USFS
11/18/2002	353/584	F	7	Human, Poaching	Yaak River, MT	Yes	Yes	PRIV
11/18/2002	None	F	Cub	Human, Poaching	Yaak River, MT	Yes	Yes	PRIV
11/18/2002	None	Unk	Cub	Human, Poaching	Yaak River, MT	Yes	No	PRIV
10/15/2004[1]	None	F	AD	Human, Management	Newgate, BC	Yes	Yes	PRIV
2005?	363	M	14	Human, Undetermined	Curley Creek, MT	Yes	Yes	USFS
10/9/2005	694	F	2	Human, Undetermined	Pipe Creek, MT	Yes	No	PCT
10/9/2005	None	F	2	Human, Train collision	Government Creek, MT	Yes	Yes	MRL
10/19/2005	668	M	3	Human, Mistaken Identity, Black bear	Yaak River, MT	Yes	Yes	PRIV
5/28/2006[1]	None	F	4	Human, Research	Cold Creek, BC	Yes	No	BC
6/1/2006[1]	292	F	5	Human, Management	Moyie River, BC	Yes	Yes	PRIV
9/22/2007	354	F	11	Human, Self Defense	Canuck Creek, MT	Yes	Yes	USFS
9/24/2008	?	M	3	Human, Under Investigation	Fishtrap Creek, MT	Yes	Yes	PCT
10/20/2008[2]	790	F	3	Human, Poaching	Clark Fork River. MT	Yes	Yes	PRIV

Mortality Date	Tag #	Sex	Age	Mortality Cause	Location	Open Road <500 m	Public Report	Owner[1]
10/20/2008[2]	635	F	4	Human, Train collision	Clark Fork River. MT	Yes	Yes	MRL
11/15/2008[1]	651	M	13	Human, Mistaken Identity, Wolf Trap	NF Yahk River, BC	Yes	Yes	BC
6/5/2009	675-cub	Unk	Cub	Natural	Copper Creek, ID	Unk	No	USFS
6/5/2009	675-cub	Unk	Cub	Natural	Copper Creek, ID	Unk	No	USFS
6/7/2009[3]	None	M	3-4	Human, Mistaken Identity, Black bear	Bentley Creek, ID[3]	Yes	Yes	PRIV
11/1/2009	286	F	Adult	Human, Self Defense	EF Bull River, MT	No	Yes	USFS
6/25/2010	675-cub	Unk	Cub	Natural	American Creek, MT	Unk	No	USFS
7/7/2010	303-cub	Unk	Cub	Natural	Bearfite Creek, MT	Unk	No	USFS
9/6/2010[1]	1374	M	2	Human, Under Investigation	Hawkins Creek, BC	Yes	No	BC
9/24/2010[1]	None	M	2	Human, Wolf Trap, Selkirk Relocation	Cold Creek, BC	Yes	Yes	BC
10/11/2010	None	M	AD	Human, Under Investigation	Pine Creek, MT	No	Yes	USFS
2011	None	F	1	Unknown	EF Rock Creek, MT	No	Yes	USFS
9/16/2011	None	M	AD	Human, Mistaken Identity	Faro Creek, MT	No	Yes	USFS
11/13/2011	799	M	4	Human, Mistaken Identity	Cherry Creek, MT	Yes	Yes	USFS
11/24/2011	732	M	3	Human, Defense of life	Pipe Creek, MT	Yes	Yes	PRIV
November 2011	342	M	19	Human, Under Investigation	Little Creek, MT	Yes	Yes	PRIV
5/18/2012	None	F	AD	Human, Under Investigation	Mission Creek, ID	Yes	Yes	USFS
5/18/ 2012	None	M	Cub	Human, Under Investigation	Mission Creek, ID	Yes	Yes	USFS
4/30/2012[1]	5381	M	8	Human, Management	Duck Creek, BC	Yes	Yes	PRIV
10/26/2014	79575279	M	6	Human, Self Defense	Little Thompson River, MT	Yes	Yes	PRIV
5/15/2015[1]	552-ygl	Unk	1	Natural	Linklater Creek, BC	Unk	No	BC
5/23/2015[2]	921	F	3	Natural	NF Ross Creek, MT	No	No	USFS
5/24/2015	None	M	4?	Human, Poaching	Yaak River, MT	Yes	Yes	USFS
8/12/2015	818	M	2	Human, Self Defense	Moyie River, ID	Yes	Yes	PRIV
9/30/2015[2]	924	M	2	Human, Mistaken Identity	Beaver Creek, ID[3]	Yes	Yes	PRIV
10/11/2015	1001	M	6	Human, Under Investigation	Grouse Creek, ID	Yes	No	PRIV
9/1/2017[1]	922	M	5	Human, Self Defense	Porthill Creek, BC	Yes	Yes	BC
4/16/2018	821	M	4	Unknown probable	Pine Creek, MT	Yes	Yes	PRIV
5/21/2018	9077	M	3	Human, Under Investigation	Bristow Creek, MT	Yes	No	USFS
9/5/2018	810	F	15	Human, Under Investigation	Spruce Creek, ID	Yes	No	USFS
5/24/2019	None	Unk	Cub	Natural	Skin Creek, MT	No	No	USFS
5/24/2019	None	Unk	Cub	Natural	Skin Creek, MT	No	No	USFS
8/2/2019	None	F	Adult	Human, Self Defense	EF Bull River, MT	No	Yes	USFS
11/10/2019	770	M	25	Human, Management	Libby Creek, MT	Yes	Yes	PRIV
5/22/2020[1]	675	F	18	Human, Self Defense	Cold Creek, BC	Yes	Yes	BC
8/31/2020	BC 4-121	M	3	Human, Mistaken Identity	Deer Creek, ID	No	Yes	USFS
11/19/2020	729	F	10	Human, Under Investigation	Clay Creek, MT	Yes	No	PRIV
July 2021	None	M	1	Natural	4th of July, MT	Unk	No	USFS
5/22/2021[1]	None	M	Unk	Human, Self Defense, hounds	Bloom Creek, BC	No	Yes	BC
6/24/2022	893	F	3	Human, Management	Silver Butte Creek, MT	Yes	Yes	PRIV
8/24/2022	None	F	AD	Human, Vehicle collision	West Fisher HWY2, MT	Yes	Yes	MDT
9/22/2022	831	F	25	Natural	St. Paul Lake, MT	No	No	USFS
9/23/2022	726	M	13	Human, Property	Pipe Creek, MT	Yes	Yes	PRIV

[1]The recovery plan (USFWS 1993) specifies that human-caused mortality or female with young sightings from Canada will not be counted toward recovery goals in the CYGBRZ. BC – British Columbia, MRL – Montana Rail Link, MDT-Montana Dept. of Transportation, PRIV – Individual Private, PCT – Plum Creek Timber Company, USFS – U.S. Forest Service.
[2]Bears transplanted to the Cabinet Mountains under the population augmentation program were counted as mortalities in their place of origin and are not counted toward recovery goals in this recovery zone.
[3]Bear Killed more than 10 miles outside recovery zone in the US and not counted in recovery calculations.

Table 2. Credible grizzly bear sightings, credible female with young sightings, and known human caused mortality by bear management unit (BMU) or area, 2022. Females with young occurring outside of the recovery zone, but within 10 miles in the U.S. are counted in the nearest BMU for occupancy.

BMU OR AREA	2022 Credible[1] Grizzly Bear Sightings	2022 Sightings of Females with Cubs (Total)	2022 Sightings of Females with Cubs[2] (Unduplicated)	2022 Sightings of Females with Yearlings or 2-year-olds (Total)	2022 Sightings of Females with Yearlings or 2 year-olds[2] (unduplicated)	2022 Human Caused Mortality
1	0	0	0	0	0	0
2	1	0	0	0	0	0
3	1	0	0	0	0	0
4	4	0	0	1	1	0
5	23	1	1	1	1	0
6	3	0	0	1	0	0
7	0	0	0	0	0	2
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	5	0	0	2	1	0
12	8	1	1	2	1	0
13	12	0	0	1	0	0
14	4	0	0	1	1	0
15	2	0	0	1	0	0
16	1	0	0	1	0	0
17	1	0	0	1	0	1
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	3	0	0	1	1	0
21	0	0	0	0	0	0
22	1	0	0	0	0	0
BC Yahk GBPU[3]	0	0	0	0	0	1
Cabinet Face	0	0	0	0	0	0
Mission-Moyie	7	0	0	1	0	0
Fisher River[4]	2	1	0	0	0	0
South Clark Fork Idaho[4]	2	1	1	0	0	0
South Clark Fork Montana[4]	2	0	0	0	0	0
Troy	0	0	0	0	0	0
West Kootenai	2	0	0	0	0	0
2022 TOTAL	81	2	2	21	7	4

[1]Credible sightings are those rated 4 or 5 on a 5-point scale (see methods).
[2]Sightings may duplicate the same animal in different locations. Only the first sighting of a duplicated female with cubs is counted toward total females (Table 3), however subsequent sightings contribute toward occupancy (Table 8).
[3]Areas in Canada outside of Cabinet-Yaak recovery zone that do not count toward recovery goals.
[4]Areas with portions <16 km outside the Cabinet-Yaak recovery zone that may not count toward recovery goals.

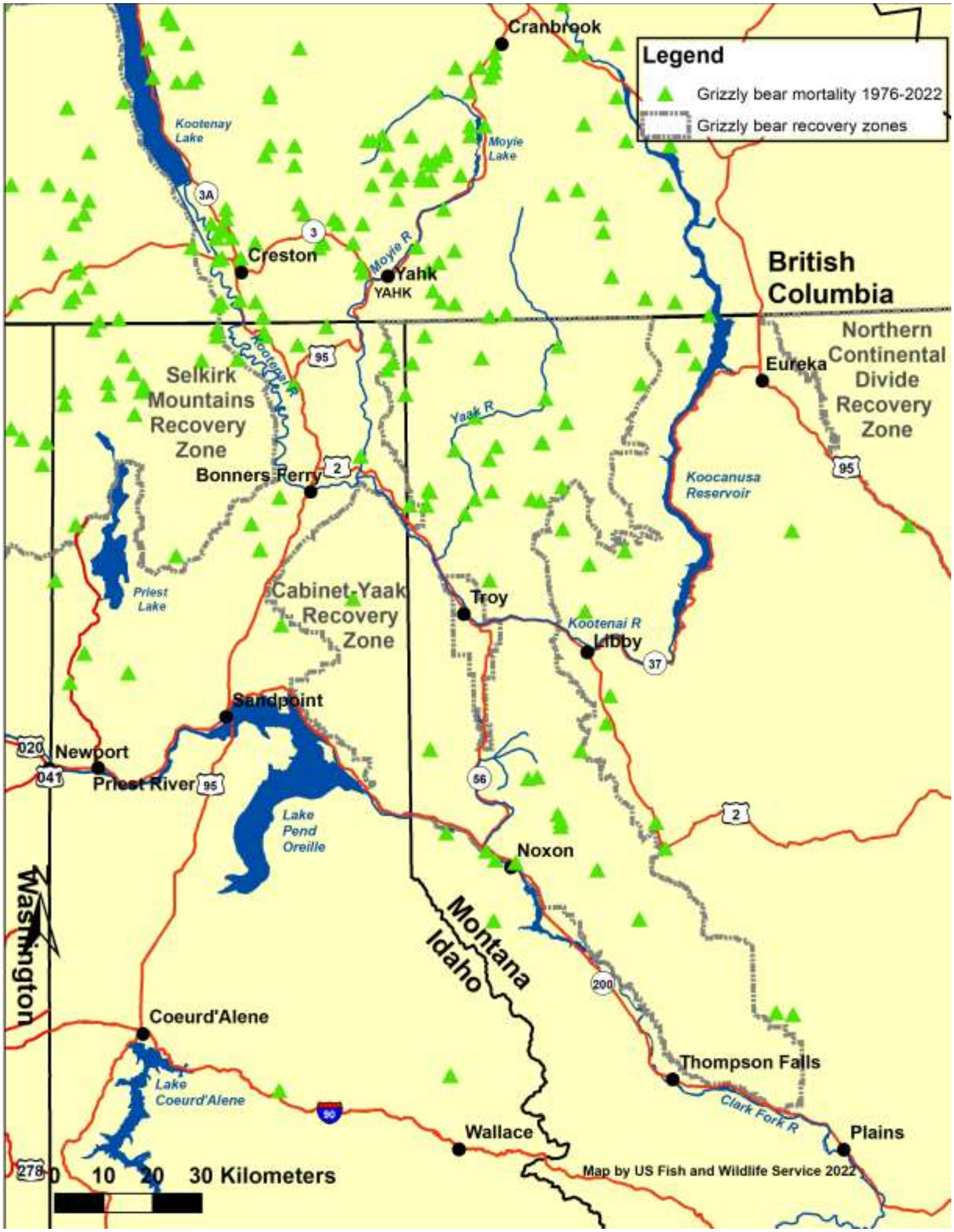

Figure 3. Grizzly bear known or probable mortalities from all causes (1976–2022) in and around the Cabinet-Yaak recovery area.

Table 3. Status of the Cabinet-Yaak recovery zone during 2017–2022 in relation to the demographic recovery targets from the grizzly bear recovery plan (USFWS 1993).

Recovery Criteria	Target	2017–2022
Females w/cubs (6-year avg)	6	3.3 (20/6)
Human Caused Mortality limit (4% of minimum estimate)[1]	1.9	1.5 (6 year avg)
Female Human Caused mortality limit (30% of total mortality)[1]	0.6	0.8 (6 year avg)
Distribution of females w/young	18 of 22	16 of 22

[1] The grizzly bear recovery plan states "Because of low estimated population and uncertainty in estimates, the current human-caused mortality goal to facilitate recovery of the population is zero. In reality, this goal may not be realized because human bear conflicts are likely to occur at some level within the ecosystem".

Table 4. Annual Cabinet-Yaak recovery zone (excluding Canada) grizzly bear unduplicated counts of females with cubs (FWC's) and known human-caused mortality, 1993–2022.

YEAR	ANNUAL FWC'S	ANNUAL HUMAN CAUSED ADULT FEMALE MORTALITY	ANNUAL HUMAN CAUSED ALL FEMALE MORTALITY	ANNUAL HUMAN CAUSED TOTAL MORTALITY	4% TOTAL HUMAN CAUSED MORTALITY LIMIT	30% ALL FEMALE HUMAN CAUSED MORTALITY LIMIT	TOTAL HUMAN CAUSED MORTALITY 6 YEAR AVERAGE	FEMALE HUMAN CAUSED MORTALITY 6 YEAR AVERAGE
1993	2	0	0	0	0.9	0.3	0.5	0.3
1994	1	0	0	0	0.9	0.3	0.3	0.2
1995	1	0	0	0	0.9	0.3	0.2	0.0
1996	1	0	0	1	0.7	0.2	0.2	0.0
1997	3	0	0	1	1.2	0.4	0.3	0.0
1998	0	0	0	0	0.9	0.3	0.3	0.0
1999	0	0	0	1	0.7	0.2	0.5	0.0
2000	2	0	1	1	0.5	0.1	0.7	0.2
2001	1	1	2	2	0.5	0.1	1.0	0.5
2002	4	1	4	4	1.2	0.4	1.5	1.2
2003	2	0	0	0	1.2	0.4	1.3	1.2
2004	1	0	0	0	1.4	0.4	1.3	1.2
2005	1	0	2	4	0.9	0.3	1.8	1.5
2006	1	0	0	0	0.7	0.2	1.7	1.3
2007	4	1	1	1	1.2	0.4	1.5	1.2
2008	3	0	0	1	1.6	0.5	1.0	0.5
2009	2	1	1	1	1.6	0.5	1.2	0.7
2010	4	0	0	1	1.9	0.6	1.3	0.7
2011	1	0	0	4	1.4	0.4	1.3	0.3
2012	3	1	1	2	1.6	0.5	1.7	0.5
2013	2	0	0	0	1.2	0.4	1.5	0.3
2014	3	0	0	1	1.6	0.5	1.5	0.3
2015	2	0	0	3	1.6	0.5	1.8	0.2
2016	3	0	0	0	1.9	0.6	1.7	0.2
2017	3	0	0	0	1.9	0.6	1.0	0.2
2018	5	1	1	2	2.3	0.7	1.0	0.2
2019	2	1	1	2	1.9	0.6	1.3	0.3
2020	5	1	1	2	2.1	0.6	1.5	0.5
2021	2	0	0	0	1.6	0.5	1.0	0.5
2022	3	1	2	3	1.9	0.6	1.5	0.8

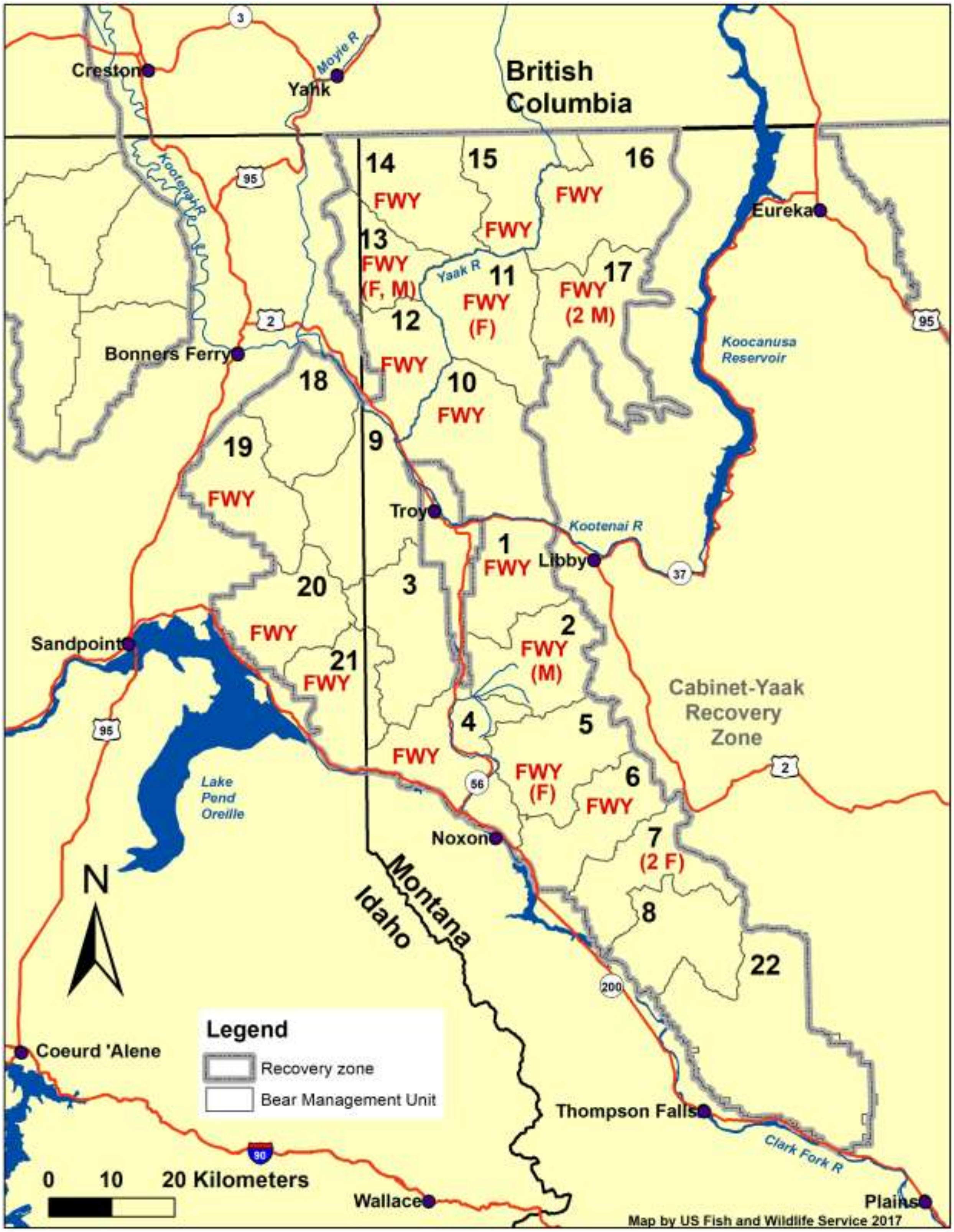

Figure 4. Female with young occupancy and known or probable mortality within Bear Management Units (BMUs) in the Cabinet-Yaak recovery zone 2017–2022. (FWY is occupancy of a female with young and sex of any mortality is in parentheses).

Table 5. Credible observations of females with young in or within 10 miles of the Cabinet-Yaak recovery zone including Canada, 1993–2022. Canadian credible observations shown in parentheses.

Year	Total credible[1] sightings females with young	Unduplicated females with cubs	Unduplicated females with yearlings or 2-year-olds	Unduplicated adult females without young	Minimum probable adult females[2]
1993	6	2	1	0	3
1994	5	1	2	0	3
1995	8	1	2	0	3
1996	5	1	1	0	2
1997	14 (1)	3	4	0	7
1998	6 (1)	0	2 (1)	2	2 (1)
1999	2	0	2	3	2
2000	6 (1)	2 (1)	1	0	3 (1)
2001	5 (2)	1 (1)	3	0	4 (1)
2002	10 (1)	4 (1)	1	0	5 (1)
2003	11	2	4	0	6
2004	11	1	4	0	5
2005	10 (1)	1	4 (1)	1	5 (1)
2006	7 (1)	2 (1)	2	1	4 (1)
2007	17	4	2	2	6
2008	7 (1)	3 (1)	3	1	6 (1)
2009	5 (0)	2 (0)	2 (0)	1	4 (0)
2010	14 (0)	4 (0)	2 (0)	1	6 (0)
2011	4 (0)	1 (0)	1 (0)	1	2 (0)
2012	12 (0)	3 (0)	3 (0)	0	6 (0)
2013	9 (0)	2 (0)	5 (0)	0	7 (0)
2014	20 (1)	3 (0)	3 (0)	1	7 (0)
2015	19 (1)	2 (0)	5 (0)	2	9 (0)
2016	11 (0)	3 (0)	3 (0)	2	8 (0)
2017	8 (0)	3 (0)	3 (0)	2	8 (0)
2018	20 (0)	5 (0)	2 (0)	1	8 (0)
2019	10 (0)	2 (0)	5 (0)	1	8 (0)
2020	14 (1)	5 (0)	4 (0)	1	10 (0)
2021	23 (0)	2 (0)	7 (0)	1	10 (0)
2022	16 (0)	3 (0)	6 (0)	2	11 (0)

[1]Credible sightings are those rated 4 or 5 on a 5-point scale (see page 8).
[2]Minimum does not count females detected by mortality.

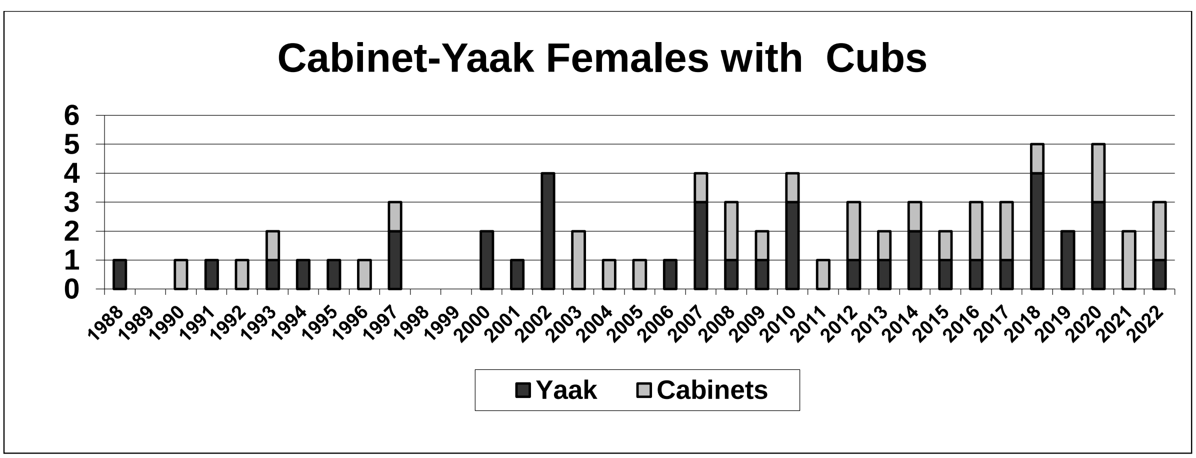

Figure 5. Credible observations of females with cubs in or within 10 miles of the Cabinet-Yaak recovery zone (excluding Canada), 1988–2022. Credible sightings rated 4 or 5 on a 5-point scale.

Table 6. Occupancy of bear management units by grizzly bear females with young in the Cabinet-Yaak recovery zone 1993–2022.

	1 - CEDAR	2 - SNOWSHOE	3 - SPAR	4 - BULL	5 - ST. PAUL	6 - WANLESS	7 - SILVER BUTTE	8 - VERMILION	9 - CALLAHAN	10 - PULPIT	11 - RODERICK	12 - NEWTON	13 - KENO	14 - NW PEAK	15 - GARVER	16 - E FORK YAAK	17 - BIG CREEK	18 - BOULDER	19 - GROUSE	20 - N LIGHTNING	21 - SCOTCHMAN	22 - MT HEADLEY	BMUs OCCUPIED LAST 6 YEARS
1993	N	N	N	N	Y	Y	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	14
1994	N	N	N	N	N	N	N	N	N	N	Y	N	N	Y	Y	N	N	N	N	Y	N	N	13
1995	N	N	N	N	N	N	N	N	N	N	Y	N	N	Y	Y	N	N	N	N	N	N	N	11
1996	N	N	N	N	N	Y	N	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	9
1997	N	Y	N	Y	N	Y	Y	N	N	N	Y	N	N	Y	Y	Y	N	N	N	N	Y	N	14
1998	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	N	14
1999	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N	N	N	N	N	12
2000	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	13
2001	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	Y	N	N	N	N	N	13
2002	N	Y	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	N	Y	N	N	N	N	N	13
2003	N	Y	N	N	Y	Y	N	N	N	N	N	N	Y	N	N	Y	N	Y	N	N	Y	N	12
2004	N	Y	N	N	Y	Y	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	12
2005	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	13
2006	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	13
2007	N	N	Y	Y	Y	Y	N	N	N	N	Y	N	Y	Y	N	N	Y	N	N	N	N	N	13
2008	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N	12
2009	N	N	N	Y	Y	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	11
2010	N	N	Y	N	Y	N	Y	N	N	N	Y	N	Y	Y	N	N	Y	N	N	N	N	N	12
2011	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	Y	N	Y	N	N	N	N	N	13
2012	N	Y	N	N	Y	N	N	N	N	N	Y	N	N	N	N	Y	Y	N	N	N	N	N	13
2013	N	N	N	N	Y	Y	N	N	N	N	Y	N	N	Y	Y	Y	Y	N	N	N	N	N	13
2014	N	N	N	N	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	N	N	N	N	N	12
2015	N	N	N	N	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	12
2016	N	N	N	N	Y	N	N	Y	N	N	Y	N	Y	Y	N	Y	Y	N	N	N	N	N	11
2017	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	11
2018	N	N	N	N	Y	Y	N	N	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	N	10
2019	N	N	N	Y	Y	N	N	N	N	N	Y	Y	N	N	N	N	Y	N	N	N	N	N	11
2020	N	Y	N	Y	Y	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	13
2021	Y	Y	N	N	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	14
2022	N	N	N	N	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	16

Cabinet Mountains Population Augmentation

No bears were transported into the Cabinet Mountains during 2022. Bear / human conflict issues and poor berry production precluded capture efforts. The last augmentation bear was a female released in 2019 as a two-year-old and was monitored until she lost her radio collar in early July of 2021. Her movements during 2019–2021 encompassed much of the West Cabinet Mountains in Idaho and Montana.

Four female grizzly bears were captured in the Flathead River of British Columbia and released in the Cabinet Mountains from 1990–1994 (Table 7). Twenty-two different grizzly bears were captured during 840 trap-nights to obtain the 4 subadult females. Capture rates were 1 grizzly bear/38 trap-nights and 1 suitable subadult female/210 trap-nights. One transplanted bear and her cub died of unknown causes one year after release. The remaining three bears were monitored until collars dropped. The program was designed to determine if transplanted bears would remain in the target area and ultimately contribute to the population through reproduction. Three of four transplanted bears remained in the target area for more than one year. One of the transplanted bears produced a cub but had likely bred prior to translocation and did not satisfy our criteria for reproduction with resident males. One other female was known to have reproduced. In 2005 the augmentation program was reinitiated through capture by MFWP personnel and monitoring by this project. During 2005–2022, 10 female and 8 male grizzly bears were released in the Cabinet Mountains (Table 7).

Of 22 bears released through 2022, eight are known to have left the target area (one was recaptured and brought back, two returned in the same year, and one returned a year after leaving), three were killed within 4 months of release, one was killed within 10 months of release, and one was killed 16 years after release (Figure 6). One animal was known to have produced at least 10 first-generation offspring, 16 second-generation offspring, and one third-generation offspring. Another female was known to have produced three offspring and a male was known to have produced one offspring. The genetic results in this report have more details.

Table 7. Sex, age, capture date, capture location, release location, and fate of augmentation grizzly bears moved to the Cabinet Mountains, 1990–2022.

Bear	Sex	Age	Capture date	Capture Location	Release Location	Fate
218	F	5	7/21/1990	NF Flathead R, BC	EF Bull River	Den Cabinet Mtns 1990, Lost collar Aug. 1991, observed July 1992.
258	F	6	7/21/1992	NF Flathead R, BC	EF Bull River	Den Cabinet Mtns 1992 Produced 1 cub 1993, Natural mortality July 1993.
286	F	2	7/14/1993	NF Flathead R, BC	EF Bull River	Den Cabinet Mtns 1993–95 Lost collar at den Apr. 1995, hair snag 2004–2009, self-defense mortality Nov. 2009.
311	F	3	7/12/1994	NF Flathead R, BC	EF Bull River	Lost collar July 1994, recaptured Oct. 1995 south of Eureka, MT, released EF Bull River, Signal lost Nov. 1995.
A1	F	7-8	9/30/2005	NF Flathead R, MT	Spar Lake	Den West Cabinet Mtns 2005–06, Lost collar Sept. 2007.
782	F	2	8/17/2006	SF Flathead R, MT	Spar Lake	Den West Cabinet Mtns 2006–07, Lost collar Aug. 2008.
635	F	4	7/23/2008	Stillwater R, MT	EF Bull River	Killed by train near Heron, MT Oct. 2008.
790	F	3	8/7/2008	Swan R, MT	EF Bull River	Illegally killed near Noxon, MT Oct. 2008.
715	F	10	9/17/2009	NF Flathead R, MT	Spar Lake	Den West Cabinet Mtns 2009–10, returned to NF Flathead R, May 2010. Lost collar June 2010.
713	M	5	7/18/2010	NF Flathead R, MT	Spar Lake	Den Cabinet Mtns 2010, Lost collar Sept. 2011.
714	F	4	7/24/2010	NF Flathead R, MT	Silverbutte Cr	Returned to NF Flathead July 2010. Lost collar Oct. 2013.
725	F	2	7/25/2011	MF Flathead R, MT	Spar Lake	Moved to Glacier National Park, Sept. 2011 den, returned to Cabinet Mtns Aug. 2012 and den, moved to Glacier National Park and returned to Cabinet Mtns, lost collar Oct. 2013
723	M	2	8/18/2011	Whitefish R, MT	Spar Lake	Den Cabinet Mtns 2011. Lost collar June 2012.
918	M	2	7/6/2012	Whitefish R, MT	EF Bull River	Den Cabinet Mtns 2012–-13. Lost collar Oct. 2014.
919	M	4	7/30/2013	NF Flathead R, MT	Spar Lake	Den Cabinet Mtns 2013. Lost collar Aug. 2014.
920	F	2	6/18/2014	NF Flathead R, MT	Spar Lake	Den Cabinet Mtns 2014–15.
921	F	2	6/18/2014	NF Flathead R, MT	Spar Lake	Den West Cabinet Mtns 2014. Died of unknown cause May 2015.
924	M	2	7/25/2015	SF Flathead R, MT	Spar Lake	Mistaken identity mortality Sept. 2015
926	M	3	7/25/2016	SF Flathead R, MT	Spar Lake	Den Cabinet Mtns 2016. Lost collar July 2017
927	M	2	7/20/2018	NF Flathead R, MT	Spar Lake	Den West Cabinet Mtns 2018 and Cabinet Mtns 2019, lost collar Aug. 2020
923	F	2	7/12/2019	NF Flathead R, MT	Spar Lake	Den West Cabinet Mtns 2019, 2020, and 2021. Lost collar July 2021
892	M	3	7/14/2019	NF Flathead R, MT	Spar Lake	Den Cabinet Mtns 2019, killed June 2020 west of Whitefish, MT

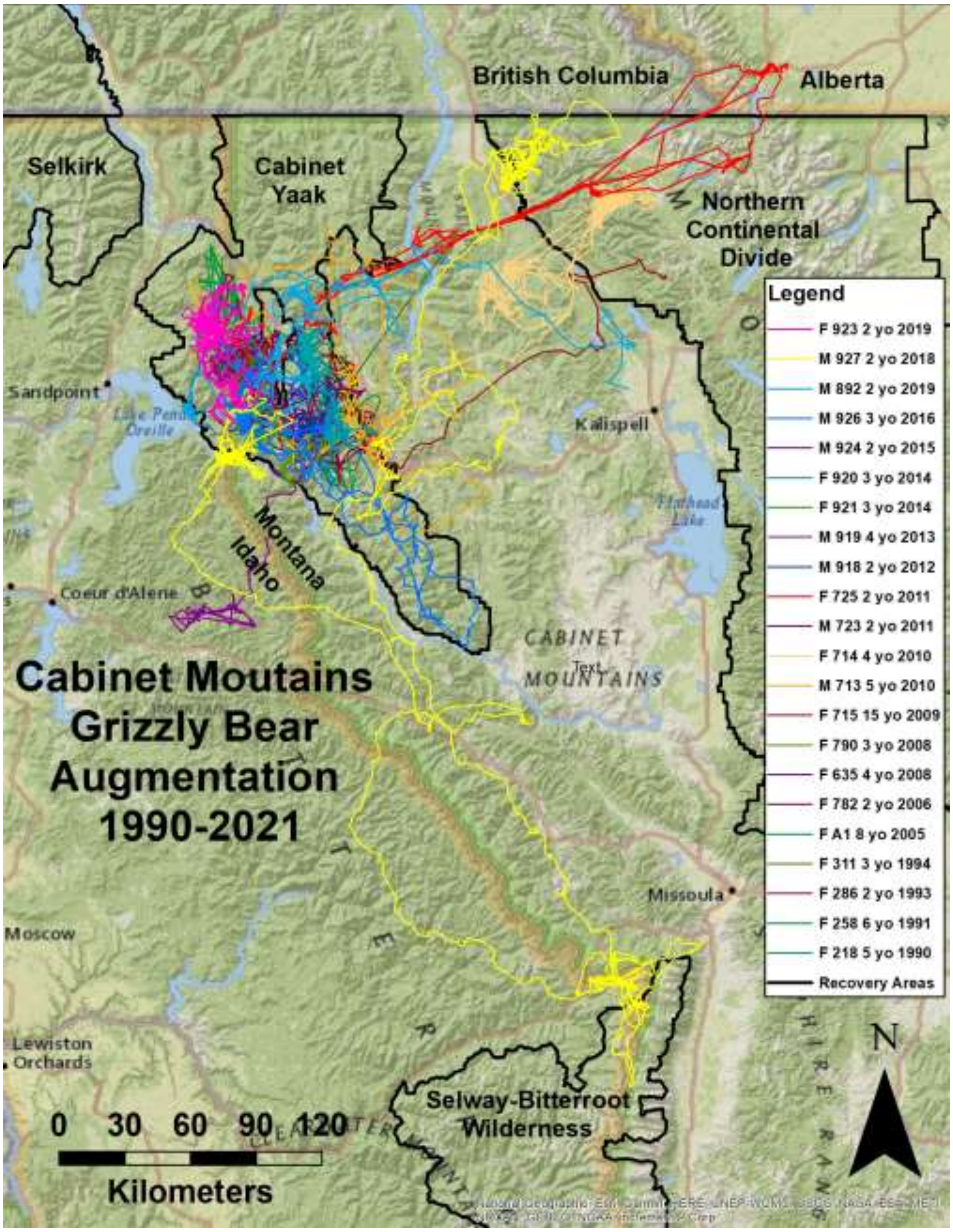

Figure 6. Movements of Cabinet Mountains augmentation bears, 1990-2021.

The Cabinet Mountains population was estimated to be 15 bears or fewer in 1988 based on independent tracks, sightings, and expert opinion (Kasworm and Manley 1988). However, lack of resident bears identified since 1989 suggests the population was well below 15 individuals. Genetic samples from the Cabinet Mountains (1983–2021) were determined to originate from 86 different grizzly bears. Three of these were from captures during 1983–1988, 21 were from augmentation bears during 1990–2019 (1 augmentation bear 218 genetically unmarked), and 62 from other captures, mortalities, or hair snagging during 1997–2021.

One of these genotypes identified by hair snagging was from grizzly bear 286. She was released in the Cabinet Mountains as part of population augmentation in 1993 as a 2-year-old (Kasworm *et al*. 2007). She was 13 years old when the first hair sample was obtained during 2004. Pedigree analysis indicates she has produced at least 10 first generation offspring, 23 second generation offspring, and 4 third generation offspring. Six of those first-generation offspring were females, and all 6 are known to have reproduced (Fig. 7). Bear 286 was killed in a self-defense incident with a hunter in November of 2009.

Four other augmentation bears have successfully produced young in the Cabinet Mountains. Female 782, released as a 2-year-old in 2006, has produced at least 3 offspring. Female 920, released as a 2-year-old in 2014, has produced 2 offspring (both sired by augmentation male 723). To bolster genetic diversity, male augmentation bears have been added to the Cabinet Mountains. Males 723 (3 total offspring) and 919 (1 offspring) have recently been documented as successful breeders. In total, 44 bears are known to be direct or descendant offspring of augmentation bears.

The augmentation effort appears to be the primary reason grizzly bears remain and are increasing in the Cabinet Mountains. Only 18 genotyped bears not known to be augmentation bears or their offspring have been identified in the Cabinet Mountains since 1990 and nine are known dead. The following describes each individual and fate. Two are adult males that bred with 286 to produce first generation of augmentation offspring, both are known dead. Four are a family group (adult female with 3 cubs) identified south of the Clark Fork River in 2002. The adult female and one of the young are known dead. Three are males with past human-bear conflict histories in the Northern Continental Divide population (NCDE) to the northeast and subsequently traveled to the CYE in 2014–2018, including: 1) an adult male killed in self-defense in the Little Thompson River in 2014; 2) a subadult male caught in Flathead Valley in spring of 2016, traveled to Cabinets fall 2016 or spring 2017, traveled back toward NCDE, and died by poaching in May 2017; and 3) subadult male caught spring 2018 between the NCDE and Cabinets, relocated into the Yaak and soon thereafter died by human-cause (under investigation) in May 2018. One bear was a subadult male captured near Thompson Falls in 2011 in an incident involving livestock depredation, unknown status thereafter. Three bears were male migrants from the Selkirk Mountains: 1) identified in 2012, who is now known to have moved back to the Selkirks before breeding, has bred and remains in Selkirks in 2021; 2) a collared subadult male with movement in 2018 but lost collar in fall 2018; and 3) a subadult male preemptively moved and denned in West Cabinets, lost collar spring of 2022. Two bears appear to be the result of subadult male movements from the NCDE with no conflict history, 1) one caught in 2019 in Cabinets, and spent much time in the Salish range before casting collar, fate unknown; and 2) sampled as subadult at corral in 2021, fate unknown. The remaining three bears were adult males born in the Yaak and identified in the Cabinets in 2016-19, 2 of which are known dead.

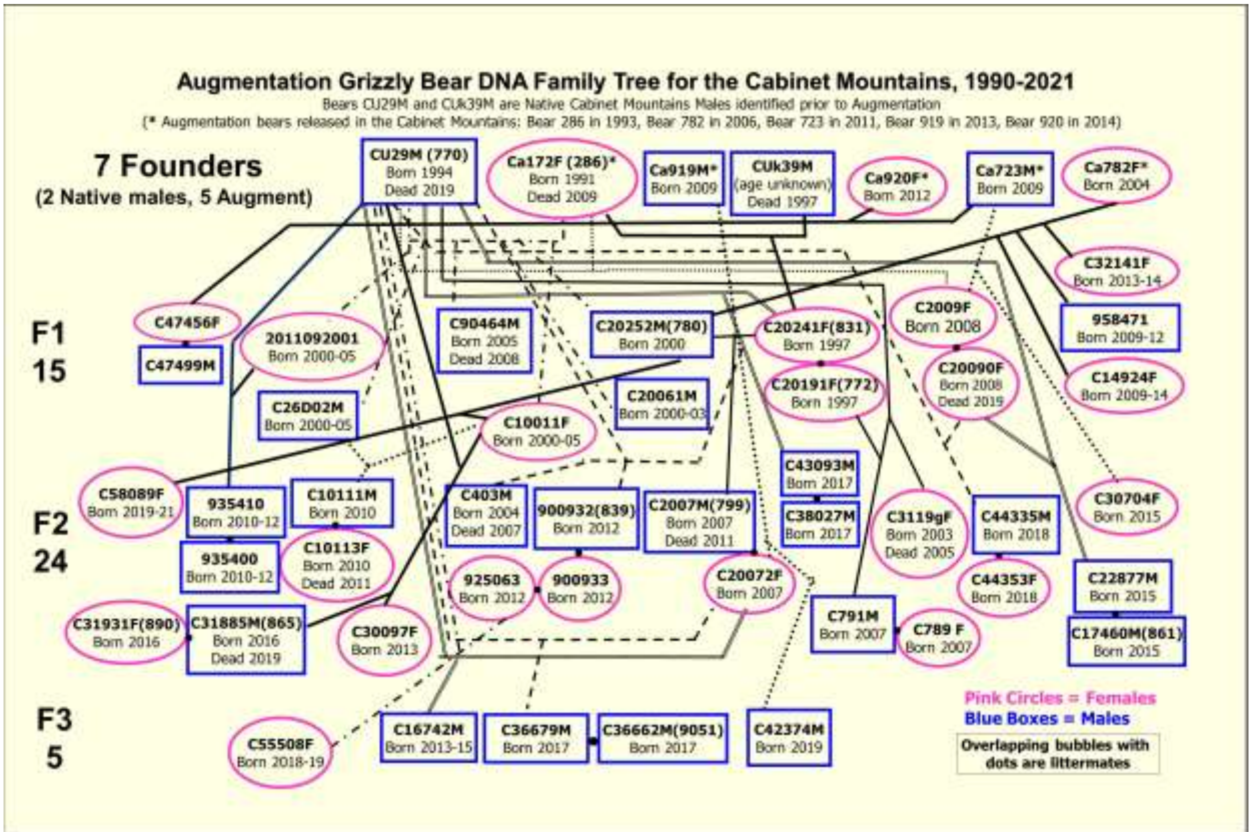

Figure 7. Most likely pedigree resulting from augmentation grizzly bears (females 286, 920, and 782; males 723 and 919) in the Cabinet Mountains, 1993–2022. Squares indicate males and circles represent females. Lines indicate a parent-offspring relationship. Founders are the initial founding generation, F1 the first generation of offspring for translocated females, F2 the second generation and F3 the third generation.

Cabinet-Yaak Hair Sampling and DNA Analysis

Claws from a grizzly bear were discovered in Baree Creek of the Cabinet Mountains in 1993. Analysis of DNA from these claws matched bear 678 originally captured in the Cabinet Mountains in 1983 when 28 years old. Tissue present on the claws suggested that she died no earlier than 1992. Bear 678 would have been at least 37 years old at the estimated time of death. Pedigree analysis also indicated that the three bears captured in the Cabinet Mountains from 1983–1988 were a triad with bear 680 being the offspring of bears 678 and 14.

Hair snag sampling occurred at barb wire corrals baited with a scent lure during 2000–2022 (Table 8 and Fig. 8). Sampling occurred from May–October but varied within years. Sites were selected based on prior grizzly bear telemetry, sightings, and access. Remote cameras supplemented hair snagging at most sites and were useful in identifying family groups and approximate ages of sampled bears. Genetic analysis from 2022 field collected samples is not yet complete; we will report on these results in the 2023 report. In 2002, study personnel assisted a MFWP black bear population estimate effort that sampled 285 sites in the Yaak River portion of the CYE. During 2003, 184 sites on a 5 km^2 grid were sampled on 4,300 km^2 in the Cabinet Mountains portion of the CYE. In 2009, 98 sites were sampled south of the Clark Fork River. In 2012, United States Geological Survey (USGS) researchers completed an ecosystem-wide mark-recapture population estimate using DNA from hair collected at more than 850 corrals. Other years had much lower numbers of sampled sites. Collectively, USFWS, USGS, and MFWP crews have sampled 2,085 corral traps from 2000–2022 (Table 8 and Fig. 7). Through 2021, corral traps alone were successful during seven percent of site visits and provided hair from 85 grizzly bears.

Table 8. Hair snagging corrals and success in the Cabinet-Yaak study area, 2000–2022. DNA genetic results not yet complete for 2022 samples.

Year	Number of corral sessions[1]	Sessions with grizzly bear DNA(%[2])	Sessions with grizzly bear photos or DNA(%[2])	Individual grizzly bear genotypes	BMUs with grizzly bear pictures or hair	Comments
2000	1	0	0	0		
2001	3	0	0	0		
2002	319	9 (3)	10 (3)	9	BMUs 2, 5, 6, 12, 14, 16, 17	
2003	184	1 (1)	1 (1)	1	BMUs 5, 6	
2004	14	2 (14)	2 (14)	3	BMU 5	
2005	17	1 (6)	2 (12)	1	BMU 5	
2006	19	3 (16)	3 (16)	3	BMUs 3, 5, 7	
2007	36	4 (11)	5 (14)	9	BMUs 5, 11, 13	Female with young BMU 5
2008	21	1 (5)	1 (5)	1	BMU 5	
2009	125	2 (2)	4 (3)	4	BMUs 5, 6, 9	Female with young BMU 5
2010	27	3 (11)	4 (15)	5	BMUs 3, 5, 6	Female with young BMU 5
2011	72	9 (13)	12 (17)	13	BMUs 3, 4, 5, 6, 11, 13, 14, 15, 16, 17	Female with young BMU 16
2012	854	48 (6)	48 (6)	29	BMUs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20	
2013	5	2 (40)	2 (40)	2	BMUs 2, 3, 5, 6, 7, 11, 13, 14, 15, 16, 17	Female with young BMU 6
2014	42	3 (7)	8 (7)	4	BMUs 1, 2, 3, 5, 6, 11, 12, 13, 14, 15, 16, 17, 19	Female with young BMU 13
2015	73	5 (7)	12 (17)	7	BMUs 2, 3, 4, 5, 6, 10, 11, 12, 13, 14, 15, 16, 17	Female with young BMU 13 Female with cubs BMU 5
2016	39	6 (15)	9 (23)	10	BMUs 2, 3, 5, 6, 7, 10, 11, 13, 14, 15, 16, 17, 19	Female with young BMU 13, 5 Female with cub BMU 16
2017	82	18 (22)	18 (22)	18	BMUs 1, 2, 3, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17	Female with cubs BMU 5 Female with young BMU 5
2018	48	13 (27)	16 (33)	17	BMUs 1, 2, 3, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17	Female with cubs BMU 5, 13, 14 Female with young BMU 6
2019	49	7 (14)	12 (24)	6	BMUs 4, 5, 6, 8, 10, 13	Female with young BMU 13
2020	40	9 (23)	13 (33)	10	BMUs 5, 8, 11, 12, 13, 14, 16	Female with cubs BMU 12 Female with young BMU 11,13, 16
2021	73	9 (12)	18 (25)	11	BMUs 5, 12, 13, 14, 16	Female with young BMU 13
2022	128	--	25 (20)[3]	--	BMUs 2, 3, 4, 5, 6, 11, 12, 13, 14, 15, 19, 22	Female with young BMU 13
Total	2271	155 (7)	225 (10)	85[4]		

[1]Some corral sites were deployed for multiple sessions per year. A "session" is typically 3-4 weeks long and defined as the interval between site set-up and revisits to collect samples and photos.
[2]Percent success at all corral sessions
[3]Sites with photos only. Awaiting 2022 genetic results.
[4]Some individuals captured multiple times among years.

In 2022, we collected 2649 samples from 2508 visits to 824 individual rub trees (Table 9). Samples were evaluated during cataloging and 2136 were judged to be black bears (based on solid black coloration), leaving 513 to be sent to Wildlife Genetics International Laboratory in Nelson, British Columbia for DNA extraction and genotyping. Lab analysis on 2022 samples is still in progress, and we will report on results in the 2023 report. We genetically identified 94 individual grizzly bears (61 males, 33 females) from 20966 rub samples alone, 2013–2021.

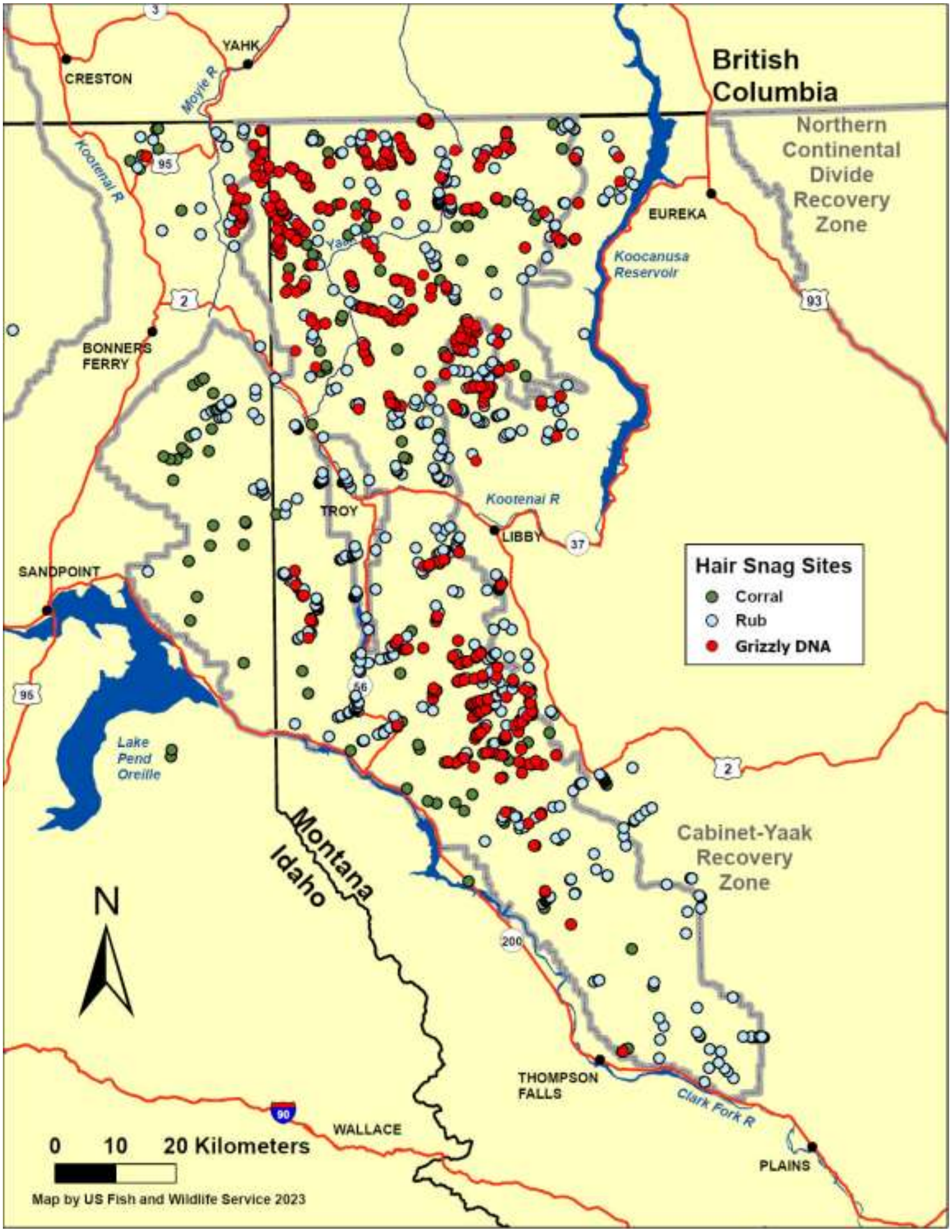

Figure 8. Location of hair snag sample sites in the Cabinet-Yaak Ecosystem study area, 2013–2022. Sites with grizzly bear DNA are identified (2013–2021).

Table 9. Grizzly bear hair rubs and success in the Cabinet-Yaak study area, 2012–2022.

Year	Number of rubs checked[4]	Number of samples collected (%GB[1])	Number of samples sent to Lab (%GB[1])	Number of rubs with grizzly DNA	Individual grizzly bear genotypes	Males	Females
2012[2]	1376	8356 (2)	4639 (3)	85	33	19	14
2013	488	1038 (6)	480 (12)	33	17	9	8
2014	583	1894 (7)	708 (19)	50	25	14	11
2015	693	2258 (6)	622 (22)	76	30	20	10
2016	780	3779 (5)	1511 (13)	90	30	18	12
2017	828	2958 (13)	676 (55)	147	37	23	14
2018	775	2265 (8)	481 (38)	96	42	26	16
2019	839	2154 (7)	466 (33)	87	30	25	5
2020	346	415 (15)	153 (42)	40	24	17	7
2021	766	2113 (5)	296 (37)	60	25	14	11
2022	824	2649 (--)	513 (--)	--	--	--	--
Total[3]	1711[4]	27230 (6)	10032 (16)	356[4]	94[5]	61[5]	33[5]

[1] Percentage of samples yielding a grizzly bear DNA genotype.

[2] 2012 results from USGS population estimation study (Kendall et al. 2016). 2013-22 efforts are from USFWS-coordinated efforts.

[3]Totals are through 2021. 2022 genetic results from the lab are not yet complete.

[4] Unique rub locations. Some rub locations visited multiple times among years.

[5]Some individuals captured multiple times among years.

Grizzly Bear Genetic Sample Summary

We provide data leading up to and including 2021; 2022 sample results have not been completed by the laboratory. Our genetics investigations are designed to provide data regarding genetic health, gene flow from other populations, reproductive success, and success of the augmentation program. It is not currently used to estimate population size though we do provide numbers of bears detected. Using all methods (capture, collared individuals, all sources of DNA sampling, photos, credible observations), we detected a minimum of 49 individual grizzly bears alive in the CYE grizzly bear population at some point during 2021. One of these bears was known dead by end of 2021 (yearling male). Twenty-four bears were detected in the Cabinets (8 males, 11 females, 5 unknown sex). Twenty-five bears were detected in the Yaak (16 males, 9 females, 5 unknown sex).

It is biologically inappropriate to infer changes in minimum counts from year to year as changes in total population size. These minimum counts are influenced by and dependent on the level of effort available each year. Available effort is influenced by funding, number of personnel, area of emphasis, and most recently COVID-19. All these factors have varied in recent years and have contributed to variable minimum counts. Hence, we use the word “minimum” rather than “total” population size. For population growth estimates, refer to population trend section later in this report (page 38).

Using all DNA sampling sources, ninety-one unique individuals were genotyped within the CYE study area during the six-year period 2016–2021 (36 female, 55 male). Fifty-three of these bears (58%) had been handled (capture, mortality) at some point in their past. Eighty-two bears (90%) had been DNA sampled at one or more corral or rub sites during 2016–2021. By the end of 2021, twelve were known dead, and another seven bears are known to have emigrated outside the Cabinet-Yaak. Assuming no additional mortality or emigration, this leaves 72 bears for the six-year period. This accounting does not include 1) unknown, unreported mortality, 2) unknown emigration, or 3) undetected individuals. Sex-age class proportions of the remaining sample (as of 2021) were as follows: 31% adult females, 9% subadult females, 34% adult males, 14% subadult males, and 11% dependents (less than 2 years old).

We determined parent-offspring relationships of Yaak grizzly bears using sample genotypes from 1986–2021. A majority of our detected sample in the Yaak descends from female grizzly bear 106, born in 1978 (Figure 9). She produced five known litters, and her matrilines tie to 64 known first, second, third, and fourth generation offspring. In 2018, we identified her first fourth generation offspring, male Y38004M, presumed dead in 2019. In 2019, two more fourth generation cubs were detected (cub-of-the-year offspring of female 842). Both died in 2019 (natural mortality). In 2020, four more 4th generation offspring were born; 2 male cubs of female 842 (one dead in 2021, other captured as bear #882 in 2021) and 2 cubs of female 822 (one male captured in 2021 as #848 and one female captured in 2022 tagged 1070). Female 1070 is the first known fourth generation female of 106. Since 1986, we have genetically detected 42 female grizzly bears in the US Yaak and BC Yahk, 30 (71%) of which are maternal descendants of bear 106. Since 2014, all female bears genetically detected in the US Yaak are her maternal descendants. In 2016–2021, we detected 1 daughter, 7 granddaughters, 7 great-granddaughters, and 1 great-great-granddaughter of 106.

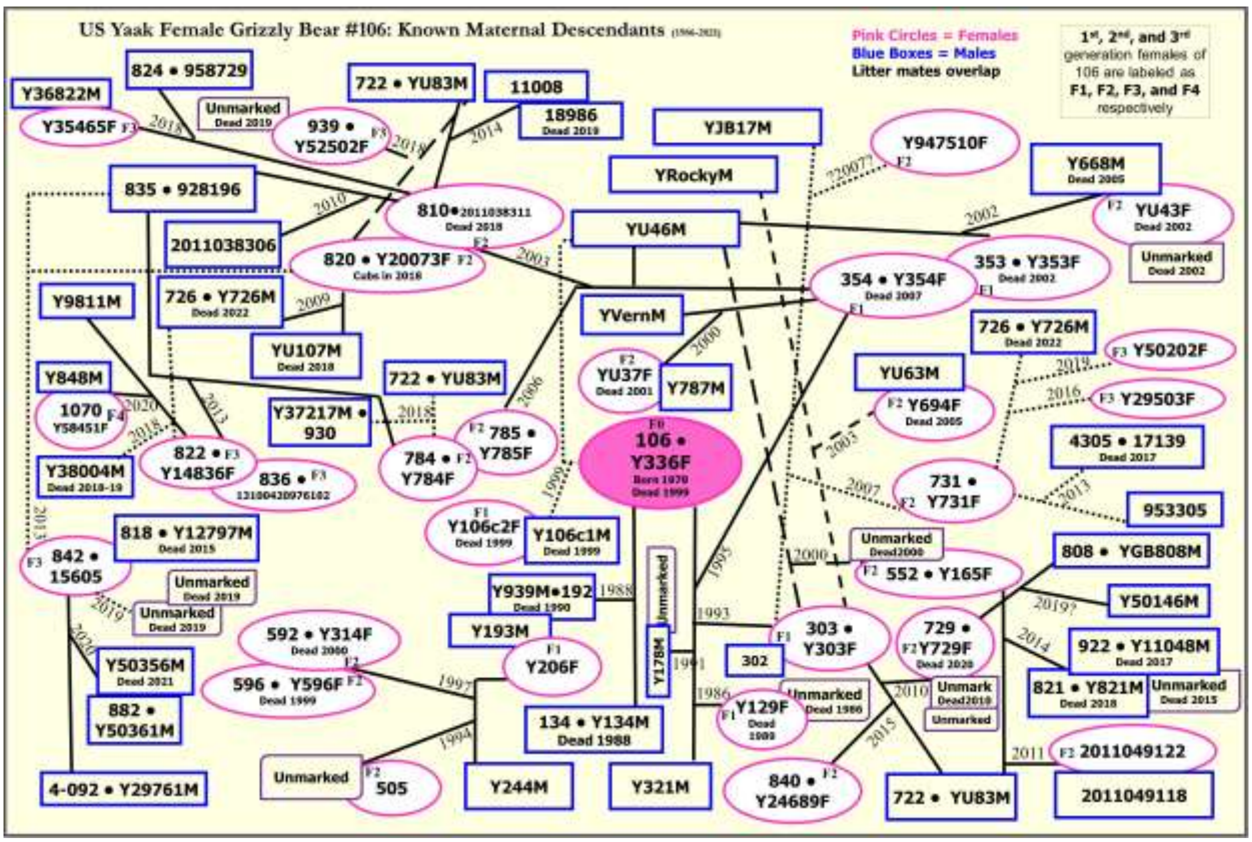

Figure 9. Most likely pedigree displaying matrilineal ancestry of female grizzly bear 106 in the Yaak River, 1986–2021. Squares indicate males and circles represent females. Lines indicate a parent-offspring relationship. F0 is the initial generation, F1 the first generation, F2 the second generation, F3 the third generation, and F4 the fourth generation. Numbers along lines indicate when the litter was produced.

Grizzly Bear Movements and Gene Flow Within and Between Recovery Areas

Population linkage is a goal of the CYE recovery plan (USFWS 1993). The population goal of approximately 100 animals requires genetic connectivity to maintain genetic health over time. Movement data from telemetry or genetic methods may be a precursor of linkage, but gene flow through reproduction by immigrant individuals is the best measure of connectivity.

Capture, telemetry, and genetic data were analyzed to evaluate movement and subsequent reproduction resulting in gene flow into and out of the CYE. Fifty-two grizzly bears were identified as immigrants or emigrants to or from the CYE from 1983–2022 (Appendix Table T4). While movement and gene flow out of the CYE may benefit other populations, gene flow into the CYE is most beneficial to genetic health. Thirty-three individuals (30 males and 3 females) are known to have moved into the CYE from adjacent populations; however, eleven of these were killed, removed, or emigrated out of the CYE prior to any known gene flow (Figure 10). Twenty of these immigrants originated from the North Purcells (4 known mortalities), five from the NCDE (three known mortalities), and seven from the South Selkirks (one known mortality, 2 subsequently left Cabinet-Yaak). Gene flow has been identified through reproduction by nine immigrants from the North Purcells (eight males and one female) resulting in 26 offspring in the CYE. We have no evidence of gene flow from any other population.

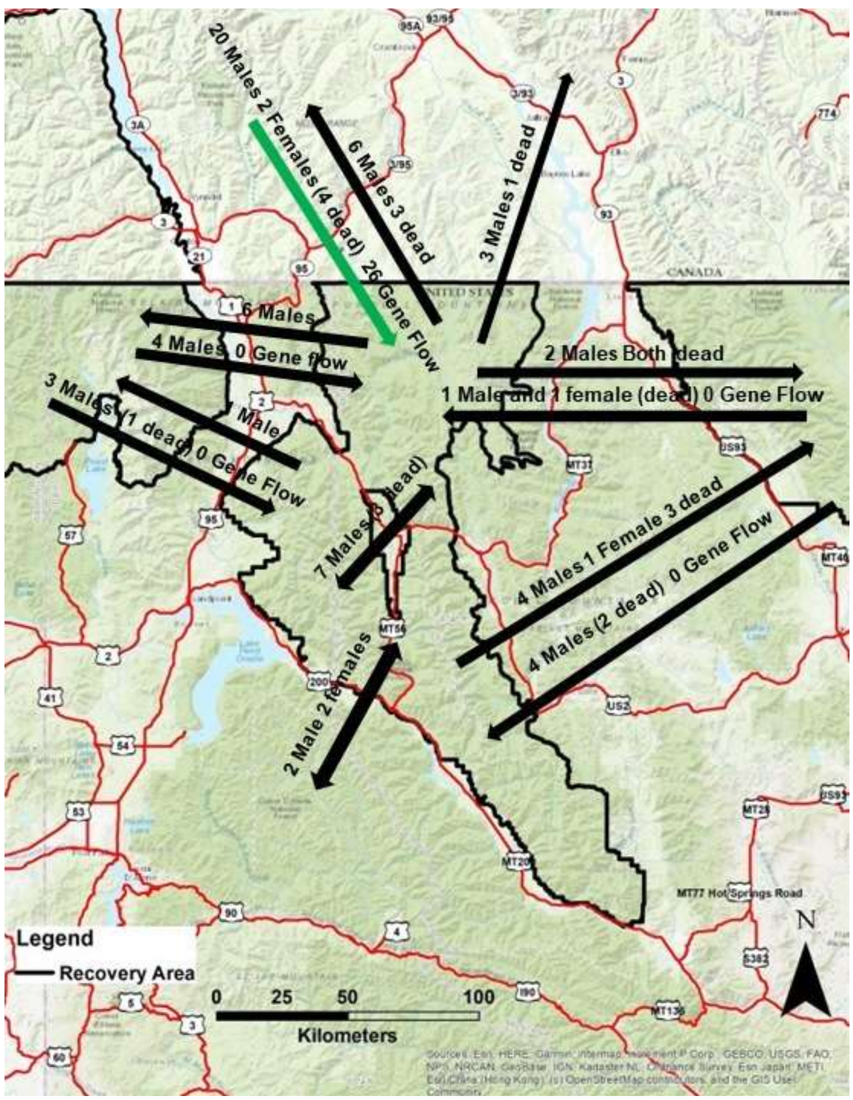

Figure 10. Known immigration or emigration events (black arrows) and gene flow (green arrows) in the Cabinet-Yaak, 1988–2022.

Known Grizzly Bear Mortality

There were four instances of known or probable grizzly bear mortality in or within 10 mi (16) km of the CYE (including BC) during 2022 (one subadult female, 2 adult females, and one adult male). The subadult female was captured after several instances of killing chickens and approaching a resident that was standing on their porch and receiving a shot of bear spray prior to leaving. One adult female was killed in a vehicle collision, and another died of unknown causes but was believed to be a natural mortality. The individual was 25 years old. The adult male mortality was the result of defense of property. Sixty-seven instances of known and probable grizzly bear mortality from all causes were detected inside or near the CYE (excluding Canada) during 1982–2022 (Tables 1 and 10, Fig. 11). Forty-nine were human-caused, 14 were natural mortality, and 4 were unknown cause. There were 20 instances of known grizzly bear mortality in Canada within 10 mi (16 km) of the CYE in the Yahk and South Purcell population units from 1982–2022 (Tables 1 and 10, Fig. 11). Fifteen were human-caused and 5 were natural mortalities.

Table 10. Cause, timing, and location of known and probable grizzly bear mortality in or within 10 mi (16 km) of the Cabinet-Yaak recovery zone (including Canada), 1982–2022. Radio collared bears included regardless of mortality location.

	Mortality cause											
Country/ age / sex / season / ownership	Defense of life	Legal Hunt	Hound hunting	Management removal	Mistaken identity	Natural	Poaching	Trap predation	Vehicle collision	Unknown, human	Unknown	Total
U.S.												
Age / sex												
Adult female	4					3	1		2	3	1	14
Subadult female				1		1	1	1	2	3		9
Adult male	2			3	1		2			4		12
Subadult male	2				3		2			4	1	12
Yearling					1	2					1	4
Cub					1	9	2			3		15
Unknown					1							1
Total	8			4	7	15	8	1	4	17	3	67
Season[1]												
Spring					1	3	1			4	1	10
Summer	1			1	1	11	1	1	1			17
Autumn	7			3	5	1	5		3	12		36
Unknown							1			1	2	4
Ownership												
US Private	3			4	2		5		3	6	1	24
US Public	5				5	15	3	1	1	11	2	43
Canada												
Age / sex												
Adult female	1			2								3
Subadult female	1							1				2
Adult male	1	1	1	2	1					1		7
Subadult male				1						1		2
Yearling						1						1
Cub						4						4
Unknown			1									1
Total	3	1	2	5	1	5		1		2		20
Season[1]												
Spring	1	1	1	2		1		1				7
Summer			1	1		4						6
Autumn	2			2	1					2		7
Unknown												
Ownership												
BC Private				4								4
BC Public	3	1	2	1	1	5		1		2		16

[1]Spring = April 1 – May 31, Summer = June 1 – August 31, Autumn = September 1 – November 30

Sixty-three percent (15 of 24) of known human-caused mortalities occurring on the US National Forests were <500m of an open road from 1982–2022. Thirty-seven percent (9 of 24) of known human-caused mortalities occurring on National Forests were located within core habitat (area greater than 500m from an open or gated road).

Mortality rates were examined by breaking the data into periods of increase (1982–1998, 2007–2022) and decrease (1999–2006) in population trend. From 1982–1998, 16 instances of known mortality occurred in the U.S. and Canada, with 12 (75%) of these mortalities being human-caused (Table 1). The annual rate of known human-caused mortality was 0.71 mortalities per year. Twenty-seven instances of known mortality occurred during 1999–2006 with 18 (67%) of these human-caused. Annual rate of known human-caused mortality was 2.25 per year. Forty-five instances of known mortality occurred from 2007–2022 with 34 (76%) of these human-caused. Annual rate of known human-caused mortality was 2.13 per year. Though the rate of known human-caused mortality declined slightly between the two most recent time periods, it is important to consider the rate of female mortality. The loss of females is the most critical factor affecting the trend because of their reproductive contribution to current and future growth. The rate of known female mortality was 0.29 and human-caused female mortality was 0.18 during 1982–1998. Both total known female and human-caused female mortality rate increased from 1982–1998 to 1999–2006 periods. Total known female mortality rate decreased from 1.88 during 1999–2006 to 0.94 during 2007–2022 and known human-caused female mortality rate decreased from 1.5 to 0.7. This decline of female mortality is largely responsible for the improving population trend from 2007–2022 (Pages 39–42). Efforts to detect mortality were probably lowest during 1982–1998 because of fewer collared bears and less personnel presence in the Yaak portion of the recovery zone. Comparisons involving the two most recent time periods represent more similar amounts of effort to detect mortality.

The increase in total known mortality beginning in 1999 may be linked to poor food production during 1998–2004. Huckleberry production during these years was about half the long-term average. Poor berry production years can be expected at various times, but in this case, there were several successive years of poor production. Huckleberries are the major source of late summer food that enables bears to accumulate sufficient fat to survive the denning period and females to produce and nurture cubs. Poor nutrition may not allow females to produce cubs in the following year and cause females to travel further for food, exposing young to greater risk of mortality from conflicts with humans, predators, or accidental deaths. Years with below average huckleberry production average 0.85 to 1.0 more known grizzly bear mortalities than years with average or above average huckleberry production, respectively (Fig. 11). One female bear lost litters of 2 cubs each during spring of 2000 and 2001. Another mortality incident involved a female with 2 cubs that appeared to have been killed by another bear in 1999. The effect of cub mortality may be greatest in succeeding years when some of these animals might have been recruited to the reproductive segment of the population.

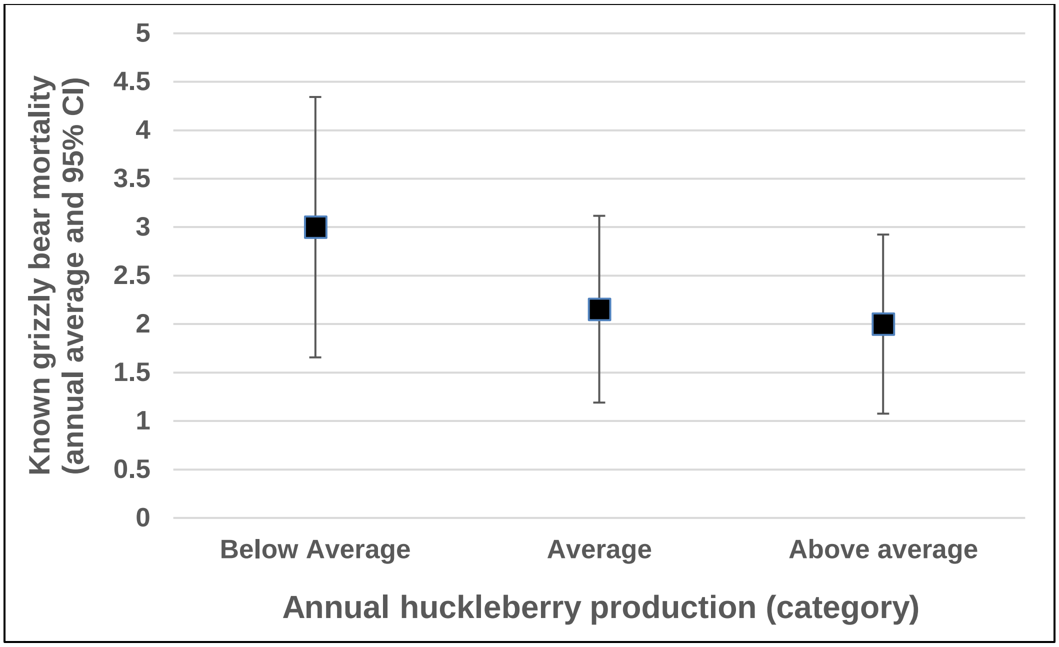

Figure 11. Known grizzly bear annual mortality from all causes in or within 16 km of the Cabinet-Yaak recovery zone (including Canada) and all radio-collared bears by cause, 1982–2022 and huckleberry production counts, 1989–2022.

Using counts of known human-caused mortality probably under-estimates total human-caused mortality. Numerous mortalities identified by this study were reported only because animals wore a radio-collar at death. The public reporting rate of bears wearing radio-collars can be used to develop a correction factor to estimate unreported mortality (Cherry *et al*. 2002). Correction factors were not applied to natural mortality, management removals, mortality of radio-collared bears or bears that died of unknown causes (Table 11). All radioed bears used to develop the unreported mortality correction were >2 years-old and died from human related causes. Twenty radio-collared bears died from human causes during 1982–2022. Eleven of these were reported by the public (55%) and 9 were unreported (45%). The Bayesian statistical analysis described by Cherry *et al*. (2002) was used to calculate unreported mortality in 3 year running periods in the Yellowstone ecosystem, but samples sizes in the CYE are much smaller, so we grouped data based on the cumulative population trend (ʎ, Fig. 11). The unreported estimate added 25 mortalities to the 89 known mortalities from 1982–2022. The unreported estimate includes bears killed in BC which are not counted in recovery criteria (USFWS 1993).

Table 11. Annual human-caused grizzly bear mortality in or within 16 km of the Cabinet-Yaak recovery zone (including Canada) and estimates of unreported mortality, 1982–2022 (including all radio-collared bears regardless of mortality location).

Years	Population trend	Natural	Management or research	Radio monitored	Unknown cause	Public reported	Unreported estimate	Total
1982-1998	Improving	3	2	4	1	6	5	21
1999-2006	Declining	9	4	7	0	7	5	32
2007-2022	Improving	10	4	11	2	19	15	61
Total		22	10	22	3	32	25	114

Grizzly Bear Survival, Reproduction, Population Trend, and Population Estimate

This report segment updates information on survival rates, cause-specific mortality, and population trend following the methods used in Wakkinen and Kasworm (2004).

Grizzly Bear Survival and Cause-Specific Mortality

Kaplan-Meier survival and cause-specific mortality rates were calculated for 6 sex and age classes of native grizzly bears from 1983–2022 (Table 12). We calculated survival and mortality rates for augmentation and management bears separately (see below).

Table 12. Survival and cause-specific mortality rates of native grizzly bear sex and age classes based on censored telemetry data in the Cabinet–Yaak recovery zone, 1983–2022.

	Demographic parameters and mortality rates					
Parameter	Adult female	Adult male	Subadult female	Subadult male	Yearling	Cub
Individuals / bear-years	189 / 56.7	31 / 40.8	22 / 28.4	28 /23.4	37 / 19.3	46 / 46[a]
Survival[b] (95% CI)	0.915 (0.845–0.985)	0.881 (0.786-0.977)	0.867 (0.746–0.989)	0.871 (0.740-1.0)	0.902 (0.775–1.0)	0.632 (0.481–0.783)
Mortality rate by cause						
Legal Hunt Canada	0	0.029	0	0	0	0
Natural	0.0185	0	0	0	0.097	0.319
Defense of life	0	0.046	0.016	0.017	0	0
Mistaken ID	0	0	0	0	0	0
Poaching	0.032	0	0	0.040	0	0.049
Trap predation	0	0	0.039	0	0	0
Unknown human	0.034	0.045	0.079	0.056	0	

[a]Cub survival based on counts of individuals alive and dead.
[b]Kaplan-Meier survival estimate which may differ from BOOTER survival estimate.

Mortality rates of all sex and age classes of resident non-management radio-collared grizzly bears ≥2 years old were summarized by cause and location of death (Table 13). Rates were categorized by public or private land and human or natural causes. Rates were further stratified by death locations in BC or U.S. and broken into three time periods. The three periods (1983–1998, 1999–2006, and 2007–2022) correspond to a period of population increase followed by a period of decline followed by a period of increase in long term population trend (λ). Grizzly bear survival of all sex and age classes decreased from 0.899 during 1983–1998 to 0.792 during 1999–2006 and then rose to 0.916 during 2007–2022. Some of this decrease in the 1999–2006 period could be attributed to an increase in natural mortality probably related to poor berry production during 1998–2004. Mortality on U.S. private lands increased during this period, suggesting that bears were searching more widely for foods to replace the low berry crop. Several mortalities occurring during 1999–2006 were associated with sanitation issues on private lands. Declines in mortality rate on private lands beginning in 2007 correspond to and may be the result of the initiation of the MFWP bear management specialist position. Several deaths of management bears occurred on private lands but were not included in this calculation due to capture biases (traps were set only once a conflict occurred and removed after capture). Point estimates for human-caused mortality occurring on public lands in the U.S. and BC decreased from 1983–1998 to 1999–2006 and again from 1999–2006 to 2007–2022. Implementation of access management on U.S. public lands could be a factor in this apparent decline.

Table 13. Survival and cause-specific mortality rates of native radio-collared grizzly bears ≥2 years old by location of death based on censored telemetry data in the Cabinet–Yaak recovery zone, 1983–2022.

Parameter	1983–1998	1999–2006	2007–2022
Individuals / bear-years	23 / 48.9	21 / 20.3	54 / 78.6
Survival[b] (95% CI)	0.899 (0.819–0.979)	0.792 (0.634–0.950)	0.916 (0.855–0.977)
Mortality rate by location and cause			
Public / natural	0	0.059	0
U.S. public / human	0.061	0.036	0.0240
U.S. private / human	0	0.075	0.048
B.C. public / human	0.040	0.038	0
B.C. private / human	0	0	0

Augmentation Grizzly Bear Survival and Cause-Specific Mortality

Kaplan-Meier survival rates were calculated for 22 augmentation grizzly bears from 1990–2021. Fourteen female and eight male bears ranged in age from 2–10. Survival was calculated based on release week for each individual, as the common starting point and progressing by week until death or censor. Bears that left the target area were censored during that week from the survival calculation to obtain survival rates indicative of CYGBE conditions. Four females are known to have left the target area, but one returned while radio collared. Four females are known to have died within the target area. None of the augmentation males died within the target area. Four are known to have left the target area and two are known to have died outside the target area. All known female and male mortality occurred within the first-year post release.

First year annual survival rate for augmentation females was 0.600 (95% CI=0.296–0.904, *n* =14) with a natural mortality, a poaching, a train collision, and an unknown cause. The natural mortality occurred during spring, the unknown mortality occurred during summer, and the poaching, mistaken identity, and train mortality occurred during autumn. The female that died of unknown cause produced a cub before her death and it is assumed the cub died. Female survival for all years radio monitored was 0.784 (95% CI=0.611–0.957, *n* =14. No males died within the target area during their first year though two males were known to have died outside the target area (mistaken identification and a self-defense). Male survival for all years radio monitored was 0.771 (95% CI=0.531–1.0 *n* =8).

Management Grizzly Bear Survival and Cause-Specific Mortality

Kaplan-Meier survival rates were calculated for 15 management grizzly bears captured at conflict sites from 2003–2022. Twelve bears were males and three were females aged 2–25. One female and five males died during monitoring. Management bear survival rate was 0.447 (95% CI=0.241–0.654, *n* =15) with an instance of mistaken identity, three management removals, and one unknown but human-caused mortality among 15 radio-collared bears monitored for 8.2 bear-years. One mortality occurred during spring, two during summer, and three during autumn.

Grizzly Bear Reproduction

Reproductive parameters originated from all bears monitored 1983–2022. Mean age of first parturition among native grizzly bears was 6.3 years (95% CI=5.9–6.7, *n* =14, Table 14). Five bears used to calculate first age of reproduction were radio-collared from ages 2–8. One individual was captured with a cub at age 6 years old. We assumed this was a first reproductive event given her age. Eight other first ages of reproduction were established through genetic parentage analysis and known age of offspring. Thirty-one litters comprised of 67 cubs were observed through both monitoring radio-collared bears and known genetic parentage analysis paired with remote camera observation, for a mean litter size of 2.16 (95% CI=1.98–2.34, n =31, Table 14). Twenty-seven reproductive intervals were determined through monitoring radio-collared bears and known genetic parentage analysis paired with remote camera observation (Table 14). Mean inter-birth interval was calculated as 2.89 years (95% CI=2.58–3.30, n =27). Booter software provides several options to calculate reproductive rate (m) and we selected unpaired litter size and birth interval data with sample size restricted to the number of females. The unpaired option allows use of bears from which accurate counts of cubs were not obtained but interval was known, or instances where litter size was known but radio failure or death limited knowledge of birth interval. Estimated reproductive rate using the unpaired option was 0.386 female cubs/year/adult female (95% CI=0.310–0.497, n =16 adult females, Table 15). Sex ratio of cubs born was assumed to be 1:1. Reproductive rates do not include augmentation bears.

Table 14. Grizzly bear reproductive data from the Cabinet-Yaak 1983–2022.

Bear	Year	Age at first reproduction	Reproductive Interval[1]	Cubs	Cubs (relationship and fate, if known)
106	1986		2	2	1 dead in 1986, ♀ 129 dead in 1989
106	1988		3	3	♂ 192 dead in 1991, ♂ 193, ♀ 206
106	1991		2	2	2 cubs 1 male other unknown sex and fate
106	1993		2	2	♂ 302 dead in 1996, ♀ 303
106	1995		4	2	♀ 353 dead in 2002, ♀ 354 dead in 2007
106	1999			2	♀ 106 and 2 cubs dead in 1999
206	1994	6	3	2	♀ 505
206	1997			2	♀ 596 dead in 1999, ♀ 592 dead in 2000
538	1997	6	3		1 yearling separated from ♀ 538 in 1998
538	2000		1	2	2 cubs dead in 2000
538	2001		1	2	2 cubs dead in 2001
538	2002			2	2 cubs of unknown sex and fate
303	2000	7	3	2	1 cub dead in 2000, ♀ 552
303	2003		4		At least 2 cubs
303	2007		3		At least 2 cubs
303	2010			3	1 cub dead in 2010
303	2013				Observed with courting male in May 2014
303	2016				1 yearling observed in 2016
354	2000	5	3		Genetic data indicated reproduction of at least two cubs in 2000
354	2003		3		At least 2 cubs
354	2006				At least 2 cubs
353	2002	7		3	♀ 353 dead in 2002, 3 cubs (1 female) all assumed dead in 2002
772	2003	6	4		Genetic data indicated reproduction of at least one cub in 2003
772	2007			2	♀ 789, ♂ 791
675	2009	7	1	2	2 cubs dead in 2009
675	2010			1	1 cub dead in 2010
552	2011		3	2	♀ 2011049122, ♂ 2011049118
552	2014			3	3 cubs, 2 males and one of unknown sex
784	2013	7			At least 2 cubs
784	2018				At least one cub
810	2010	7	4		At least one cub
810	2014		4	2	2 cubs observed at camera site, August 2014
810	2018			2	2 cubs observed June 2018
820	2009	6	4		At least one cub
820	2013			2	2 cubs ♀ 842, ♂ 818, 818 dead in 2015

Bear	Year	Age at first reproduction	Reproductive Interval[1]	Cubs	Cubs (relationship and fate, if known)
820	2018		5	2	2 cubs observed July 2018
831	2004	7	3		At least 1 cub
831	2007			2	2 cubs ♂ 799 and ♀ C20072F
831	2012			3	3 cubs, ♂ 839, ♀ 900933, ♀ 925063
831	2017		4	3	Photo with 3 cubs July 2017
831	2021			3	Photo with 3 cubs August 2021
731	2013	6	3		At least one cub ♂ 17139
731	2016				At least one cub ♀Y29503F
731	2019		3		At least one cub
822	2018	5	2	1	one cub ♂ Y38004M. Photo June 2018
822	2020			2	2 cubs observed July
842	2019	6	1	2	2 cubs dead in 2019
842	2020			2	2 cubs observed October

[1]Number of years from birth to subsequent birth.

Population Trend

Approximately 87% of the survival data and 89% of the reproductive data used in population trend calculations came from bears monitored in the Yaak River portion of this population. However, only the Kootenai River divides the Cabinet Mountains from the Yaak River, and the trend produced from this data would appear to be applicable to the entire population of native bears in the absence of population augmentation. Furthermore, overall annual survival of all bears was very similar at 0.841 in the Cabinets and 0.839 in the Yaak. The Cabinet Mountains portion of the population was estimated to be <15 in 1988 (Kasworm and Manley 1988) and subsequent lack of identification of resident bears through genetic techniques would suggest the population was possibly 5–10. Population augmentation has added 22 bears into this population since 1990 and a mark recapture population estimate from 2012 indicated the population was 22–24 individuals (Kendall *et al*. 2016). These data indicate the Cabinet Mountains population has increased by 2–4 times since 1988, but this increase is largely a product of the augmentation effort with reproduction from that segment.

The estimated finite rate of increase (λ) for 1983–2022 using Booter software with the unpaired litter size and birth interval data option was 1.016 (95% CI=0.939–1.079, Table 15). Finite rate of change over the same period was an annual 1.6% (Caughley 1977). Subadult female survival and adult female survival accounted for most of the uncertainty in λ, with reproductive rate, yearling survival, cub survival, and age at first parturition contributing much smaller amounts. The sample sizes available to calculate population trend are small and yielded wide confidence intervals around our estimate of trend (i.e., λ). The probability that the population was stable or increasing was 67%. Utilizing the entire survival and reproductive data set from 1983–2022 is partially the product of small sample sizes but also produces the effect of smoothing the data over time and results in a more conservative estimate of population trend. The Booter technique has been published in at least three different peer reviewed journals (Hovey and McLellan 1996, Mace and Waller 1998, Wakkinen and Kasworm 2004).

Finite rates of increase calculated for the period 1983–1998 (λ = 1.067) suggested an increasing population (Wakkinen and Kasworm 2004). Lack of mortality in specific sex-age classes limited calculations for many time periods other than those shown here (Fig. 12). Annual survival rates for adult and subadult females were 0.948 and 0.901 respectively, during 1983–1998, and then declined to 0.926 and 0.740 for the period of 1983–2006, respectively. Cumulative lambda calculations reached the lowest point in 2006 (Fig. 12). Human-caused mortality has accounted for much of this decline in annual survival rates and population trend. Improved adult female survival and subadult female survival rates resulted in an improving population trend estimate since 2006. Improving survival by reducing human-caused mortality is crucial for recovery of this population (Proctor *et al*. 2004).

Table 15. Booter unpaired method estimated annual survival rates, age at first parturition, reproductive rates, and population trend of native grizzly bears in the Cabinet–Yaak recovery zone, 1983–2022.

Parameter	Sample size	Estimate (95% CI)	SE	Variance (%)[a]
Adult female survival[b] (S_a)	18 / 56.3[c]	0.917 (0.825–0.980)	0.040	39.2
Subadult female survival[b] (S_s)	23 / 28.1[c]	0.866 (0.731–0.969)	0.062	44.0
Yearling survival[b] (S_y)	37 / 18.9[c]	0.898 (0.751–1.0)	0.068	2.7
Cub survival[b] (S_c)[d]	46/46	0.652 (0.522–0.783)	0.070	5.3
Age first parturition (*a*)	14	6.3 (5.9–6.6)	0.185	0.5
Maximum age (*w*)	Fixed	27		
Unpaired Reproductive rate (*m*)[e]	18/27/31[f]	0.380 (0.301–0.503)	0.051	8.3
Unpaired Lambda (λ)	5000 bootstrap runs	1.016 (0.939–1.079)	0.036	

[a] Percent of lambda explained by each parameter.
[b]Booter survival calculation which may differ from Kaplan-Meier estimates in Table 13.
[c]individuals / bear-years
[d]Cub survival based on counts of individuals alive and dead.
[e]Number of female cubs produced/year/adult female. Sex ratio assumed to be 1:1.
[f]Sample size for individual reproductive adult females / sample size for birth interval / sample size for litter size from Table 14.

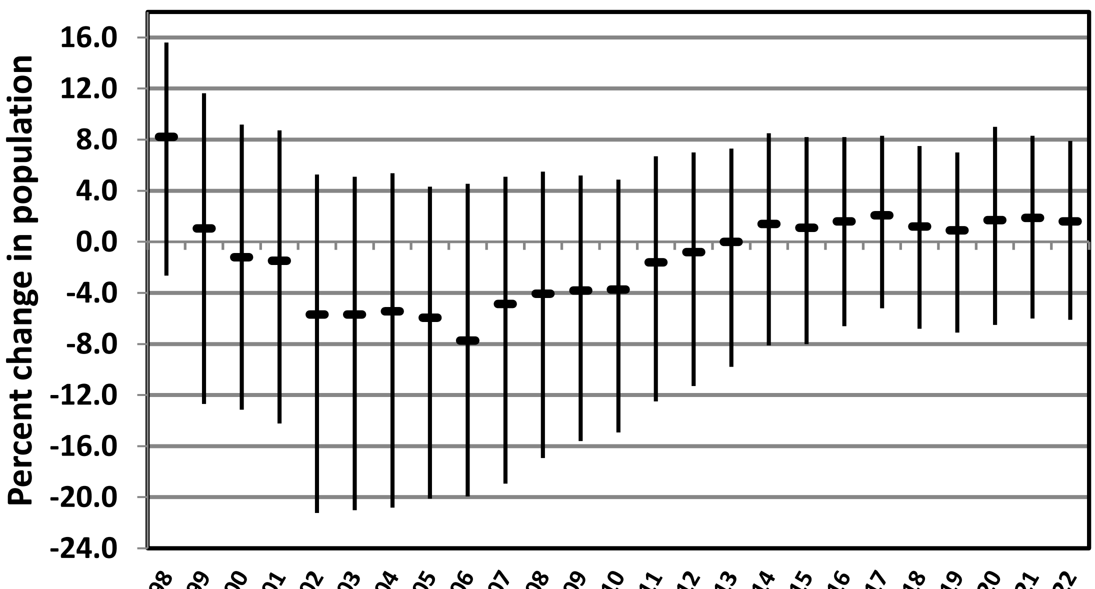

Figure 12. Point estimate and 95% confidence intervals for cumulative annual calculation of population rate of change for native grizzly bears in the Cabinet-Yaak recovery area, 1983–2022. Each entry represents the annual rate of change from 1983 to that date.

Population Estimate

During 2012, USGS used mark-recapture techniques to estimate the CYE grizzly bear population at 48–50 (95% CI = 44–62) (Kendall *et al*. 2016). Using the midpoint of this estimate

(49), the calculated rate of increase (1.6%), results in a gain of 8 bears through 2022 to a population of 57. The augmentation program added 8 bears since 2012 but four of those have either left the target area or are known dead. Based on this information, a population estimate of about 60-65 bears would seem reasonable.

Capture and Marking

Seven grizzly bears were captured for research purposes within the Cabinet and Yaak study area (3 subadult females, 1 adult female, 2 sub-adult males, and 1 adult male) during 2022. A sub-adult female was captured twice within the Cabinet Mountains portion in management conflict situations in 2022. On the second capture, the bear was euthanized for killing chickens and approaching a resident on the porch of their home. The bear was shot with bear spray and showed little response as it was walking away. The bear had been captured in Whitefish, MT the previous year and relocated. One-hundred seven individual grizzly bears have been captured 165 times as part of this monitoring program since 1983 (Tables 16 and 17). One-hundred thirty-eight captures occurred for research purposes, 7 captures occurred for management non-conflict purposes, and 20 captures occurred for management conflict purposes.

Cabinet Mountains

Research trapping was conducted in the Cabinet Mountains portion of the CYE from 1983–1987. Three adult grizzly bears were captured during this effort (1 female and 2 males). No trapping occurred from 1988–1994 as effort was directed toward the Yaak River. In 1995, an effort was initiated to recapture augmentation bears to determine success of the program and capture any native bears in the Cabinet Mountains. During 1983–2022, 6,542 research trap-nights were expended to capture 15 known individual grizzly bears and 369 individual black bears (Table 16 and 17, Fig. 13). Rates of capture by individual were 1 grizzly bear/1,473 trap-nights and 1 black bear/15 trap-nights from 1983–2022. Capture success improved to 1 grizzly bear/177 trap-nights, and 1 black bear / 294 trap-nights from 2003-2022. A trap-night was defined as one site with one or more snares set for one night. One augmentation bear was captured after release during research trapping efforts.

Yaak River, Purcell Mountains South of BC Highway 3

Trapping was conducted in the Yaak portion of the CYE during 1986–1987 as part of a black bear graduate study (Thier 1990). Research trapping was continued from 1989–2022 by USFWS. Fifty-six captures of 26 individual grizzly bears and 349 captures of 277 individual black bears were made during 5,343 trap-nights during 1986–2002. Seventy-five captures of 46 individual grizzly bears and 240 captures of 216 individual black bears were made during 8,105 trap-nights during 2003–2022 (Tables 16 and 17, Fig 13). Rates of capture by individual were one grizzly bear/206 trap-nights and one black bear/19 trap-nights during 1986–2002. Trap success increase to one grizzly / 176 trap nights and one black bear / 38 trap nights during 2003–2022. Trapping effort was concentrated in home ranges of known bears during 1995–2022 to recapture adult females with known histories. Much of the effort involved using horses and bicycles in areas inaccessible to vehicles, such as trails and closed roads.

Moyie River and Goat River Valleys North of Highway 3, British Columbia

Eight grizzly bears and 32 black bears were captured in the Moyie and Goat River valleys north of Highway 3 in BC in 2004–2008 (Table 16 and Fig. 13). Trapping was conducted in cooperation with M. Proctor (Birchdale Ecological Consultants, Kaslo, BC) and BC Ministry of Environment. Rates of capture by individual were 1 grizzly bear/32 trap-nights and 1 black bear/8 trap-nights.

Table 16. Research capture effort and success for grizzly bears and black bears within study areas, 1983–2002 and 2003-2022.

Area / Year(s)	Trap-nights	Grizzly Bear Captures	Black Bear Captures	Trap-nights / Grizzly Bear	Trap-nights / Black Bear
Cabinet Mountains,1983–2002					
Total Captures	4420	6	399	737	11
Individuals[1]	4420	3	299	1473	15
Cabinet Mountains, 2003-2022					
Total Captures	2122	13	73	163	29
Individuals[1]	2122	12	70	177	30
Yaak River South Hwy 3, 1986-2002					
Total Captures	5343	56	349	95	15
Individuals[1]	5343	26	277	206	19
Yaak River South Hwy 3, 2003-2022					
Total Captures	8105	75	240	108	34
Individuals[1]	8105	46	216	176	38
Purcells N. Hwy 3, BC 2004–09					
Total Captures	390	10	37	39	11
Individuals[1]	390	9	32	43	12

[1]Only captures of individual bears included. Recaptures are not included in summary.

Table 17. Grizzly bear capture information from the Cabinet-Yaak and Purcell populations, 1983–2022. Multiple captures of a single bear in a single year are not included.

Bear	Capture Date	Sex	Age (Est.)	Mass kg (Est.)	Location	Capture Type
678	6/29/83	F	28	86	Bear Cr., MT	Research
680	6/19/84	M	11	(181)	Libby Cr., MT	Research
680	5/12/85	M	12	(181)	Bear Cr., MT	Research
678	6/01/85	F	30	79	Cherry Cr., MT	Research
14	6/19/85	M	27	(159)	Cherry Cr., MT	Research
101	4/30/86	M	(8)	(171)	N Fk 17 Mile Cr., MT	Research
678	5/21/86	F	31	65	Cherry Cr., MT	Research
106	5/23/86	F	8	92	Otis Cr., MT	Research
128	5/10/87	M	4	(114)	Lang Cr., MT	Research
129	5/20/87	F	1	32	Pheasant Cr., MT	Research
106	6/20/87	F	9	(91)	Grizzly Cr., MT	Research
134	6/24/87	M	8	(181)	Otis Cr., MT	Research
129	7/06/89	F	3	(80)	Grizzly Cr., MT	Research
192	10/14/89	M	1	90	Large Cr., MT	Research
193	10/14/89	M	1	79	Large Cr., MT	Research
193	6/03/90	M	2	77	Burnt Cr., MT	Research
206	6/03/90	F	2	70	Burnt Cr., MT	Research
106	9/25/90	F	12	(136)	Burnt Cr., MT	Research
206	5/24/91	F	3	77	Burnt Cr., MT	Research
244	6/17/92	M	6	140	Yaak R., MT	Research
106	9/04/92	F	14	144	Burnt Cr., MT	Research
34	6/26/93	F	(15)	158	Spread Cr., MT	Research
206	10/06/93	F	5	(159)	Pete Cr., MT	Research
505	9/14/94	F	Cub	45	Jungle Cr., MT	Research
302	10/07/94	M	1	95	Cool Cr., MT	Research
303	10/07/94	F	1	113	Cool Cr., MT	Research
106	9/20/95	F	17	(169)	Cool Cr., MT	Research
353	9/20/95	F	Cub	43	Cool Cr., MT	Research
354	9/20/95	F	Cub	47	Cool Cr., MT	Research

Bear	Capture Date	S ex	Age (Est.)	Mass kg (Est.)	Location	Capture Type
302	9/24/95	M	2	113	Cool Cr., MT	Research
342	5/22/96	M	4	(146)	Zulu Cr., MT	Research
363	5/27/96	M	4	(158)	Zulu Cr., MT	Research
303	5/27/96	F	3	(113)	Zulu Cr., MT	Research
355	9/12/96	M	(6)	(203)	Rampike Cr., MT	Research
358	9/22/96	M	8	(225)	Pete Cr., MT	Research
353	9/23/96	F	1	83	Cool Cr., MT	Research
354	9/23/96	F	1	88	Cool Cr., MT	Research
384	6/12/97	M	7	(248)	Zulu Cr., MT	Research
128	6/15/97	M	14	(270)	Cool Cr., MT	Research
386	6/20/97	M	5	(180)	Zulu Cr., MT	Research
363	6/26/97	M	5	(180)	Cool Cr., MT	Research
538	9/25/97	F	6	(135)	Rampike Cr., MT	Research
354	9/27/97	F	2	99	Burnt Cr., MT	Research
354	8/20/98	F	3	(90)	Cool Cr., MT	Research
106	8/29/98	F	20	(146)	Burnt Cr., MT	Research
363	8/30/98	M	6	(203)	Burnt Cr., MT	Research
342	9/17/98	M	6	(203)	Clay Cr., MT	Research
303	9/21/98	F	5	(113)	Clay Cr., MT	Research
592	8/17/99	F	2	(91)	Pete Cr., MT	Research
596	8/23/99	F	2	(91)	French Cr., MT	Research
358	11/15/99	M	11	279	Yaak R., MT	Management, conflict
538	7/16/00	F	9	(171)	Moyie River, BC	Research
552	7/16/01	F	1	(36)	Copeland Cr., MT	Research
577	5/22/02	F	1	23	Elk Cr., MT	Management, pre-emptive move
578	5/22/02	M	1	23	Elk Cr., MT	Management, pre-emptive move
579	5/22/02	M	1	30	Elk Cr., MT	Management, pre-emptive move
353	6/15/02	F	7	(136)	Burnt Cr., MT	Research
651	9/25/02	M	7	(227)	Spread Cr., MT	Research
787	5/17/03	M	3	71	Deer Cr. ID	Management, conflict
342	5/23/03	M	11	(227)	Burnt Cr., MT	Research
648	8/18/03	F	5	(159)	McGuire Cr., MT, Salish Mtns.	Research
244	9/25/03	M	17	(205)	N Fk Hellroaring Cr., MT	Research
10	6/17/04	F	11	(159)	Irishman C., BC	Research
11	6/20/04	M	7	(205)	Irishman C., BC	Research
12	7/22/04	F	11	(148)	Irishman C., BC	Research
576	10/21/04	M	2	(114)	Young Cr., MT	Management, conflict
675	10/22/04	F	2	100	Young Cr., MT	Management, pre-emptive move
677	5/13/05	M	6	105	Canuck Cr., BC	Research
688	6/13/05	M	3	93	EF Kidd Cr., BC	Research
576	6/17/05	M	3	133	Teepee Cr., BC	Research
690	6/17/05	F	1	52	EF Kidd Cr., BC	Research
17	6/18/05	M	8	175	Norge Pass, BC	Research
2	6/20/05	M	7+	209	EF Kidd Cr., BC	Research
292	7/6/05	F	4	(114)	Mission Cr., ID	Research
694	7/15/05	F	2	73	Kelsey Cr., MT	Research
770	9/20/05	M	11	(250)	Chippewa Cr., MT	Research
M1	10/4/05	M	(2)	(80)	Pipe Cr., MT	Management, conflict garbage feeding
668	10/11/05	M	3	120	Yaak R., MT	Management, conflict garbage feeding
103	5/23/06	M	3	125	Canuck Cr., BC	Research
---	5/28/06	F	4	(125)	Cold Cr., BC (Trap predation)	Research
5381	6/6/06	M	4	(200)	Hellroaring Cr., ID	Research
651	6/28/06	M	11	198	Cold Cr., BC	Research
780	9/22/06	M	6	(250)	S Fk Callahan Cr., MT	Research
130	6/18/07	F	26	113	Arrow Cr., BC	Research
131	6/28/07	F	(5)	(80)	Arrow Cr., BC	Research
784	9/23/07	F	1	(80)	Spread Cr., MT	Research
772	9/18/07	F	10	116	Pilgrim Cr., MT	Management, preemptive, fruit trees
789	9/18/07	F	Cub	36	Pilgrim Cr., MT	Management, preemptive, fruit trees
791	9/18/07	M	Cub	39	Pilgrim Cr., MT	Management, preemptive, fruit trees
785	10/15/07	F	1	75	Pete Cr., MT	Research

Bear	Capture Date	Sex	Age (Est.)	Mass kg (Est.)	Location	Capture Type
675	5/23/09	F	7	89	Elmer Cr. BC	Research
784	7/24/09	F	3	(136)	Hensley Cr., MT	Research
731	9/17/09	F	2	(125)	Fowler Cr., MT	Research
5381	11/21/09	M	4	(273)	Kidd Cr., BC	Research
799	5/21/10	M	3	(102)	Rock Cr., MT	Research
737	7/21/10	M	4	129	Messler Cr., MT	Research
1374	8/30/10	M	2	98	Young Cr., MT	Management, conflict garbage feeding
726	5/24/11	M	2	77	Meadow Cr., MT	Research
722	5/31/11	M	12	261	Otis Cr., MT	Research
729	6/18/11	F	1	33	Beulah Cr., MT	Research
724	7/13/11	M	2	159	Graves Cr., MT	Management, conflict killed pigs
732	10/27/11	M	5	139	Otis Cr., MT	Management, killed chickens
729	6/26/12	F	2	(80)	Pipe Cr., MT	Research
737	9/19/12	M	6	(159)	Basin Cr., MT	Research
552	9/24/12	F	12	(136)	Basin Cr., MT	Research
826	6/28/13	M	(5)	(136)	Pipe Cr., MT	Research
303	7/23/13	F	20	132	Pipe Cr., MT	Research
831	6/21/14	F	14	81	Libby Cr., MT	Research
807	6/24/14	M	4	111	Canuck Cr., ID	Research
808	6/27/14	M	4	130	Spruce Cr., ID	Research
722	8/21/14	M	15	(182)	Hellroaring Cr., MT	Research
835	8/24/14	M	12	185	Hellroaring Cr., MT	Research
836	9/19/14	F	1	75	Hellroaring Cr., MT	Research
837	9/29/14	M	6	(227)	Hellroaring Cr., MT	Research
729	5/19/15	F	5	107	Cool Cr., MT	Research
839	6/19/15	M	4	78	Bear Cr., MT	Research
810	7/16/15	F	12	120	Hellroaring Cr., MT	Research
818	7/18/15	M	2	82	Meadow Cr., MT	Research
820	8/20/15	F	12	149	Hellroaring Cr., MT	Research
726	10/5/15	M	6	227	Libby Cr., MT	Management, conflict beehives
836	7/18/16	F	3	87	Hellroaring Cr., MT	Research
822	8/15/16	F	3	92	Hellroaring Cr., MT	Research
824	8/18/16	M	(12)	197	Hellroaring Cr., MT	Research
9811	8/19/16	M	(2)	(91)	Hellroaring Cr., MT	Research
821	8/27/16	M	2	127	Hellroaring Cr., MT	Research
853	9/21/16	M	5	120	Boulder Cr., MT	Research
722	9/29/16	M	17	238	17 Mile Cr., MT	Management, conflict pigs and
922	10/10/16	M	2	130	Upper Yaak R., MT	Management, conflict chicken feed
726	6/18/17	M	8	(195+)	Beulah Cr., MT	Research
1026	6/21/17	F	2	63	Upper Yaak R., MT	Management, conflict habituated
1028	6/21/17	F	2	64	Upper Yaak R., MT	Management, conflict habituated
861	6/25/17	M	2	55	Bear Cr., MT	Research
840	6/26/17	F	2	53	Cruien Cr., MT	Research
842	7/25/17	F	4	93	Fourth of July Cr., MT	Research
810	9/18/17	F	14	150	Hellroaring Cr., MT	Research
9077	4/30/18	M	3	112	Thompson R., MT	Management
927	9/5/18	M	2	92	Dry Cr., ID	Management, conflict Black Bear Bait
722	9/23/18	M	19	238	Hellroaring Cr., MT	Research
844	6/22/19	M	4	122	Pipe Cr, MT	Research
866	6/25/19	M	4	134	Bear Cr, MT	Research
835	7/23/19	M	17	175	Canuck Cr, MT	Research
822	7/25/19	F	6	109	Canuck Cr, MT	Research
770	10/11/19	M	25	207	Bear Cr,MT	Management, conflict Livestock feed
930	6/23/20	M	2	78	Whitetail Cr.,MT	Research
784	7/24/20	F	14	115	Hellroaring Cr.,MT	Research
729	9/21/20	F	10	158	Burnt Cr.,MT	Research
718	5/24/21	M	4	147	SF Meadow Cr, MT	Research
848	7/17/21	M	1	(50)	Copper Cr, ID	Research
890	7/27/21	F	5	108	Silta Cr, MT	Management, Preemptive
835	8/17/21	M	19	169	4th July Cr, MT	Research
939	8/20/21	F	3	107	Hellroaring Cr, MT	Research

Bear	Capture Date	Sex	Age (Est.)	Mass kg (Est.)	Location	Capture Type
882	8/24/21	M	1	62	Cyclone Cr, MT	Research
884	9/10/21	M	3	150	Rapid Lightning Cr, ID	Management, Preemptive
940	10/28/21	M	4	130	Parmenter Cr, MT	Management, Preemptive
882	5/26/22	M	2	62.4	Ferrell Cr., MT	Research
848	5/31/22	M	2	64	Whitetail Cr.,MT	Research
880	6/19/22	M	(6)	(181)	Poorman Cr.,MT	Research
893	6/19/22	F	4	87	Silver Butte Cr,MT	Management, conflict chicken feed
886	7/14/22	F	(3)	55	Howard Cr, MT	Research
831	7/22/22	F	25	89	Libby Cr.,MT	Research
939	9/18/22	F	4	117	Hellroaring Cr.,MT	Research
1070	9/20/22	F	2	80	Hellroaring Cr.,MT	Research

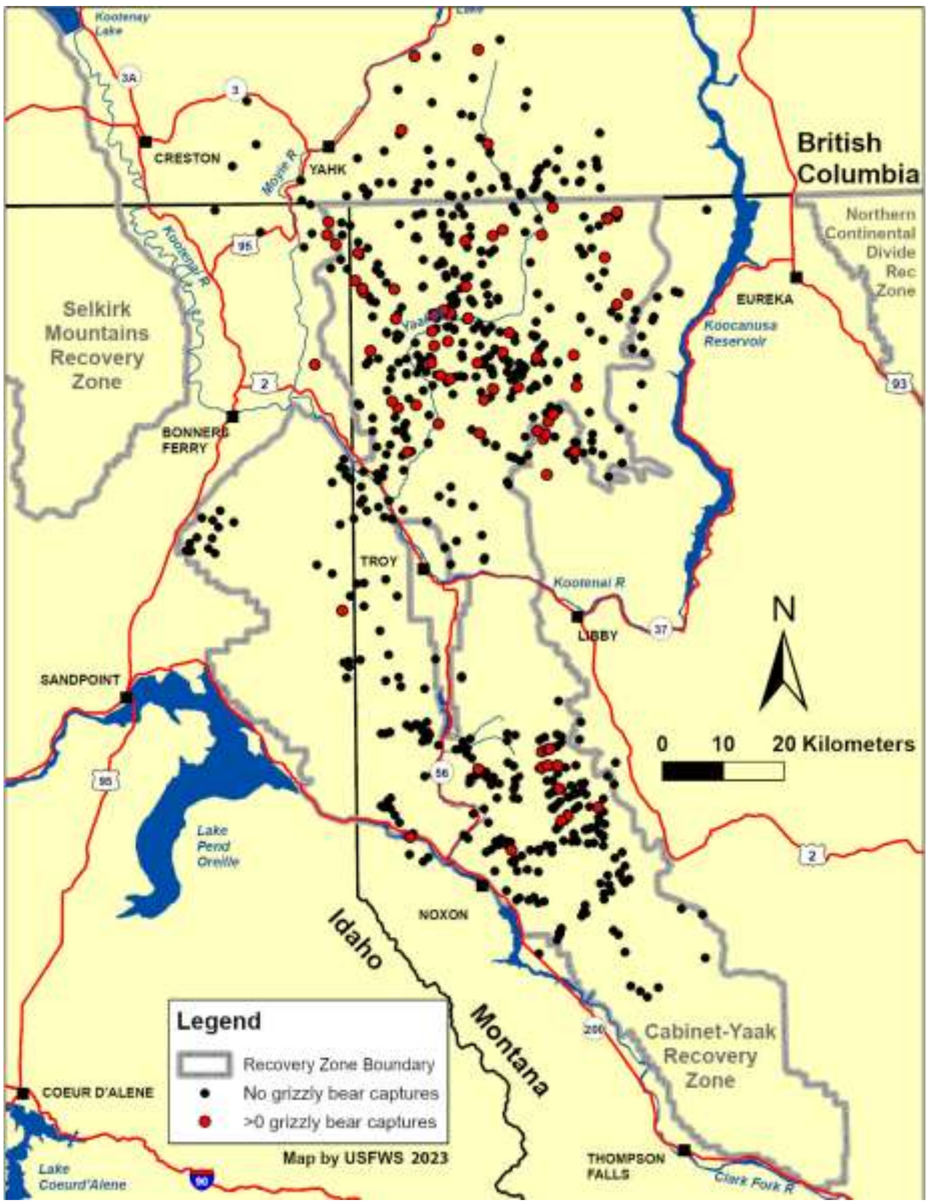

Figure 13. Trap site locations in the Cabinet-Yaak study areas 1983–2022. Red dots represent sites with ≥ one grizzly bear capture.

Grizzly Bear Monitoring and Home Ranges

Convex polygon annual home ranges were computed for bears monitored during 1983-2022. Annual home range estimates and basic statistics were calculated for research bears by sex and age class with ≥ 5 months of telemetry data per year (Table 18). Fourteen grizzly bears were monitored with radio-collars during portions of 2022. Research monitoring included eight females (four adults and four subadult) and six males (three adult and three subadults) in the CYE. One female was from the Cabinet Mountains augmentation program. One male and one female bear were collared for preemptive purposes.

Aerial telemetry locations and GPS collar locations were used to calculate home ranges. The convex polygon annual ranges were computed for bears monitored during 1983–2022 (Appendix 4 Figs. A1-A119). Resident, non-augmentation bears with annual range estimates for bears with ≥ 5 months of telemetry were used to calculate basic statistics. Adult male annual range averaged 1,895 km^2 (95% CI ± 704, n = 20) and adult female annual range averaged 403 km^2 (95% CI ± 146, n = 15) using the minimum convex polygon estimator (Table 18).

Young female bears typically utilize home ranges adjacent to or a part of their mother's home range. The minimum convex polygon estimator for bear 106 was 852 km^2 during her 1986–1999 lifetime (Fig. 14). Her home range was smallest during the five years that she had cubs. Four known female offspring of bear 106 established home ranges around their maternal range (Fig. 14). Bear 206 has established a home range adjacent to and north of her mother's home range. Bear 303 has established a home range east of her mother's home range and female 354 may have established her home range west of her mothers. Bear 353 lived within her mother's old range, before her death. Second-generation female offspring of 106 occupied habitats east and west of first-generation offspring. In recent years, third-generation females have established home ranges south of second-generation females (Fig. 14).

Home ranges of collared grizzly bears overlap extensively on a yearly and lifetime basis. However, bears typically utilize the same space at different times. Male home ranges overlap several females to increase breeding potential, but males and females consort only during the brief period of courtship and breeding. Adult male bears, whose home ranges overlap, seldom use the same area at the same time to avoid conflict.

Table 18. Cabinet-Yaak research bears, mean annual home range by sex and age class 1983-2022. Bears that have less than 5 months of data per year were not included in calculations.

Sex and age class	N	Mean	95% CI
Male subadult	17	1,577	± 819
Female subadult	12	471	± 248
Male adult	20	1,895	± 704
Female adult	15	403	± 146

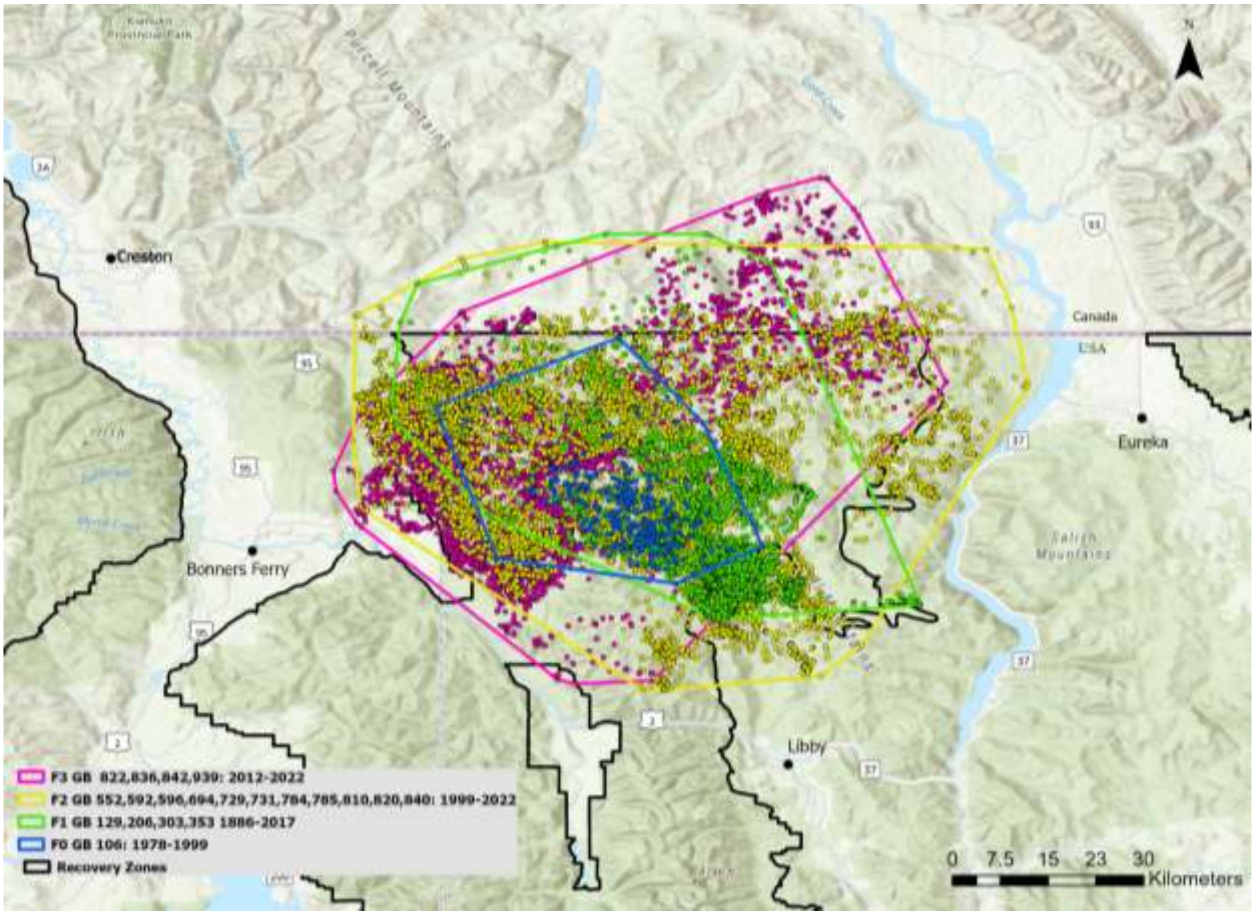

Figure 14. Generational home ranges of female grizzly bears in the Yaak River descended from grizzly bear 106 that characterize female range expansion, 1986–2022.

Grizzly Bear Denning Chronology

We summarized den entry and exit dates of radio-collared grizzly bears using VHF and GPS location data (1983–2022). Radio-collars deployed since the late 2000s include an activity monitoring device (i.e., accelerometer), which allows a more detailed assessment of den entrance and exit and activity during the denning period.

Den entry dates (n = 146) ranged from the third week of October to the last week of December. Ninety-five percent (139) of entries occurred between the 4th week of October and the 3rd week of December (Fig. 15). Grizzly bears in the Cabinet Mountains (median entry in 2nd week of November) entered dens 2 weeks earlier than bears in the Yaak River drainage (median entry during 4th week of November). Males generally entered dens later than females. Female-offspring family groups tended to enter dens later than independent adult females (Fig. 16). By December 1, 38% of Cabinet and Yaak grizzly bears had not yet entered winter dens (24% of females and 57% of males, Fig. 17).

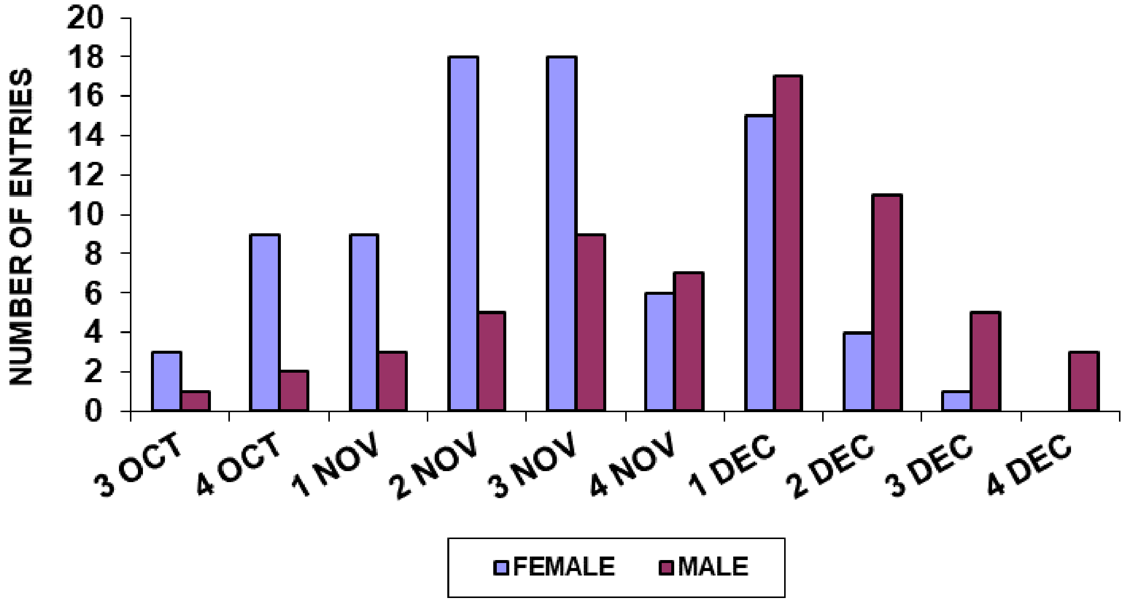

Figure 15. Month and week of den entry for male and female radio-collared grizzly bears in the Cabinet-Yaak grizzly bear recovery zone, 1983–2022.

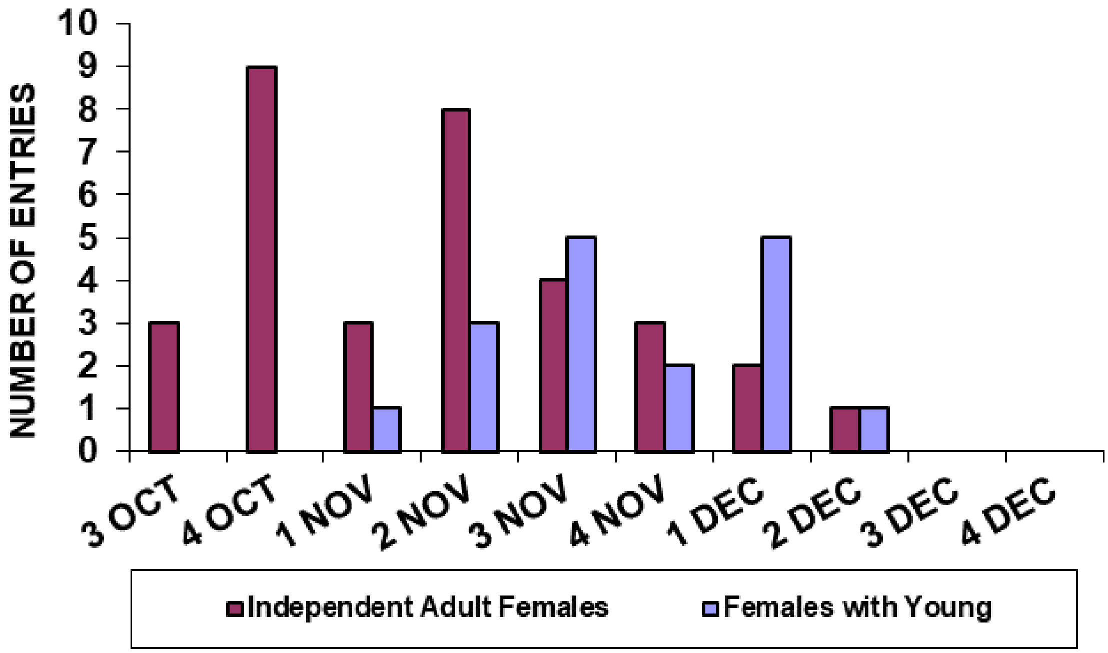

Figure 16. Month and week of den entry for adult female, radio-collared grizzly bears in the Cabinet-Yaak grizzly bear recovery zone, 1983–2022.

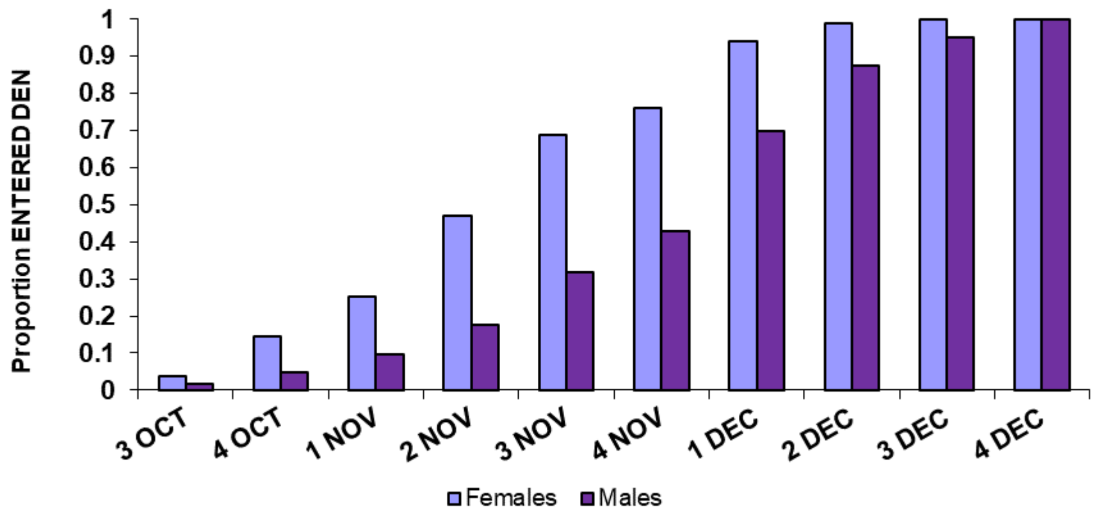

Figure 17. Cumulative proportion of den entries for female and male, radio-collared grizzly bears in the Cabinet-Yaak grizzly bear recovery zone, by month and week, 1983–2022.

Den exit dates (n = 131) ranged from the first week of March to the third week of May (Fig. 18). Ninety-six percent (126) of exit dates occurred from the 2nd week of March through the 2nd week of May. Grizzly bears in the Cabinet Mountains generally exited dens one week later than bears in the Yaak river drainage. Males tended to exit dens two weeks earlier than females. Sixty-nine percent of den exits occurred during the month of April. By May 1, 14% of Cabinet and Yaak grizzly bears were still in dens, well over half of which were females with cubs. Females with cubs generally exit dens later than other adult females (median exit during 1st week of May; Fig. 19). All adult females with cubs remained at dens until at least April 15.

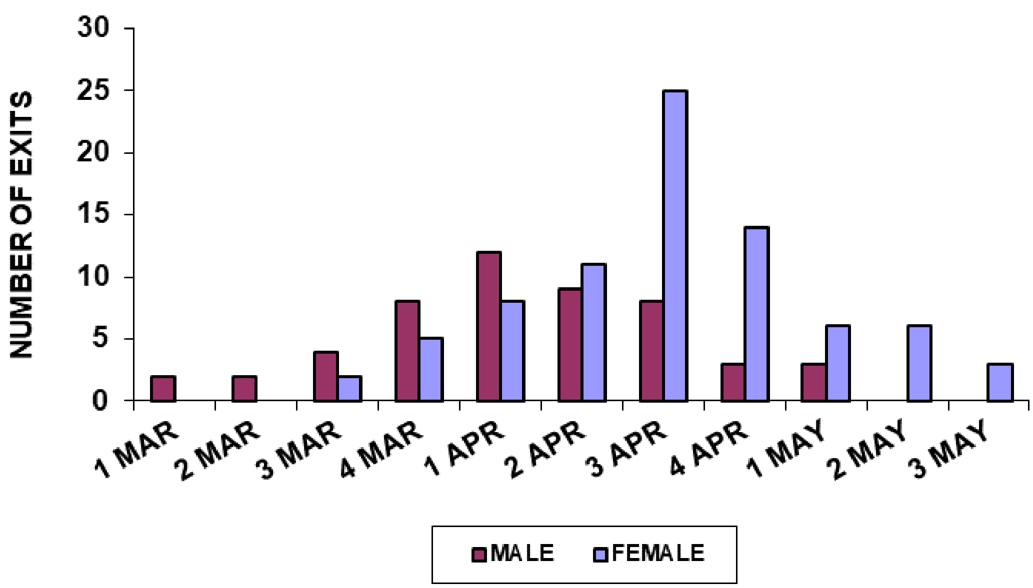

Figure 18. Month and week of den exit for male and female radio-collared grizzly bears in the Cabinet-Yaak grizzly bear recovery zone, 1983–2022.

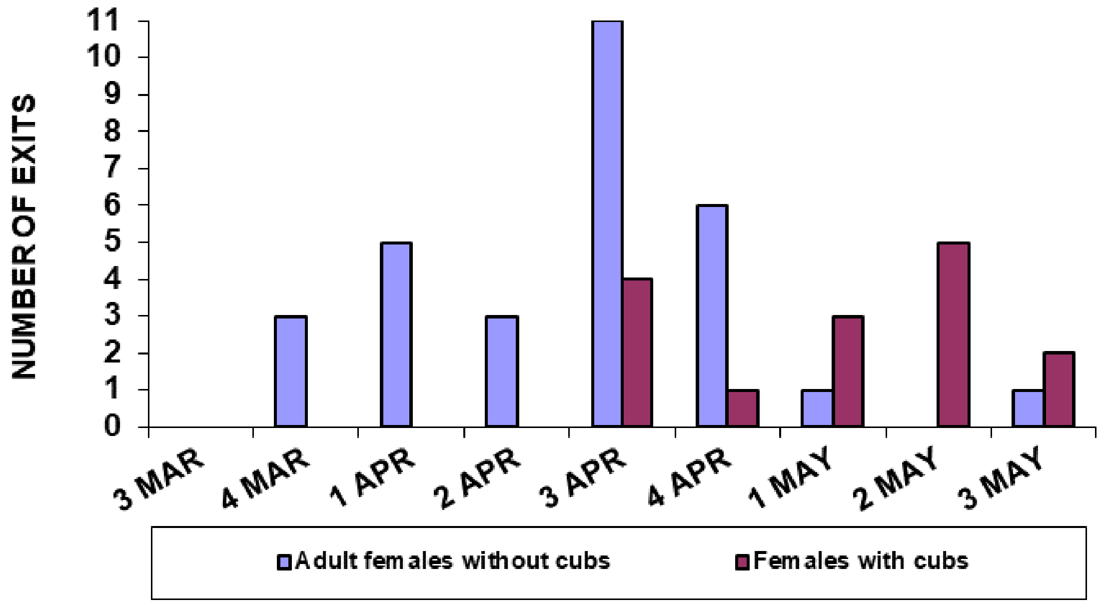

Figure 19. Month and week of den exit for adult female, radio-collared grizzly bears (with and without cubs) in the Cabinet-Yaak grizzly bear recovery zone, 1983–2022.

Grizzly Bear Habitat Analysis

Resource selection functions were utilized to develop seasonal habitat use maps for the Cabinet-Yaak and Selkirk Mountains recovery area zones and surrounding area based on telemetry locations collected from 2004–2010. See Appendix 5 for methodology and maps. The following habitat analysis will discuss both recovery areas.

Grizzly Bear Use by Elevation

Differences in elevation between the Cabinet-Yaak and Selkirk Mountains are reflected in individual bear's radio location data (GPS &VHF) from both areas. To account for differences in sample size between VHF and GPS collared bears, monthly mean elevation for each bear was first calculated. These means were then averaged. Only bears with at least four locations per month were utilized. Grizzly bears in all three study areas exhibited the same general pattern of elevation use (Figure 20). In spring, bears are at lower elevations accessing early green vegetation. As the year progresses, bears move to higher elevations to utilize a variety of berry species. Yaak River (Purcell Mountains) bear's decrease in elevation during October and November correspond to the Montana general hunting season. Bears may be utilizing wounded animals and gut piles. Selkirk bears show an increase in meat consumption later in the year, but by the first week of November 50% of bears have entered dens and may not have the ability to respond to the presence of this protein source. The difference in Idaho and Montana's hunt season structure may account for some of the differences in fall elevation use.

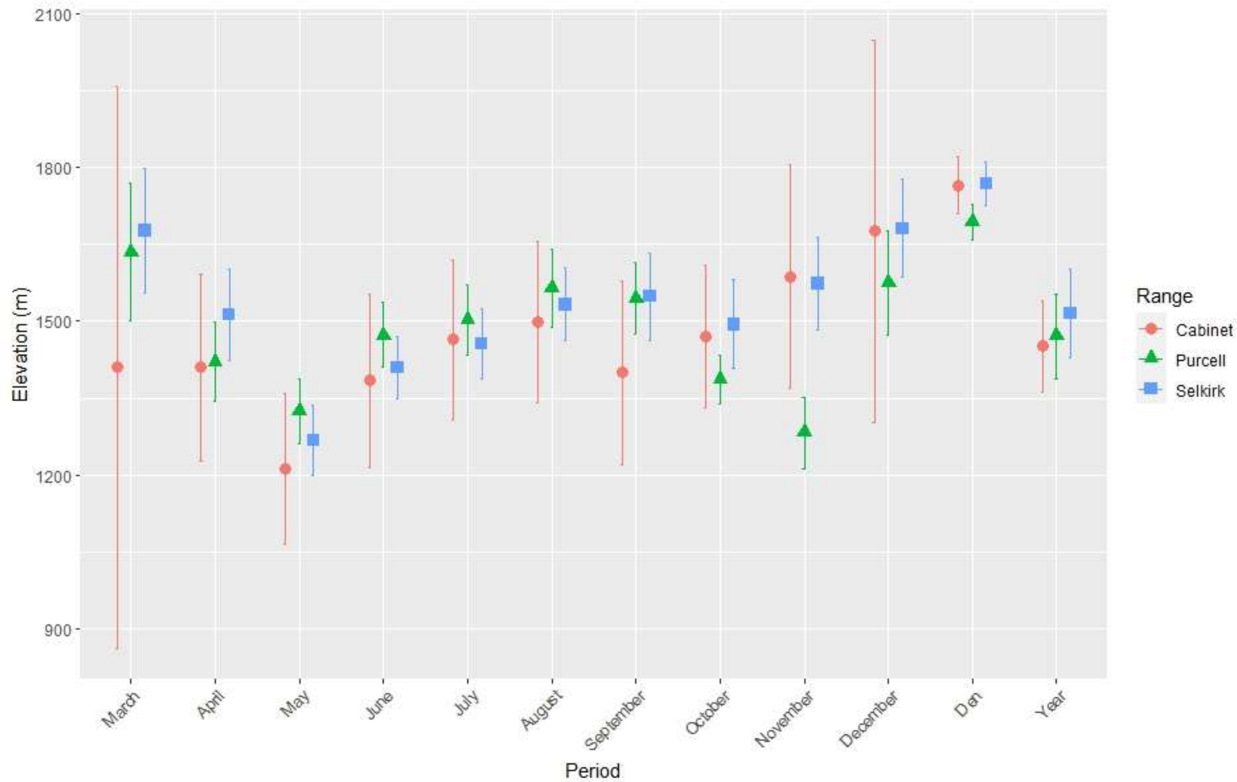

Figure 20. Mean monthly use by elevation for bears in the Cabinet Mountains (*n* = 18) from 1983–2022, the Purcell Mountains (*n* = 48) from 1986–2022, and the Selkirk Mountains (*n* = 110) from 1986–2022 for VHF and GPS collared bears. Error bars represent 95% CI.

Grizzly Bear Use by Aspect

Annual grizzly bear VHF and GPS location summary indicates that Cabinet bears (*n* = 15,011) utilize north facing slopes more so than bears in other study areas (Figure 21). Bears in the Yaak River (*n* = 99,968) and Selkirk (*n* = 113,787) exhibit similar use of aspect, using east the most and north the least.

Bear dens in the Yaak River (*n* = 108) and Selkirk study area (*n* = 103) occurred on east facing slopes more than other aspects (Figure 22). Yaak River bear dens occurred on north slopes more than other study areas. Cabinet bear dens (*n* = 42) utilized east and south facing slopes to the same degree and north facing slopes the least. These differences may be a result of varying topography among study areas and where snowpack is present.

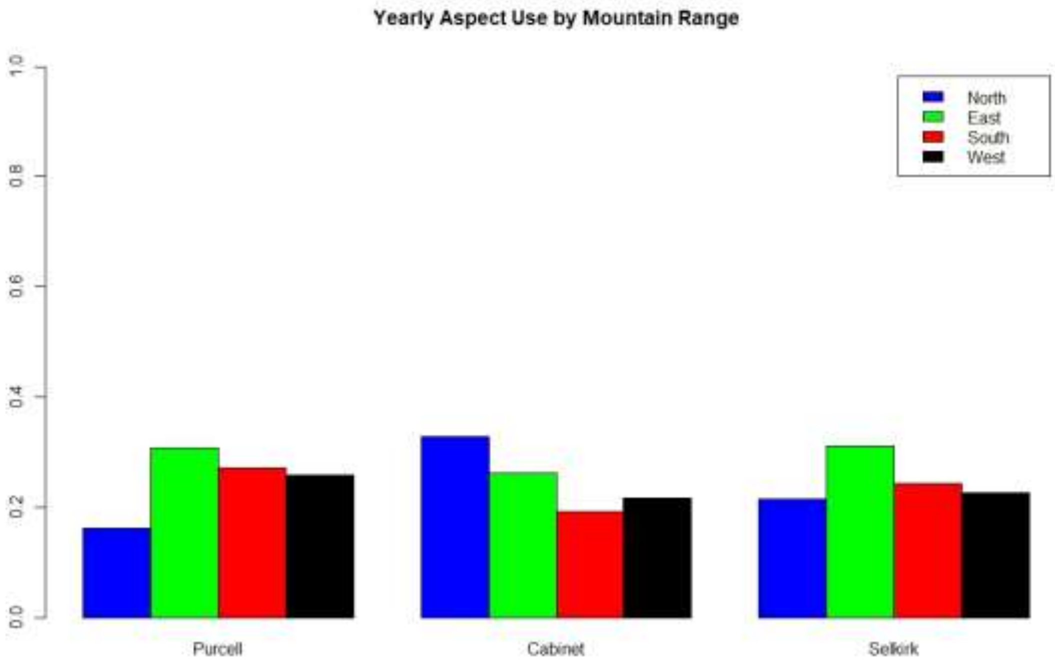

Figure 21. Yearly proportional use of aspect for grizzly bear VHF and GPS locations in the Yaak River from 1986–2022, the Cabinet Mountains from 1986–2022, and the Selkirk Mountains from 1986–2022.

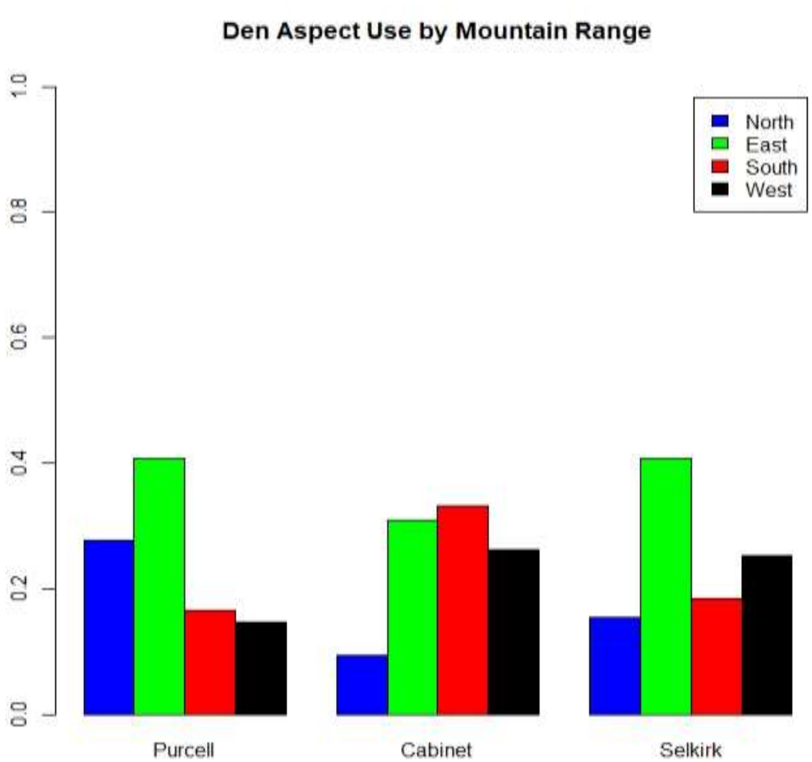

Figure 22. Aspect of grizzly bear dens in the Yaak River (n=108) from 1986–2022, the Cabinet Mountains (n=42) from 1983–2022, and the Selkirk Mountains (n=103) from 1986–2022.

Grizzly Bear Spring Habitat Description

After den emergence in spring, bears seek sites that melt snow early and produce green vegetation. These sites can often overlap with ungulate winter range and provide winterkill carrion. Spring habitat use in both study areas (April and May) indicated use of low elevation sites. Cabinet Mountain radio locations indicated most use below 1,600 m with primary use of southerly facing snow chutes, alder shrub fields, grassy sidehill parks, and closed timber. Yaak River radio locations indicated most use below 1,400 m with primary use of closed timber, timbered shrub fields, cutting units, and grassy sidehill parks on virtually all aspects. Lower elevation of the Yaak River area may allow snow to melt and vegetation to green-up earlier.

Inter-ecosystem Isotope Analysis

We are using isotope analysis to compare grizzly bear food use (plant vs. animal matter) between ecosystems, among sex-age classes, and across management status. Samples currently analyzed are only from grizzly bears of known sex and age. Most samples came from capture events; future analysis will include samples from known grizzly bears at hair rub and hair corral sites. To date, we have obtained carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope ratios from 237 grizzly bear hair and blood samples between 1984 and 2015 from the CYE and Selkirk ecosystems. Across the Selkirk and CYE ecosystems, adult males consume slightly more animal matter (22%) than adult females (14%) and subadults (13%). Adult females in the Yaak River consume higher proportions of animal matter (22%) than do adult females in the Cabinets (10%) and the Selkirks (6%).

We estimate that 14% of the annual diet of Cabinet Mountain grizzly bears (n =19 hair samples from non-management bears) is derived from animal matter. Adult males had slightly higher $\delta^{15}N$ stable isotope signatures (4.2‰) than adult females (3.1‰), indicating greater use of available animal matter (24% vs. 10% animal matter, respectively).

Yaak grizzly bear diets contained nearly 22% animal matter (n = 84 hair samples). Adult female use of animal matter varied widely; $\delta^{15}N$ and diet values ranged as low as 2.3‰ (~6% animal matter) to as high as 7.2‰ (~80% animal matter).

Sampled grizzly bears in the Selkirk ecosystem consumed less animal matter than Cabinet and Yaak bears (12%; n =36 hair samples). Diets of non-management, adult female bears include only 7% animal matter. However, one adult female captured in a management incident in the Creston Valley fed on animal matter at a rate of 82%. We suspect bears such as her likely gain meat from bone piles or dead livestock at nearby dairy operations.

Across ecosystems, management bears had slightly higher proportions of meat (26%) in assimilated diets than research bears (17%). Management bears did not necessarily have higher $\delta^{13}C$ signatures as would indicate a more corn-based or anthropogenic food source (-23‰ for both research and management bears). In fact, highest $\delta^{13}C$ in our dataset came from a research female caught in Corn Creek of the Creston Valley, BC in 2008. By all indications, she likely fed extensively on corn from nearby fields without human conflict.

By analyzing different hair types that initiate growth at different times of the year, we have observed increases in proportion of animal matter in bear diets as they transition from summer months (diet estimated from guard hairs) to fall months (diet from underfur). Previous studies have emphasized the importance of splitting these hair types due to temporal differences in growing period (Jones *et al*. 2006). We currently have 45 bear capture events with paired guard hair and underfur samples collected at capture. In all cases, grizzly bears have either 1) the same dietary meat proportion in summer vs. fall or 2) have higher amounts of meat in their fall diet. On average, grizzly bears meat consumption nearly doubles from summer to fall (10.7% summer to 17.6% fall). Fall shifts toward meat use were not isolated to a specific sex-age class. Larger shifts include: an adult male (4327) shifting from 31% meat in summer to 82% meat in fall, an adult female (mortality 5/18/2012) consuming 14% in spring, then 38% in the fall, and a subadult female grizzly (675) with a summer diet consisting of 6% meat and fall diet of

16% meat. We suspect that wounding loss and gut piles from hunted ungulates contribute to observed increases in meat use by grizzly bears in fall months.

Food Habits from Scat Analysis

Grizzly bear scats (*n* =180) were collected in the Cabinet-Yaak between 1981 and 1992. Graminoids (grasses and sedges) were consumed frequently (43% of scats) by grizzly bears in May (Kasworm and Their 1993). Additionally, meat, presumably from winter-killed deer and moose, accounted for 40% of all dry matter consumed in April and May (Fig. 23). In June, the use of forbs increased markedly, yet grasses and sedges were still a dominant food category. Cow parsnip (*Heracleum lanatum*), clover (*Trifolium spp.*), and dandelion (*Taraxacum officinale*) were commonly used in June; over half (52%) of scats in June included parts of at least one of these three forbs. By July, forbs (mainly *Heracleum*) comprised 32% of dry matter consumed by grizzly bears. Only 8% of dry matter consumed in July came from grasses and sedges; graminoids begin to cure in July and provide far less digestible nutrition. Grizzly bears began to feed upon berries (huckleberry and whortleberry [*Vaccinium spp.*]*,* serviceberry [*Amelanchier alnifolia*]) and insects (mainly ants) in July. Food habits during August and September were dominated by use of berries (*Vaccinium* spp., in particular), yet September habits include an increased use of animal matter. Unlike black bears, grizzly bears targeted animal matter (deer, elk, moose) in October. We suspect hunter-discarded gut piles or other remains account for a fair amount of the available animal meat. Fall regrowth of forbs (mainly clover) and graminoids contributed 25% of dry matter consumed by sampled grizzly bears in October. Mammal and berries (i.e., the most calorie-dense foods available) in fall constitute 64% of total dry matter consumed annually by grizzly bears.

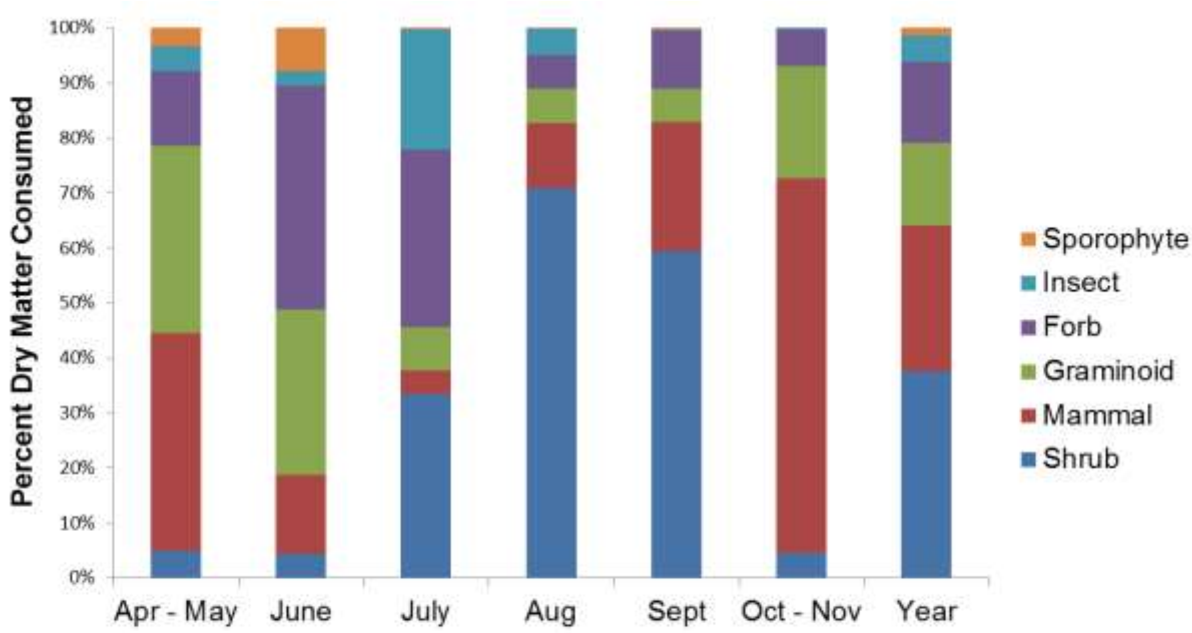

Figure 23. Monthly percent of total dry matter of foods consumed by grizzly bears in the Cabinet Mountains and Yaak River, 1981–1992.

Black bear scats (*n* =618) were collected between 1984 and 1992 (Kasworm and Their 1993). Relative use of foods was quite similar to that of grizzly bears between April and August (Fig. 24). However, black bear food habits in September and October were quite different from grizzly bears. Black bears tend to use berries (*Vaccinium* spp., *Sorbus* spp. [mountain-ash], *Amelanchier alnifolia,* and *Arctostaphylos* spp. [bear berry]) more frequently as fall progresses (percent dry matter consumed, August = 74%; September = 82%; October = 91%). In October, black bears fed heavily on mountain-ash. In contrast, grizzly bears increase relative dry matter consumption of animal meat in fall months (August = 12%, September = 24%; October = 68%). We suggest this difference in food use may be explained by either 1) early den entrance dates for black bears (i.e., den entrance before open of big game hunting season), 2) higher energetic demand of larger grizzly bears (i.e., consumption of calorie-dense foods is metabolically preferred by larger bears; Welch *et al*. 1997), 3) interspecific exclusion of black bears by grizzly bears (i.e., exploitative competition), and/or 4) differences in risk behavior between the two species. On an annual basis, black bears consumed less high-quality, calorie-dense foods (meat and berries; 42%) relative to lower-quality foods such as graminoids and forbs (46%).

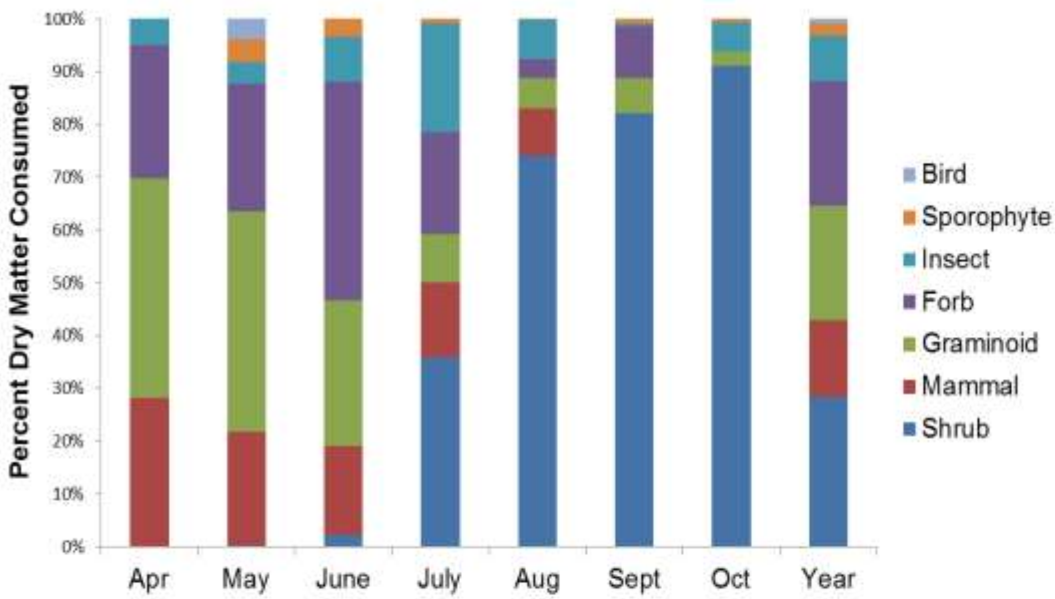

Figure 24. Monthly percent of total dry matter of foods consumed by black bears in the Cabinet Mountains and Yaak River, 1984–1992.

Berry Production

Production of four fruiting plant species was estimated at sampling transects across the Cabinet-Yaak ecosystem (CYE). Huckleberry and serviceberry production during 2022 was similar the long-term average. Mountain ash and buffaloberry both had below average production at sampling transects. Because of its relatively far-ranging distribution in the CYE and life history of inhabiting larger areas (e.g., shrub fields) when compared with other berry-producing plants, huckleberries appear to provide a greater amount of food for bears in the CYE. However, serviceberry and mountain ash may provide significant secondary food sources in some years when huckleberry crops have failed (e.g., 2001 and 2003). Mountain ash may be particularly valuable to bears in years of low food production because the berries persist and remain on the plants until after frost and leaf drop. Low berry counts for all three of these species would prove most detrimental for bears attempting to store fat for winter denning (e.g., 2002, 2004, and 2015). Because of its sparse distribution, buffalo berries appear to be the least-available berry food for grizzly bears in the CYE. Below-average production among all species surveyed occurred in 1992, 1998–2000, 2002, 2004, and 2015. The 2015 berry season marked the first time we have observed below average counts for all four berry species in one year. Sampling sites for each species were selected to best represent landscape level variation of geography, elevation, aspect, and overstory canopy (Fig. 25).

Fluctuations in berry production in the CYE may be influenced by climatic variables. Holden *et al*. (2012) found huckleberry production in the CYE to be highest in years with cool springs and high July diurnal temperature ranges. Serviceberry production was also highest in years with cool springs and high winter snowpack. Future changes in climate may influence the availability of these foods to CYE grizzly bears.

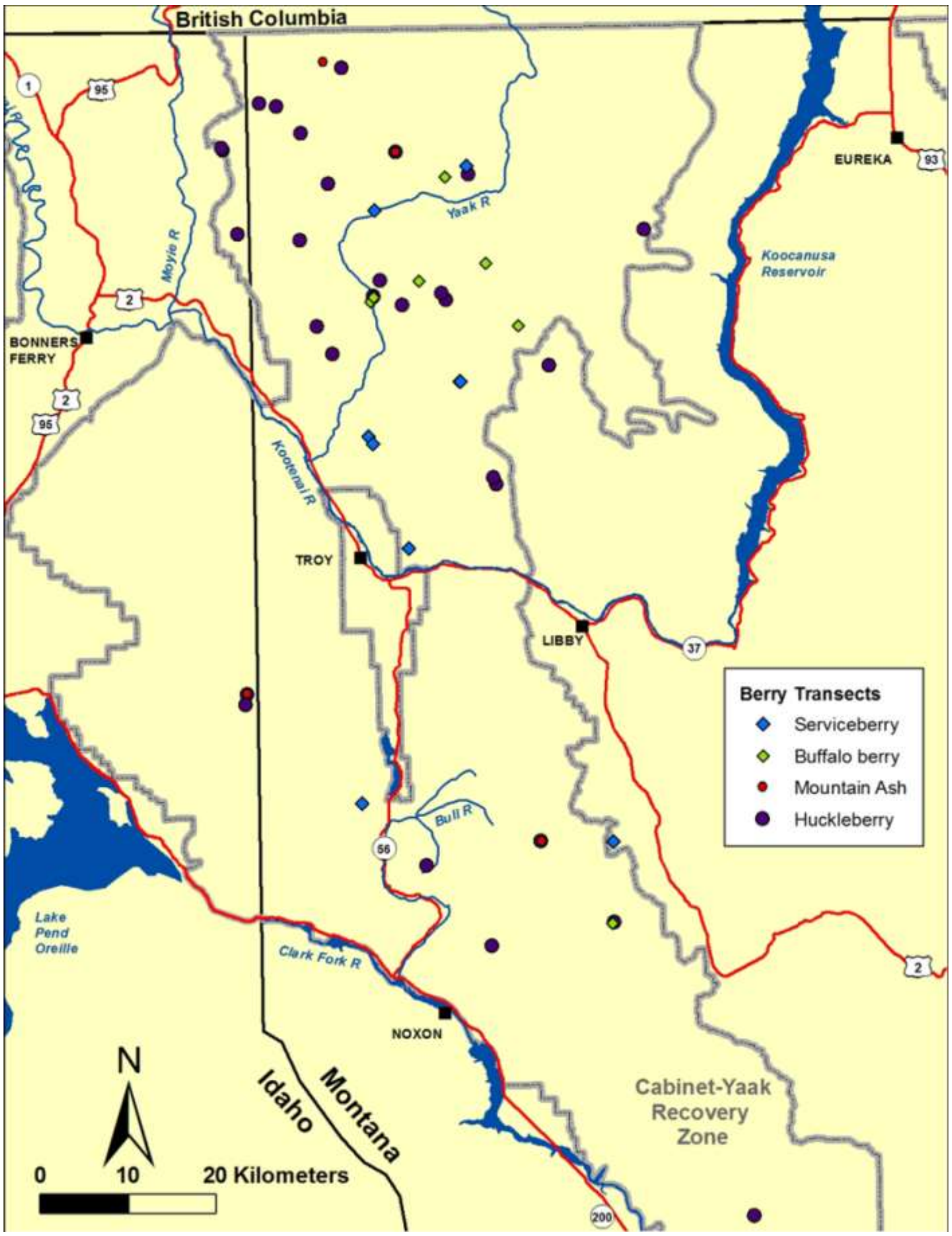

Figure 25. Locations of all serviceberry, buffaloberry, mountain ash, and huckleberry sampling sites within the CYE study area, 1989–2022. Some locations show multiple berry species sites in close proximity.

Huckleberry

We evaluated berry production at a median number of 18 (range=11–23) huckleberry transects per year within the CYE study area from 1989–2022 (Fig. 26). During this study period, the mean number of berries per plot was 1.8 (95% CI ± 0.115). Mean annual berry counts between 1989 and 2022 ranged from 0.5–3.4. Statistically below-average berry counts occurred in 11 years while above average counts occurred in nine years. Highest mean annual counts occurred in 2014. Based upon these production indices at sampled sites, the 9-year period from 1997–2005 was a prolonged stretch of years without above average annual huckleberry production; more recent mean annual counts since 2006 average 104% higher than during the 1997–2005 period (1.1 berries per plot higher). Of interest is whether lower- and higher-than-average production influences population reproduction and survival.

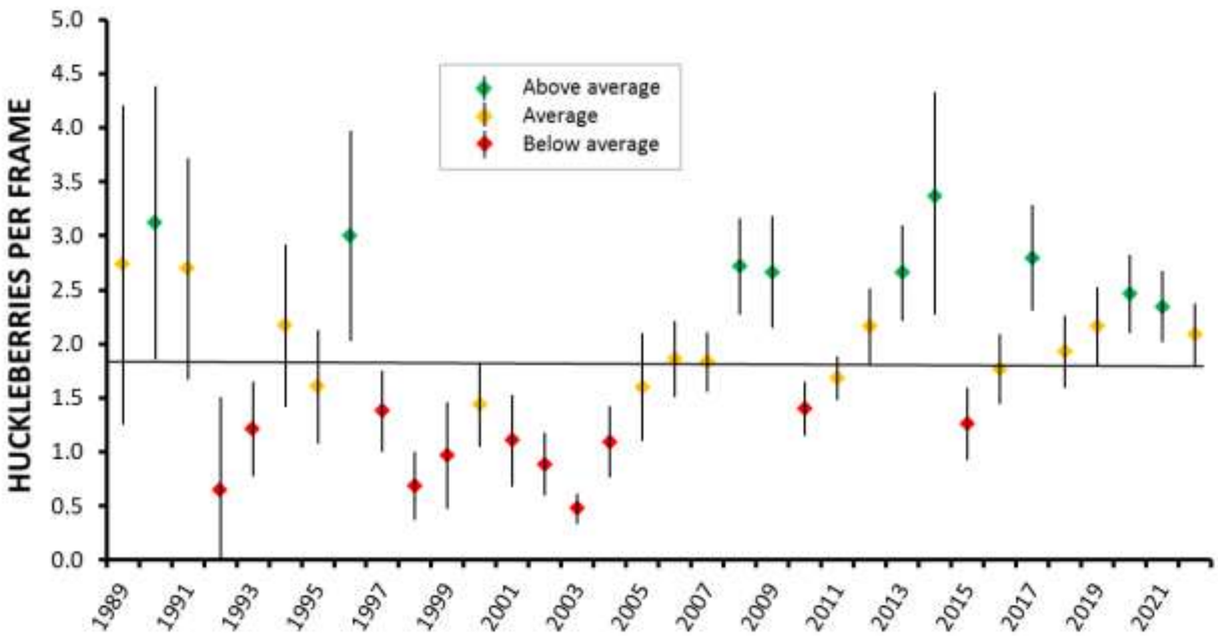

Figure 26. Mean berries per plant (± 95% confidence interval) for huckleberry transects in the Cabinet-Yaak, 1989–2022. Horizontal line indicates study-wide mean production, 1989–2022.

Serviceberry

We evaluated berry production at a median number of six (range = 4–7) serviceberry transects per year from 1990 to 2022 (Fig. 27). The overall mean berry count per plant was 106 (95% CI ± 21) during the study. Mean annual berry counts per plant ranged from 12 to 355 during the 25+ year index. Statistically below-average counts occurred during 14 years and above average counts occurred only in a single year, 1997. Considering the entirety of the data, the past seventeen years have been particularly less productive (2006–2022; 76 berries per plant) when compared to the first 16 (142 berries per plant from 1990–2005).

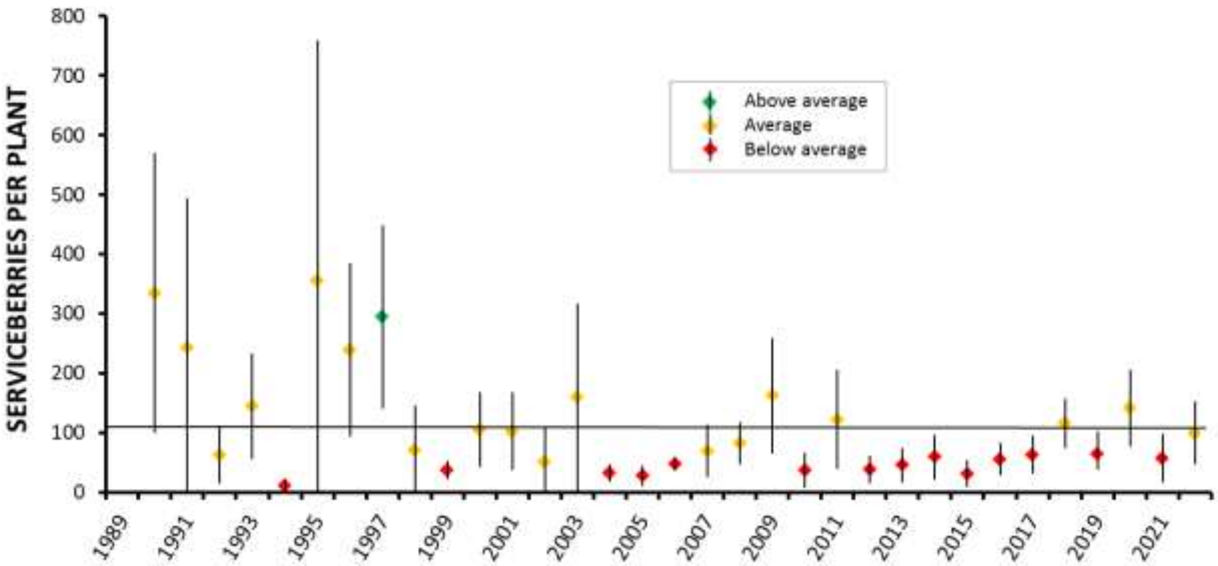

Figure 27. Mean berries per plant (± 95% confidence interval) for serviceberry transects in the Cabinet-Yaak, 1990–2022. Horizontal line indicates study-wide mean production, 1990–2022.

Mountain Ash

Three sites were evaluated for mountain ash production each year, from 2001 to 2022 (Fig. 28). Total mean berry count was 169 berries per plant (95% CI ± 45). Statistically below-average production occurred in seven years while above average production occurred in 2 years.

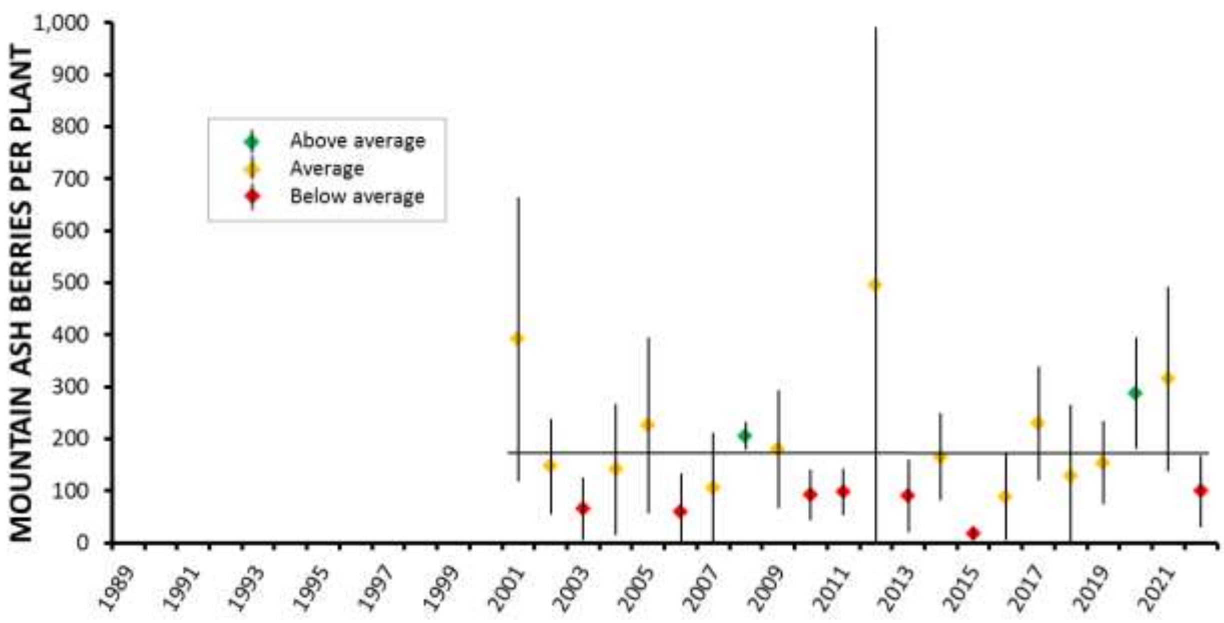

Figure 28. Mean berries per plant (± 95% confidence interval) for mountain ash transects in the Cabinet-Yaak, 2001–2022. Horizontal line indicates study-wide mean production, 2001–2022.

Buffaloberry

Five buffaloberry transects (5 plants at each transect) were evaluated during 1990–1999 and 2002–2003. No sites were sampled during 2004–2006. One new transect (10 plants) was established in 2007 and was the only transect sampled. Another transect (10 plants) was added in 2008. Two transects were evaluated each year, 2008–2022. A median of 2 sites were evaluated annually (range 1–5) between 1990 and 2022. Mean berry count per plant from all transects was 175 (95% CI ± 43) during the study period. Mean annual berry counts ranged between 15 to 627 berries per plant from 1990 to 2022 (Fig. 29); statistically below-average counts occurred during eleven years while above-average counts occurred in only four years.

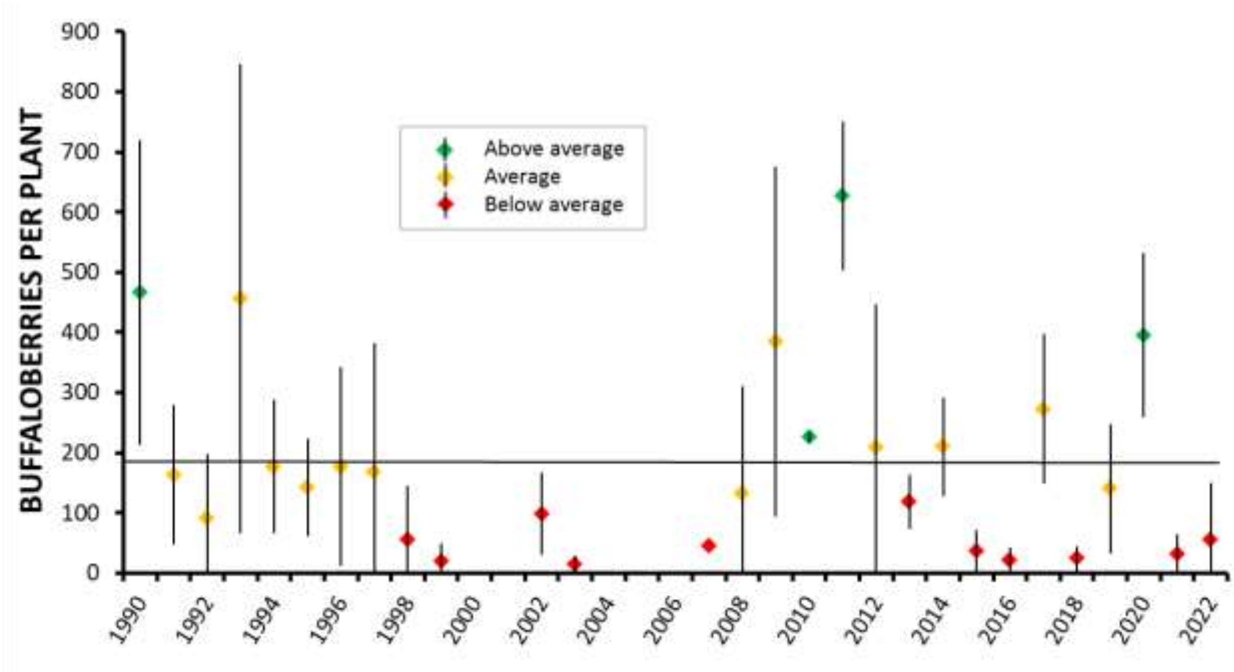

Figure 29. Mean berries per plant (± 95% confidence interval) for buffaloberry transects in the Cabinet-Yaak, 1990–2022. Horizontal line indicates study-wide mean production, 1990–2022.

Body Condition

We determined body mass of Cabinet-Yaak and Selkirk (CYS) research grizzly bears at 100 independent capture instances, May-September (1983-2022). We assessed whether body mass differed by sex and age (53 males, 47 females) and whether body mass varied for adult grizzly bears (>5 years old) by month and sex, as follows: May/June (M = 11, F = 11), July (M = 2, F = 11), August (M = 6, F = 5), September (M = 2, F = 2) (Figures 30 and 31).

Body mass of male and female grizzly bears started diverging approximate at age of two with females reaching an asymptote before males. The best-fit curve for male and females was from a von Bertalanffy based growth curve (Matsubayashi et al. 2016) (Figure 30). The mean male body mass has a declining trend from May to August and increases in September. Male body mass is similar during the months of May/June and September. The mean female body mass increases throughout the year with the largest increase in body mass being in September (Figure 31).

We estimated body fat content of Cabinet-Yaak and Selkirk (CYS) grizzly bears at 99 independent capture instances, May through November 2010–2019. We assessed whether body fat content of CYS grizzly bears differed by sex (56 males, 43 females), capture type (76 research, 23 management captures), and month of capture. Researchers in the Greater Yellowstone and Northern Continental Divide Ecosystems have noted that body fat content of grizzly bears varies by month, exhibiting a trend that is presumably dependent on denning (i.e., inactive) season and availability and quality of foods consumed during the active season (Schwartz *et al*. 2014; Teisberg et al. *in prep*). We similarly partitioned our seasonal data into categorical bins by month, as follows: May (n = 17), June (n = 39), July (n = 16), August (n = 16), and September–November (n = 1).

Body fat content of male and female grizzly bears did not differ (P = 0.077; Table 19). Body fat content of research-captured vs. management-captured grizzly bears also did not differ (P = 0.525; Table 19), suggesting that management bears do not necessarily obtain a more nutritionally rich diet than research-captured bears. However, body fat content of CYS grizzly bears did differ by month (P < 0.0001; Fig. 32). Body fat content in September–November was significantly higher than those in all other months, and August fat contents were higher than those in June (Tukey-HSD contrasts; P<0.05). With all other months, fat content did not differ. CYS grizzly bears appear to start gaining fat as early as July. These results suggest habitat and foods available to CYS grizzly bears allow for body fat gain, such that bears can attain above-average body fat contents in the months preceding den entrance. Reproductive-aged, female grizzly bears experience 1) delayed implantation of already-fertilized eggs in November and 2) cub birth in the den (Jan–Feb). Studies suggest adult females must reach a pre-denning body fat content more than ~20% to support implantation and winter cub production (Robbins *et al.* 2012).

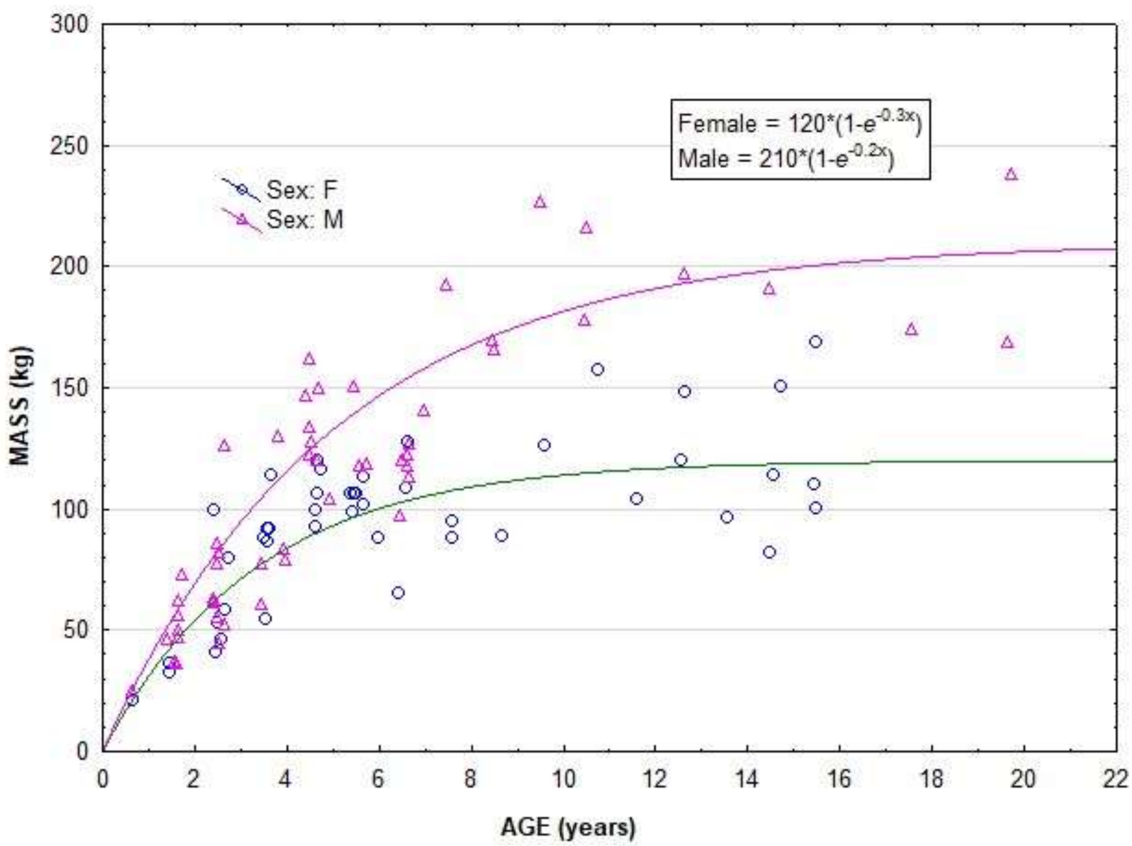

Figure 30: Body mass (Kg) of captured research male and female grizzly bears by age in the Cabinet-Yaak and Selkirk Mountains, 1983-2022.

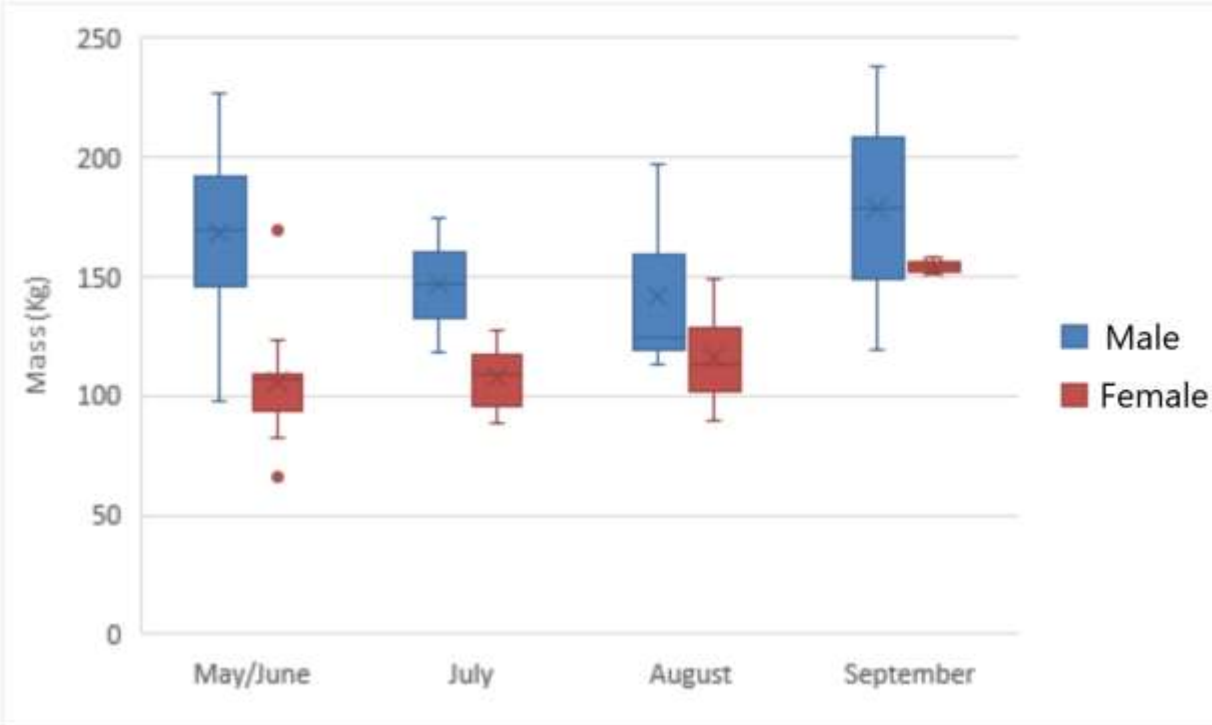

Figure 31: Box plot of body mass (Kg) of captured adult research male and female grizzly bears in the Cabinet-Yaak and Selkirk Mountains, 1983-2022. Points represent outliers in the data set, X's are the mean, and the line in the box is the median.

Table 19. Mean estimates of percent body fat content (kg fat / kg body mass) and effect size (+/- standard error, SE) of Cabinet-Yaak and Selkirk grizzly bears, by factors of interest, 2010–2019.

Factor / Level	**Mean**	**SE**
Capture Type		
Research	17.1	+/-0.8
Management	18.1	+/-1.3
Sex		
Female	16.4	+/-1.1
Male	18.8	+/-0.9
Month		
May	17.1	+/-1.6
June	12.7	+/-1.1
July	15.3	+/-1.7
August	18.1	+/-1.6
Sept-Nov	24.7	+/-1.9

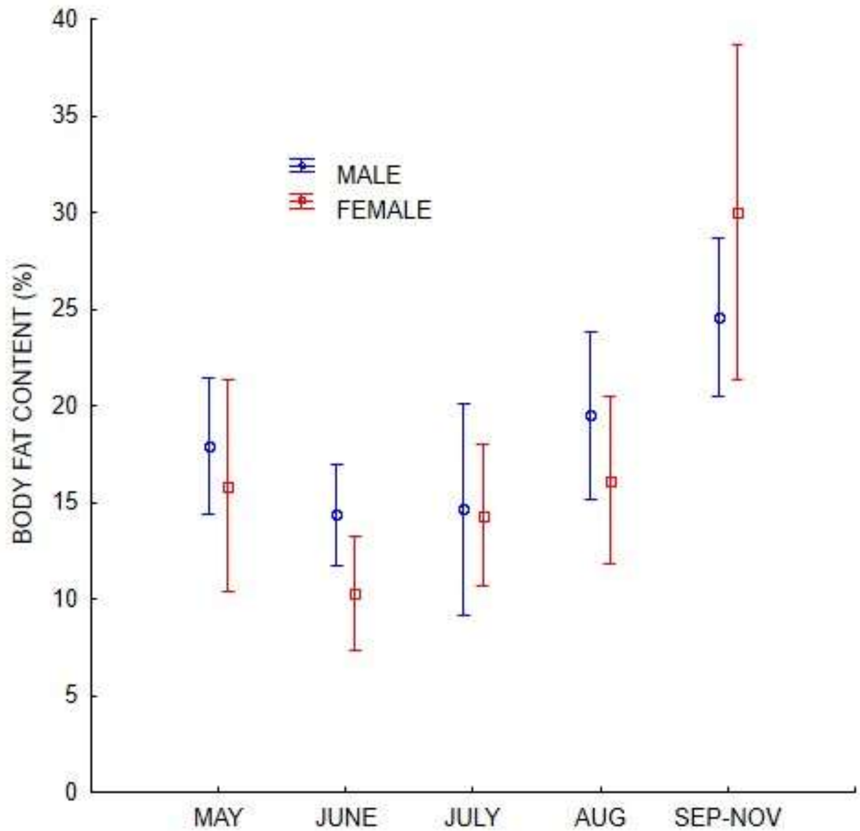

Figure 32. Mean percent body fat content (kg fat / kg body mass) of captured female and male grizzly bears in the Cabinet-Yaak and Selkirk mountains 2010–2019, by month. Error bars represent 95% confidence intervals.

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APPENDIX Table 1. Mortality assignment of augmentation bears removed from one recovery area and released in another target recovery area.

#	Scenario	Where Mortality Credited and Year [1]	
		Source	**Target**
1	Bear stays in Target recovery area[2] past Year 1.	Mortality removal year	No mortality
2	Bear dies in Target recovery area[2] during Year 1.	Mortality removal year	No mortality
3	Bear dies in Target recovery area[2] after Year 1.	Mortality removal year	Mortality, Year 2 or later
4	Bear returns to Source area[2] and dies within Year 1.	Mortality year of death	No mortality
5	Bear returns to Source area[2] and is alive in Year 1.	No mortality	No mortality
6	Bear returns to Source area[2] and is alive after Year 1.	No mortality	No mortality
7	Bear returns to Source area[2] and dies there after Year 1.	Mortality year of death	No mortality
8	Bear dies outside both Target and Source areas[2] within Year 1.	Mortality removal year	No mortality
9	Bear dies outside both Target and Source areas[2] after Year 1.	Mortality removal year	No mortality
10	Collar failure/lost bear in Target area[2] within Year 1.	Mortality removal year	No mortality
11	Collar failure/lost bear in Target area[2] after Year 1.	Mortality removal year	No mortality
12	Collar failure/lost bear outside both Target and Source areas[2] within Year 1.	Mortality removal year	No mortality
13	Collar failure/lost bear outside both Target and Source areas[2] after Year 1.	Mortality removal year	No mortality

[1] Year 1 begins on the day the bear is released in the target area and ends after 365 days. One year was chosen to give the animal an opportunity to locate and use all seasonal habitats. This rule set may conditionally require a bookkeeping correction to remove the mortality in the source area in the year of removal.
[2] Target and Source areas include 10-mile buffer around Recovery Zones. Bears dying in Canada only count against mortality limits in the Selkirk Mountains, where the Recovery Plan defines a Recovery Zone that includes Canada. If an augmentation bear leaves the target recovery area and dies, it counts as source area mortality in the removal year, but it does not count as target area mortality. If an augmentation bear leaves the target recovery area in year 2 or later, it counts as source area mortality in year 1 and target area mortality in year 2 or later if the mortality was human-caused. While this approach counts a bear as dead twice, the second mortality represents a human-caused mortality issue outside of a bear learning a new area and should be counted in the target area. (Mortalities in Canada only count inside the Selkirk recovery zone inside Canada and the 10-mile buffer will not apply to that portion of the Selkirk recovery area in Canada. Areas adjacent to the Canadian Selkirks have more robust, contiguous populations, several of which are hunted, and mortality should not be counted against the Selkirk recovery area. The 10-mile buffer was promoted inside the US because this area was believed to contain animals that spent a portion of their time outside the recovery area but were believed to be part of that recovery area population.)

Appendix 2. Guidance for Estimating Occupied Range for Grizzly Bears in the Lower-48 States

Objectives: Provide guidance to estimate **occupied range for each grizzly bear population.**

Occupied range is an estimate of the roughly contiguous area within which bears have established residency or have demonstrated habitat use. *Estimated occupied range represents a minimum known area of occupancy. It does not include occasional forays outside the estimated range or low-density peripheral areas and therefore does not represent the total known extent of occurrences. Due to the smoothing inherent in the methodology, range edges may extend over features that might act as partial barriers to grizzly bear movement, such as I-90 or Lake Koocanusa. Range estimates for neighboring populations may also overlap, but this does not represent evidence of genetic and/or demographic connectivity. Males generally disperse farther than females, and often account for the leading edge of range expansion. As grizzly bears expand into historical range, it is possible to have occupied range without female presence; however, female reproduction is necessary to establish a population.*

Background: Bjornlie *et al*. (2014) developed a technique using all verified grizzly bear location data, zonal analysis, and kriging to estimate occupied range for the Greater Yellowstone Ecosystem. This document provides clarification and guidance for applying the technique developed by Bjornlie *et al.* (2014) to each grizzly bear population in the lower-48 States.

Methods:

Data: Location data will include the following sources: known locations of captures, mortalities, human-grizzly bear conflicts, and field collection of hair samples attributed to grizzly bears through DNA analysis; VHF and GPS locations from radio-monitored bears; and locations of sightings or tracks reported or verified by experienced agency personnel.

Data from GPS collared bears will be screened. Unlike other data sources that rarely include more than one location/individual/day, GPS data sets may include as many as 48 locations/individual/day. To account for this sizable difference in data frequency, GPS data for each individual will be screened to exclude all but 1 randomly selected location/day. This will ensure that GPS data are not overrepresented in the data set and are appropriately scaled to the daily activity radius used to determine the grid size *(see Grid Size below*).

Data from bears that were relocated as a response to human-bear conflict or translocated for population and/or genetic augmentation, will be screened. After relocation and/or translocation, bears often wander widely, while trying to return to their original area or while searching for a suitable place to settle. To reduce the effect of these human-influenced movements on occupied range estimates, post-relocation/translocation locations will be excluded if they are outside of previous estimates of occupied range and they are either: (1) outside of either the bear's known home range or a circular area around the capture site with a radius equal to the mean home range radius (NCDE: 12 km for females, 21 km for males), indicating they have not successfully returned to their place of origin; or (2) they are wide-ranging and non-concentrated (i.e., do not resemble a newly-established home range).

The 1/day screening of GPS locations should help reduce the influence of any occasional long-range, single-track excursions made by collared bears (not associated with translocation). If not, however, movements such as these might be excluded if they are assumed to be associated with a temporary movement by a single individual and if they unduly distort the extent of occupied range. Other considerations may include known age and population of origin, as subadult individual movements tend to include exploratory excursions.

Timeframe: Grizzly bears are a long-lived species and due to small sample size, annual data from observations and radio-collaring efforts cannot accurately represent the extent of occurrence. Because of this, the NCDE and GYE will use a 15-year moving window. The CYE and SE will use a 20-year moving window due to the smaller population size and resulting smaller available data set.

Grid size: A 3km x 3km grid was laid across the lower-48 States using ArcGIS. The grid-cell size was selected based on the mean daily activity radius for male grizzly bears (1.44 km for the GYE, 1.29 km for the NCDE, and 1.21 km for the CYE and SE). For further details see Bjornlie *et al.* 2014.

Kriged surface: One contiguous, occupied range was mapped for each grizzly bear population. Disjunct "islands", separate from the larger population range, were excluded.

Results:

Grizzly bear occurrence data from telemetry sightings, mortality, and genetics was used to produce a map of occupied range for male and female grizzly bears and females only in the Cabinet-Yaak and Selkirk recovery areas during 2000-2022 (Figure 1). In the Cabinet-Yaak, male and female distribution covers 98% of the recovery zone and female only distribution covers 80%. In the Selkirk Mountains male and female distribution covers 95% of the recovery zone and female only distribution covers 89%. Male and female distribution from both the Cabinet-Yaak and Selkirks overlaps the other, however female only distribution does not.

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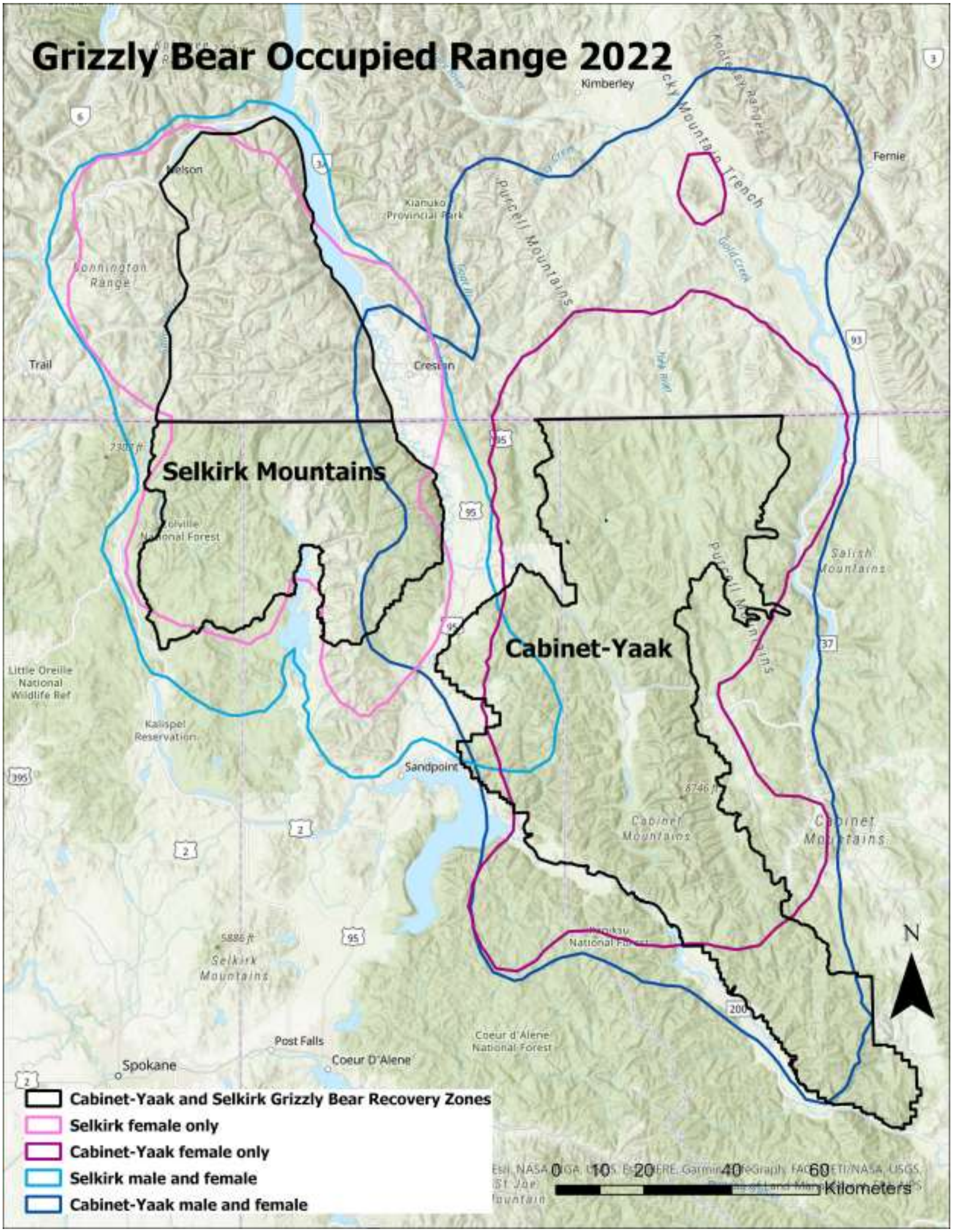


Figure 1. Occupied range of male and female grizzly bears and female grizzly bears only in the Cabinet-Yaak and Selkirk recovery areas, 2000-2022.

APPENDIX Table 3. Known historic grizzly bear mortality pre-dating project monitoring, in or near the Cabinet-Yaak recovery zone and the Yahk grizzly bear population unit in British Columbia, 1949–1978.

YEAR	LOCATION	TOTAL	SEX / AGE	MORTALITY CAUSE
1949	COPPER CR, MT	1	ADULT FEMALE	HUMAN, LEGAL HUNTER KILL
1950	SQUAW CR, MT	1	SUBADULT	UNKNOWN
1951	PETE CR, MT	1	ADULT MALE	HUMAN, MANAGEMENT REMOVAL
1951	PAPOOSE CR, MT	2	SUBADULTS	UNKNOWN
1951	GOAT CR, MT	1	SUBADULT MALE	UNKNOWN
1952	FELIX CR, MT	6	2 ADULT FEMALES, 4 YEARLINGS	HUMAN, MANAGEMENT REMOVAL
1953	OBRIEN CR, MT	1	SUBADULT MALE	HUMAN, LEGAL HUNTER KILL
1953	KENELTY MT, MT	1	UNKNOWN	HUMAN, LEGAL HUNTER KILL
1953	20-ODD MT, MT	1	UNKNOWN	HUMAN, LEGAL HUNTER KILL
1953	BURNT CR, MT	1	UNKNOWN	HUMAN, LEGAL HUNTER KILL
1953	17-MILE CR, MT	1	UNKNOWN	HUMAN, LEGAL HUNTER KILL
1954	N F BULL R, MT	1	UNKNOWN	HUMAN, LEGAL HUNTER KILL
1954	S F BULL R, MT	1	UNKNOWN	HUMAN, LEGAL HUNTER KILL
1954	CEDAR LK, MT	1	UNKNOWN	HUMAN, LEGAL HUNTER KILL
1954	CEDAR LK, MT	1	UNKNOWN	HUMAN, LEGAL HUNTER KILL
1954	TAYLOR PK, MT	1	UNKNOWN	HUMAN, LEGAL HUNTER KILL
1954	SILVERBUTTE CR, MT	1	UNKNOWN	HUMAN, LEGAL HUNTER KILL
1954	SILVERBOW CR, MT	1	ADULT FEMALE	HUMAN, LEGAL HUNTER KILL
1955	WOLF CR, MT	1	ADULT MALE	HUMAN, MANAGEMENT REMOVAL
1955	MT HEADLEY, MT	1	SUBADULT	HUMAN, MANAGEMENT REMOVAL
1955	BAREE LK, MT	1	ADULT MALE	UNKNOWN
1955	BAREE LK, MT	1	ADULT FEMALE	UNKNOWN
1955	BEAR CR, MT	1	SUBADULT MALE	HUMAN, LEGAL HUNTER KILL
1958	SQUAW CR, MT	1	ADULT FEMALE	HUMAN, MANAGEMENT REMOVAL
1959	E F ROCK CR, MT	2	ADULT FEMALE, 1 CUB	HUMAN, LEGAL HUNTER KILL
1959	W F THOMPSON R, MT	4	ADULT FEMALE, 3 CUBS	UNKNOWN
1959	CLIFF CR, MT	1	UNKNOWN	UNKNOWN
1960	PROSPECT CR, MT	2	ADULT FEMALE, 1 CUB	UNKNOWN
1964	GRAVES CR, MT	2	SUBADULTS	UNKNOWN
1964	WANLESS LK, MT	3	SUBADULTS (ADULT WOUNDED)	UNKNOWN
1965	SNOWSHOE CR, MT	2	SUBADULTS	UNKNOWN
1965	PINKHAM CR, MT	1	UNKNOWN	UNKNOWN
1967	SOPHIE LK, MT	1	UNKNOWN	UNKNOWN
1968	BEAR CR, MT	1	ADULT FEMALE	HUMAN, ILLEGAL KILL
1968	GRANITE CR, MT	1	SUBADULT MALE	HUMAN, MANAGEMENT REMOVAL
1969	PRISCILLA PK, MT	1	ADULT FEMALE	UNKNOWN
1970	THOMPSON R, MT	1	UNKNOWN	UNKNOWN
1970	CAMERON CR, MT	1	SUBADULT MALE	UNKNOWN
1970	SQUAW CR, MT	2	ADULT FEMALE, SUBADULT FEMALE	HUMAN, MANAGEMENT REMOVAL
1971	MURR CR, MT	1	ADULT FEMALE	UNKNOWN
1972	ROCK CR, MT	1	SUBADULT	HUMAN, MISTAKEN IDENTITY (Black Bear)
1974	SWAMP CR, MT	1	ADULT MALE	HUMAN, LEGAL HUNTER KILL
1977	RABBIT CR, MT	1	ADULT MALE	HUMAN, DEFENSE OF LIFE BY HUNTER
1978	MOYIE LAKE, BC	1	SUBADULT MALE	HUMAN, MANAGEMENT

APPENDIX Table 4. Movement and gene flow to or from the Cabinet-Yaak recovery area.

Area[2] Start / Finish	Action	Genetics ID	Tag #	Sex	Age at Detect	Year Action Detected	Basis	Year Known Dead	Comments
Cabs / Bitt	Movement	C680M	680	M	12	1985	Genetics, Telemetry		Born in Cabs, mom is 678. Bear moved south of hwy 200
Cabs / Bitt	Movement	C20191F	772	F	10	2007	Genetics, Telemetry		Born in Cabs, mom is 286. Captured south of hwy 200
Cabs / Bitt	Movement	C31931F	890	F	6	2021	Genetics, Telemetry		Born in Cabinets, mom C10011F. Captured and monitored south of 200 (Bitt) and bear moved back north of 200 (Cabs)
Cabs / NCDE	Movement	C36662M	9051	M	3	2020	Genetics, Telemetry, Mortality	2022	Born in Cabinets, mom is C20072F. Captured near Whitefish, MT. Mortality Mgmt removal.
Cabs / NCDE / Cabs	Movement		893	F	2	2021	Genetics, Capture, Mortality	2022	Born in Cabs, mom is 831. MGMT capture in NCDE. MGMT removal in Cabs
Cabs / Sal	Movement		886	F	3	2022	Telemetry		Captured in Cabs, spent portion of late summer in Sal
Cabs / Sal / NCDE	Movement	C403M	403	M	2-3	2007	Telemetry, Genetics, Mortality	2007	Born in Cabs, mom is 831. Captured MGMT Marion, MT 2006, traveled to Whitefish. Train kill.
Cabs / Sal / NCDE	Movement	900932	839	M	4	2016	Telemetry		Born in Cabs, mom is 831. Travel east from Cabs to NCDE and dropped collar
Cabs / SPur	Movement	C31885M	865	M	3	2018	Genetics, Telemetry, Mortality	2019	Born in Cabs, mom is C10011F. Captured near Athol, ID (mgmt). Relocate to West Cabinets. Den in SPur. Mortality mgmt removal
NCDE / Cabs	Movement	C90467M	364	M	6	2014	Genetics, Mortality	2014	Management bear from NCDE traveled to Cabs, mortality human-caused
NCDE / Cabs	Movement	C47886M		M	5	2021	Genetics		Born in NCDE, mom is Snow. Hair snagged in Cabs
NCDE / Cabs / Sal	Movement	C30604M	9061	M	4	2017	Genetics, Mortality	2017	NCDE Management bear traveled to Cabs 2017 and returned to NCDE, human-caused mortality in Salish
NCDE / Cabs / Sal	Movement	C866M	866	M	3	2019	Genetics, Telemetry		Genetics identified parents in NCDE, captured in Cabinets, dropped collar in Sal
NCDE / SPur	Movement	YGB737M	737	M	4	2010	Genetics		Captured and monitored 2010-15. Parentage in NCDE.
NCDE / SPur	Movement		43-44	F	3	2013	Capture, Mortality	2013	Management bear relocated at least twice in NCDE. Traveled to SPur, shot after killing chickens by landowner.
NPur / SPur	Movement	Y363M	363	M	4	1996	Geneclass, Telemetry		Assigns to NPur. Captured and monitored in SPur
NPur / SPur	Gene flow	YU37F		F	1	2001	Genetics, Mortality	2001	Father NPurYVernM, Mother SPur Y354F, Origin of father assigns NPur. Dead in 2001
NPur / SPur	Gene flow	Y787M	787	M	3	2003	Genetics		Father NPur YVernM, Mother SPur Y354F, Origin of father assigns NPur
NPur / SPur	Movement	PKiddM	11	M	7	2004	Telemetry		Radio collared June 2004, Travels from NPur to SPur, offspring in SPur.
NPur / SPur	Movement	P9183M		M	4-5	2004-05	Genetics		DNA captured NPur and SPur.
NPur / SPur	Movement	YMarilF	292	F	4	2005	Geneclass, Telemetry, Mortality	2006	Radio collared July 2005 in SPur, Genetic assignment to the NPur. Management removal 2006.
NPur / Spur / Cabs / Spur	Movement	YU83M	722	M	10	2009, 2018	GeneClass , Telemetry		Assigns to NPur. Captured and monitored SPur. Has produced 9 known offspring. Travel from SPur to Cabs and back.

Area[2] Start / Finish	Action	Genetics ID	Tag #	Sex	Age at Detect	Year Action Detected	Basis	Year Known Dead	Comments
NPur / SPur	Gene flow	Y729F	729	F	0.5	2010	Genetics, Mortality	2020	NPur father YU83M and SPur mother 303, Human-caused mortality
NPur / SPur	Gene flow	2011038306		M	0.5	2010	Genetics		Father NPur 928196, Mother SPur 2011038311
NPur / SPur	Movement	P1374M	1374	M	2	2010	Genetics, Mortality	2010	Hair snag as cub in 2008 NPur? Management capture SPur 2010, relocated, mortality in SPur shortly after
NPur / SPur	Gene flow	2011049118		M	0.5	2011	Genetics		NPur father YU83M and SPur mother 552
NPur / SPur	Gene flow	2011049122		F	0.5	2011	Genetics		NPur father YU83M and SPur mother 552
NPur / SPur	Movement	Y732M	732	M	3	2011	Genetics, Mortality	2011	Born in NPur and Traveled to SPur. Mortality mgmt SPur
NPur / SPur	Movement	200354a	9420	M	Adult	2011	Genetics, Mortality	2011	Assigns to NPur, human-caused, mistaken ID mortality in Faro Cr, ID
NPur / SPur	Gene flow	Y90479M	9032	M	0.5	2012	Genetics, Mortality	2012	Father Y576M Mother NPur 10569F. Human-caused mortality in SPur
NPur / SPur	Movement	10569F		F	6	2012	Genetics, Mortality	2012	Father NPur YVernM, Mother NPur PIrishF, DNA capture NPur 2005, Mortality with cub SPur
NPur / SPur	Gene flow	13082220975203		F	Unk	2013	Genetics		NPur father 958729 and SPur mother 675
NPur / SPur	Gene flow	Y14836F	822	F	0.5	2013	Genetics		Father NPur 928196, Mother SPur Y784F
NPur / SPur	Gene flow	13100420976102	836	F	0.5	2013	Genetics		Father NPur 928196, Mother SPur Y784F
NPur / SPur	Gene flow	15605	842	F	0.5	2013	Genetics		Father NPur 928196, Mother SPur Y20073F
NPur / SPur	Gene flow	Y12797M	818	F	0.5	2013	Genetics		Father NPur 928196, Mother SPur Y20073F
NPur / SPur	Gene flow	11008		M	0.5	2014	Genetics		NPur father YU83M and SPur mother 810
NPur / SPur	Movement	YGB808M	808	M	4	2014	Genetics, Telemetry		Mother NPur PHannaF. Captured and monitored in SPur
NPur / SPur	Gene flow	Y24689F	840	F	0.5	2015	Genetics		NPur father YU83M and SPur mother 303
NPur / SPur	Movement	16496	853	M	4	2015	Genetics, Telemetry, Mortality	2021	Assigns to NPur. Caught and monitored in SPur. Hair snagged in SPur. Mortality human-caused in BC SPur
NPur / SPur	Movement	958729	824	M	12	2016	Geneclass, Telemetry		Geneclass origin NPur. Caught and monitored inSPur
NPur / SPur	Movement	Y9811M	9811	M	2	2016	Genetics, Telemetry		Mother NPur P10554F, father NPur P9183M. Captured and monitored in SPur
NPur / SPur	Movement	Y22270M		M	Unk	2016	Genetics		Geneclass origin NPur. Hair snagged in SPur
NPur / SPur	Movement	Y29761M	4-092	M	6	2017	Genetics, Telemetry		Father P9101M, Mother PMaeveF, both NPur. Male offspring Y29761M Captured, monitored, and hair snagged SPur
NPur / SPur	Gene flow	Y37217M	930	M	0.5	2018	Genetics		NPur father YU83M and SPur mother 784
NPur / SPur	Gene flow	Y36822M		M	0.5	2018	Genetics		NPur father 958729 and SPur mother 810
NPur / SPur	Gene flow	Y35465F		F	0.5	2018	Genetics		NPur father 958729 and SPur mother 810
NPur / SPur	Gene flow	Y50146M		M	0.5	2019	Genetics		NPur father YGB808M and SPur mother 729
NPur / SPur	Gene flow	Y52502F	939	F	0.5	2019	Genetics		NPur father YU83M and SPur mother 820
NPur / SPur	Movement	Y40687M		M	Unk	2019	Genetics		Mother NPur P9114F. Hair snagged in SPur

Area[2] Start / Finish	Action	Genetics ID	Tag #	Sex	Age at Detect	Year Action Detected	Basis	Year Known Dead	Comments
NPur / SPur	Gene flow	Y50361M	882	M	0.5	2020	Genetics		NPur father Y29761M and SPur mother 842.
NPur / SPur	Gene flow	Y50356M		M	0.5	2020	Genetics	2021	NPur father Y29761M. Natural mortality as a yearling.
NPur / SPur	Gene flow	Y58451F	1070	F	0.5	2020	Genetics		NPur father Y9811M and SPur mother 822
NPur / SPur	Gene flow	Y848M	848	M	0.5	2020	Genetics		NPur father Y9811M and SPur mother 822
NPur / Spur / Cabs / SPur	Gene flow, Movement	Y821M	821	M	3	2017	Telemetry, Mortality	2018	Offspring of NPur father YU83M and SPur mother 552. Travel from SPur to Cabs. Presumed dead 2018
NPur / SPur SPur / SRock	Gene flow, Movement	18986	79	M	4	2018	Genetics, Telemetry, Mortality	2019	Offspring of NPur father YU83M SPur mother 810. Travel from SPur across Kootenay in BC to SRock (BC MGMT removal)
NPur / SPur SPur / SSelk	Gene flow, Movement	Y11048M	922	M	4	2017	Telemetry, Mortality	2017	Travel west from SPur to SSelk. Mortality human-caused. Offspring of NPur father YU83M and SPur mother 552
NPur / SPur / Cabs	Movement	YGB837M	837	M	6	2014	Genetics, Telemetry		Parents both NPur, Father NPur PKiddM, Mother NPur PIrishF
NPur / SPur / NPur	Movement	YVernM	386	M	7, 12	1997, 2002	Geneclass, Telemetry, Genetics		Radio collared SPur 1997. Hair snag NPur 2002.Sired offspring NPur and SPur. Assigns to NPur
NPur / SPur / Sal / SPur	Movement	Y20710M	844	M	4-5	2019-20	Geneclass, Telemetry		Assigns to NPur. Captured, monitored, and hair snagged in SPur, Locations in Sal, returned and dropped collar in SPur
NPur / SPur / SRock / Cabs / SSelk	Movement	928196	835	M	13	2015	Genetics, Telemetry		Assigns to Npur. Captured in SPur, traveled to SRock, then southwest to Cabs and SSelk and back to SPur
NPur / SPur / SSelk	Movement	SOsoM	149	M	10	2009	Genetics		Hair snagged 2001 SPur. Captured SSelk 2009. Most likely assigns to SPur
NPur / SPur / SSelk	Movement	YGB807M	807	M	4	2014, 2017	Telemetry		Assigns to NPur. Caught in SPur in 2014. Traveled west to SSelk in 2015.
SPur / Cabs / SPur	Movement	Y726M	726	M	6	2015-16	Telemetry, Mortality	2022	Travel from SPur to Cabs and back. Mortality human-caused.
SPur / NCDE	Movement	N323M		M	13	1999	Genetics	2019	Hair snagged 1999 in SPur. Hair snagged NCDE USGS 1998-2006. USGS assigned to SPur.Probable mortality NCDE
SPur / NPur	Movement	Y134M	134	M	9	1988	Telemetry, Mortality	1988	Radio collar in SPur 1987. BC Hunter kill NPur
SPur / NPur	Movement	PTerryM	688	M	3	2005	Telemetry, Genetics		Father SPS Y178M, Mother SPS Y538F Travel to NPur from SPur.
SPur / NPur	Movement	YRockyM	651	M	12	2006	Telemetry, Mortality	2008	Captured and collared SPur 2002. Recapture 2006. Traveled NPur in 2006. Mortality 2008 BC Wolf trap.
SPur / NPur	Movement	P9190M	5381	M	5	2007	Telemetry, Mortality	2012	Radio collared June 2006 SPur. Traveled to Npur, Mortality 2012 BC Mgmt removal
SPur / NPur / Sal	Movement	Y128M	128	M	4, 14, 18	1987,1997, 2001	Telemetry, Mortality	2001	Capture 1987 SPur. Monitored 1987-92 and 1997. Monitored NPur and produced offspring. Recapture 2001 in Salish Mortality in Salish
SPur / SRock	Movement	922947	826	M	5	2013	Telemetry		Travel north from SPur across Kootenay in BC to SRock and return
SPur / SSelk	Movement	YHydeM	103	M	3	2006	Genetics, Telemetry		Captured in SPur Yaak 2006. Assigns to Npur. Bear traveled to SSelk 2006-07
SPur / SSelk	Movement	Y718M	718	M	4	2021	Telemetry, Mortality	2022	Caught in SPur, traveled to Sselk and dropped collar. MGMT removal in 2022.
SSelk / Cabs	Movement	S1001M	1001	M	6	2015	Telemetry, Mortality	2015	Travel from SSelk to Cabs. Mortality human-caused

Area[2] Start / Finish	Action	Genetics ID	Tag #	Sex	Age at Detect	Year Action Detected	Basis	Year Known Dead	Comments
SSelk / Cabs	Movement	S38395M	884	M	2	2021	Telemetry		SSelk mom S21668F and SSelk father S262M. Traveled as 2 year old to West Cabinets. Dropped collar in den.
SSelk / Spur / Cabs / Sal / Bitt	Movement	S21285M	1006	M	1-2	2017-18	Genetics, Telemetry		Father NPur SCptHM, Mother SSelk S11675F, S21285M traveled to Cabs in 2018, then dropped collar in Sal, hair snagged in Bitterroot
SSelk / Cabs / SSelk	Movement	928442	1036	M	5	2012	Genetics		Father SSelk S9058aM, Mother SSelk SBettyF, Hair snagged USGS 2012 Cabs and in SSelk 2015
SSelk / SPur	Movement	S31M	31	M	6	2004-05	Telemetry, Mortality	2005	Father SSelk SS3KM, Mother SSelk S1MF, Management capture 2003 and Relocated. Hunter kill SPur
SSelk / SPur	Movement	16749		M	2	2015	Genetics		Father C134B2V2, Mother JillS226F Both SSelk. Male offspring 16749 SPur
SSelk / SPur	Movement	16521		M	4	2018	Genetics		Father SSelk 928442, Mother SSelk S808F Male offspring 16521 hair snagged in SPur

[1]Cabs – Cabinet Mountains south and west of Highway 2, NCDE – Northern Continental Divide recovery zone, NPur – Purcell Mountains north of Highway 3, SPur – Purcell Mountains south of Highway 3, SSelk – South Selkirk Mountains south of Nelson, BC, Sal – Salish Mountains east and north of Highway 2 and 35, south and west of Highway 93, Bitt – Bitterroot Mountains south of Highway 200

[2]Not a result of human-assisted action or transport via augmentation, relocation, or otherwise.

APPENDIX 5. Grizzly Bear Home Ranges

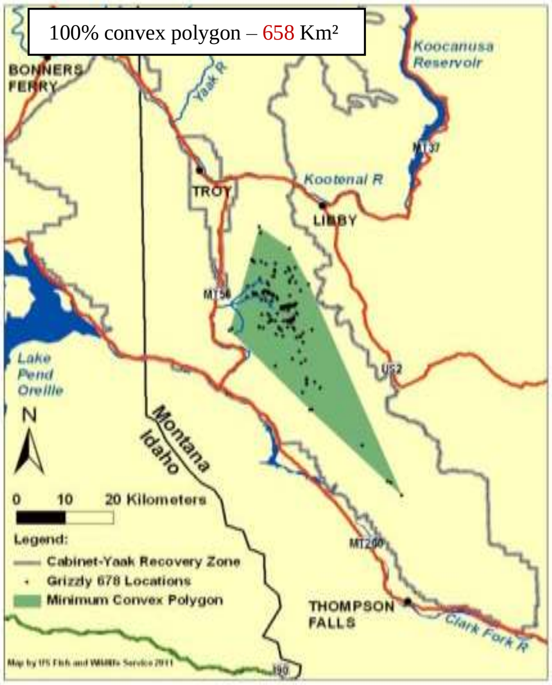


Figure A1. Radio locations and minimum convex (shaded) life range of female grizzly bear 678 in the Cabinet Mountains, 1983–1989.

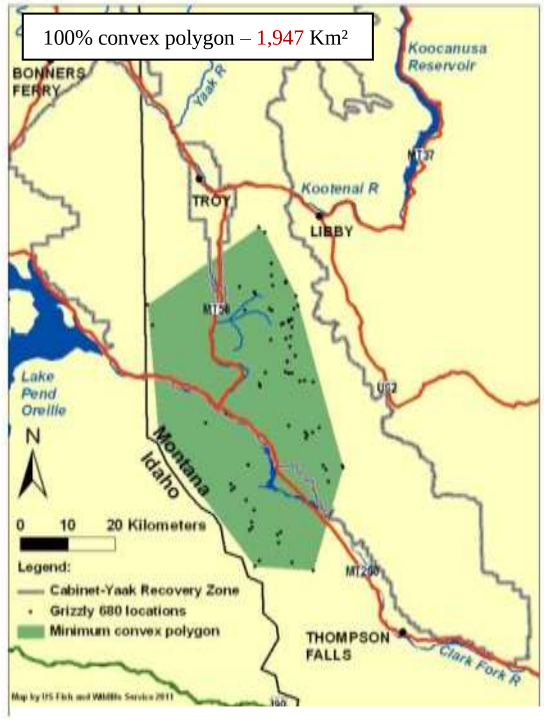


Figure A2. Radio locations and minimum convex (shaded) life range of male grizzly bear 680 in the Cabinet Mountains, 1984–1985.

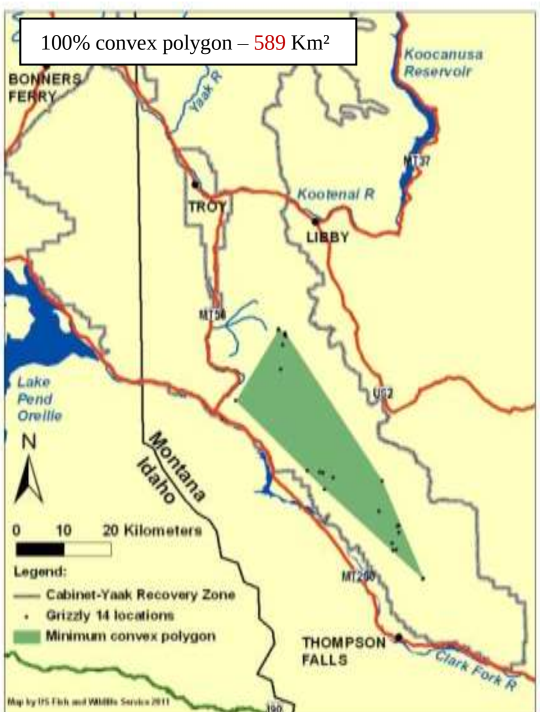


Figure A3. Radio locations and minimum convex (shaded) life range of male grizzly bear 14 in the Cabinet Mountains, 1985.

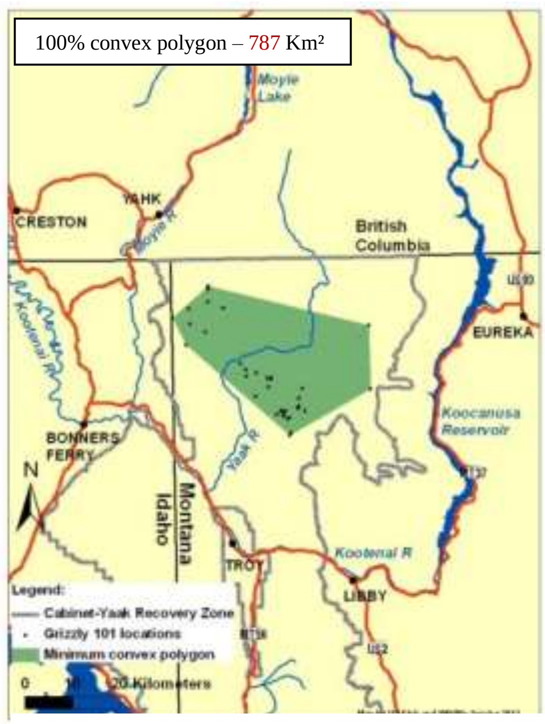


Figure A4. Radio locations and minimum convex (shaded) life range of male grizzly bear 101 in the Yaak River, 1986–1987.

Figure A5. Radio locations and minimum convex (shaded) life range of female grizzly bear 106 in the Yaak River, 1986–1999.

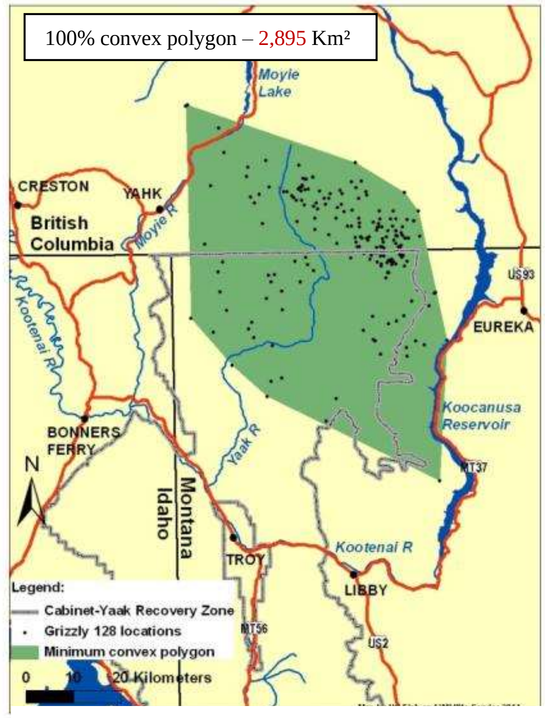


Figure A6. Radio locations and minimum convex (shaded) life range of male grizzly bear 128 in the Yaak River, 1987–1997.

Figure A7. Radio locations and minimum convex (shaded) life range of female grizzly bear 129 in the Yaak River, 1987–1989.

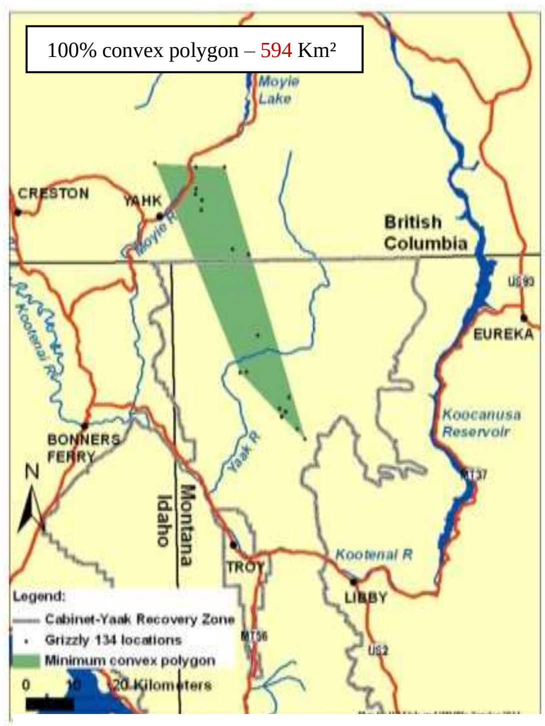


Figure A8. Radio locations and minimum convex (shaded) life range of male grizzly bear 134 in the Yaak River, 1987–1988.

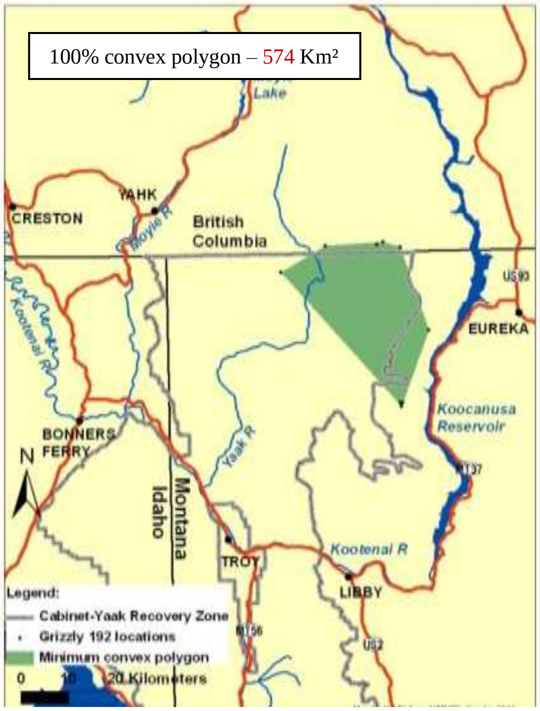


Figure A9. Radio locations and minimum convex (shaded) life range of male grizzly bear 192 in the Yaak River, 1990.

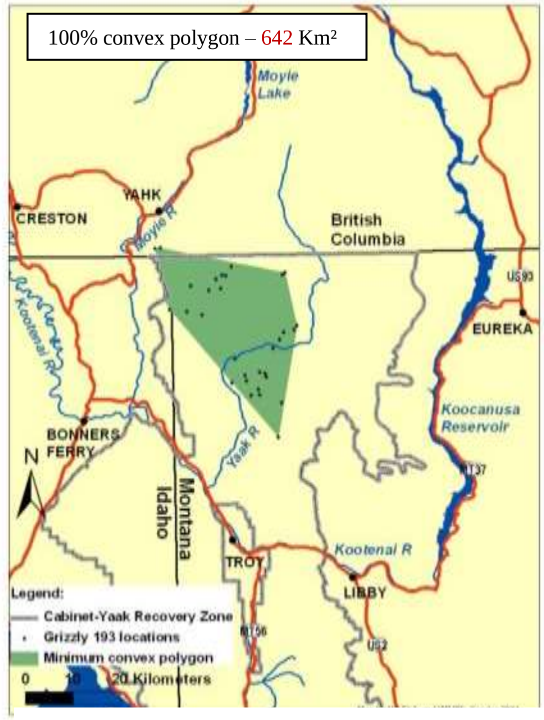


Figure A10. Radio locations and minimum convex (shaded) life range of male grizzly bear 193 in the Yaak River, 1990.

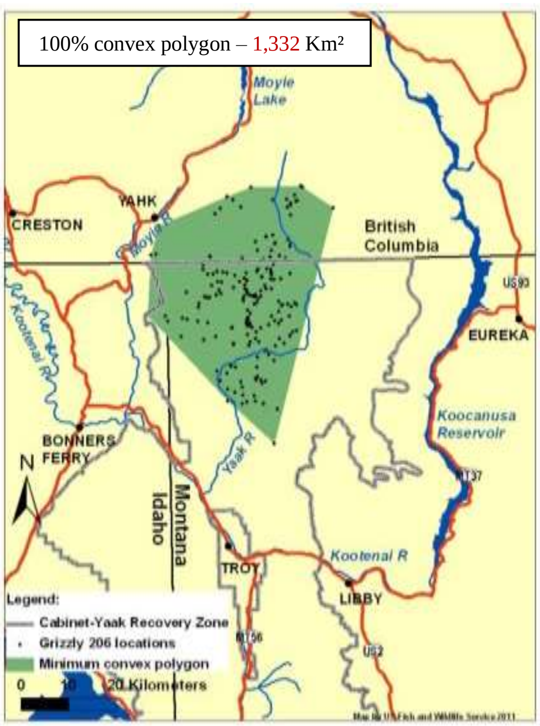


Figure A11. Radio locations and minimum convex (shaded) life range of female grizzly bear 206 in the Yaak River, 1991–1994.

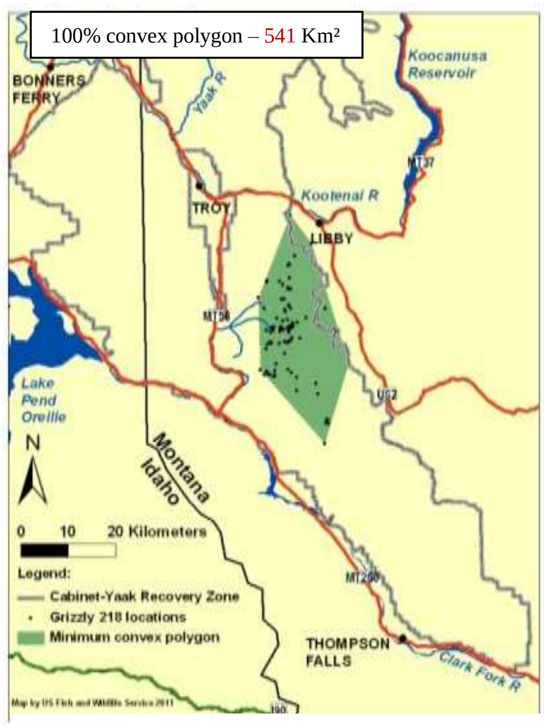


Figure A12. Radio locations and minimum convex (shaded) life range of female augmentation grizzly bear 218 in the Cabinet Mountains, 1990–1991.

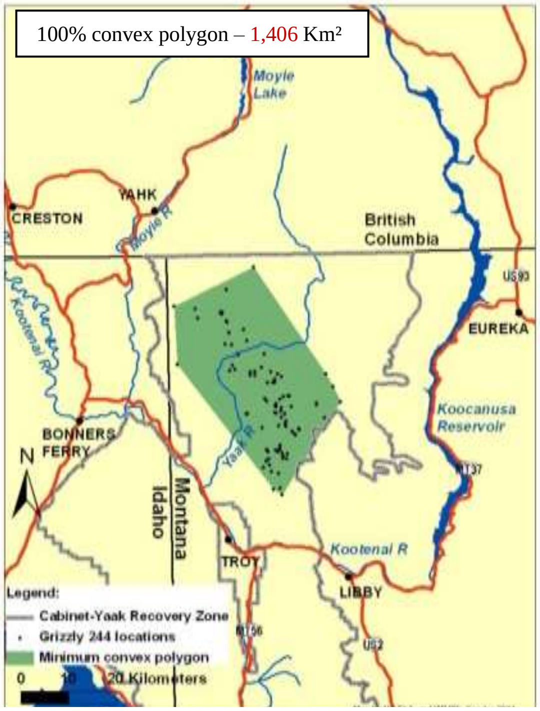


Figure A13. Radio locations and minimum convex (shaded) life range of male grizzly bear 244 in the Yaak River, 1992–2003.

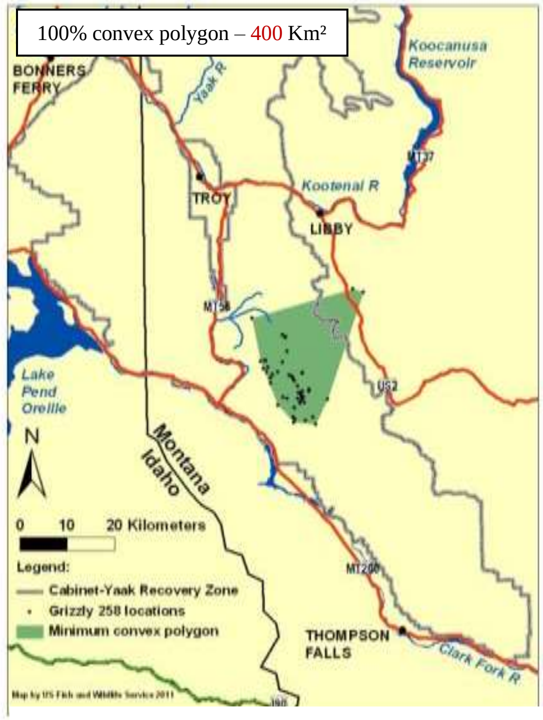


Figure A14. Radio locations and minimum convex (shaded) life range of female augmentation grizzly bear 258 in the Cabinet Mountains, 1992–1993.

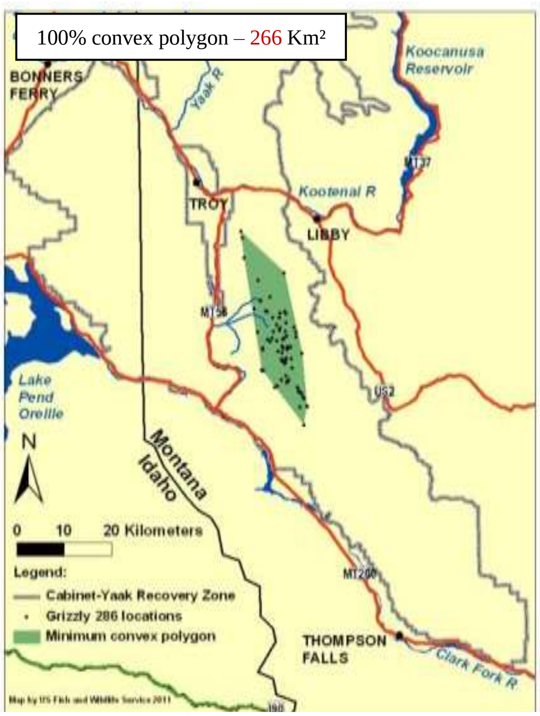


Figure A15. Radio locations and minimum convex (shaded) life range of female augmentation grizzly bear 286 in the Cabinet Mountains, 1993–1995.

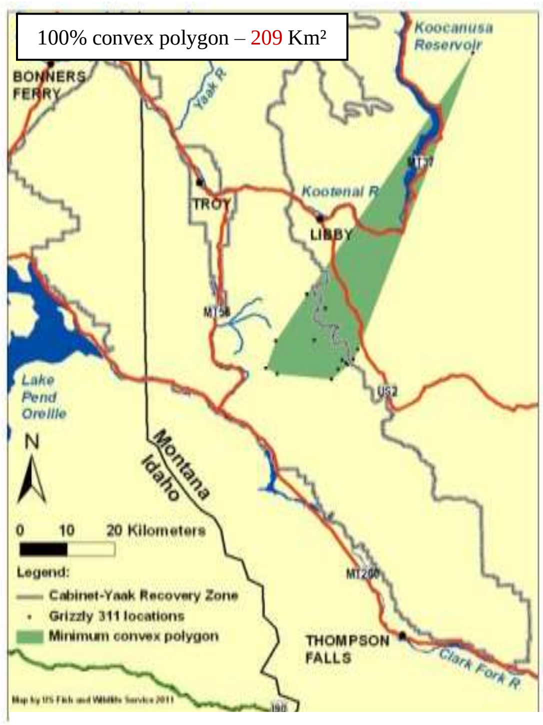


Figure A16. Radio locations and minimum convex (shaded) life range of female augmentation grizzly bear 311 in the Cabinet Mountains, 1994–1995.

Figure A17. Radio locations and minimum convex (shaded) life range of male grizzly bear 302 in the Yaak River, 1994–1996.

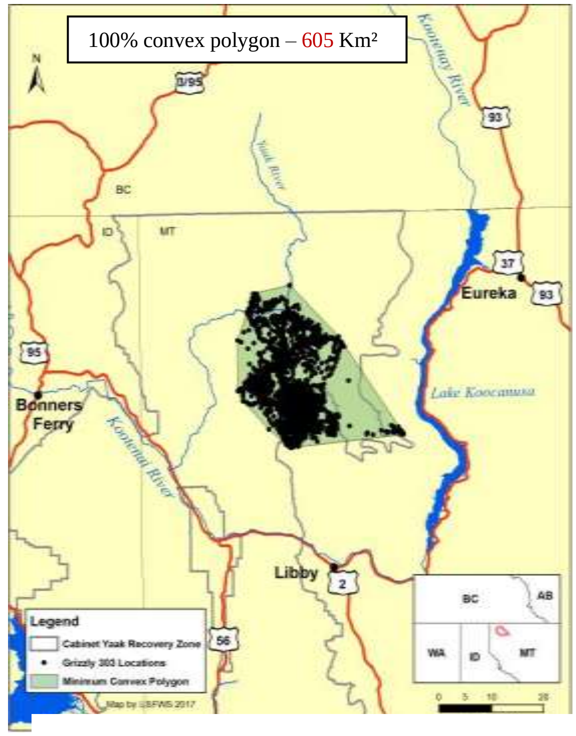


Figure A18. Radio locations and minimum convex (shaded) life range of female grizzly bear 303 in the Yaak River, 1994–2001 and 2011–2016.

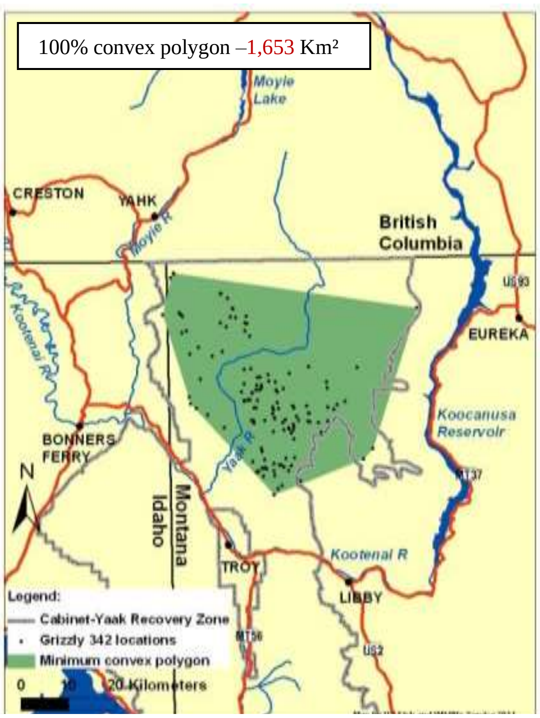


Figure A19. Radio locations and minimum convex (shaded) life range of male grizzly bear 342 in the Yaak River, 1995–2001.

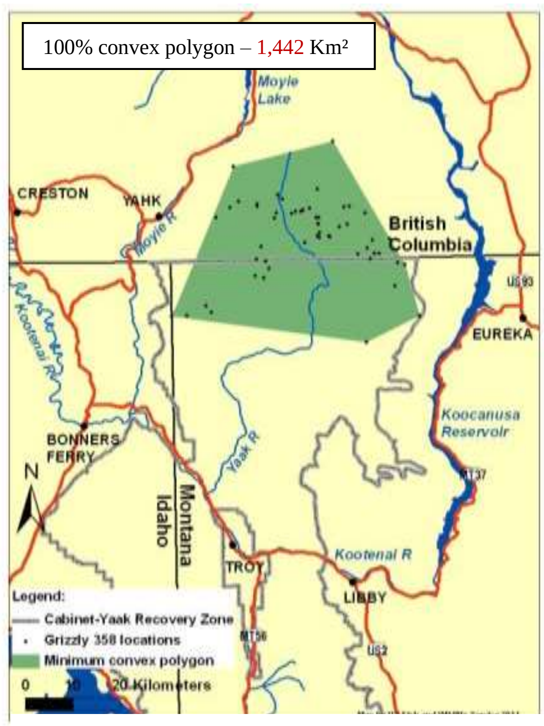


Figure A20. Radio locations and minimum convex (shaded) life range of male grizzly bear 358 in the Yaak River, 1996–1998.

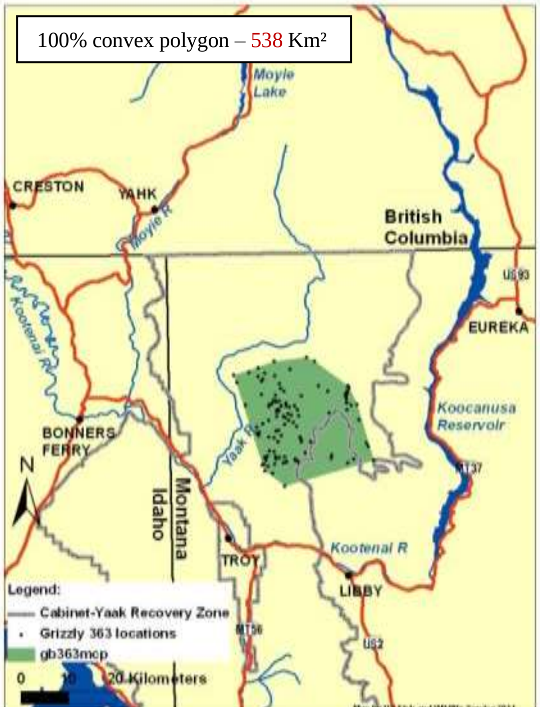


Figure A21. Radio locations and minimum convex (shaded) life range of male grizzly bear 363 in the Yaak River, 1996–1999.

Figure A22. Radio locations and minimum convex (shaded) life range of male grizzly bear 386 in the Yaak River, 1997–1999.

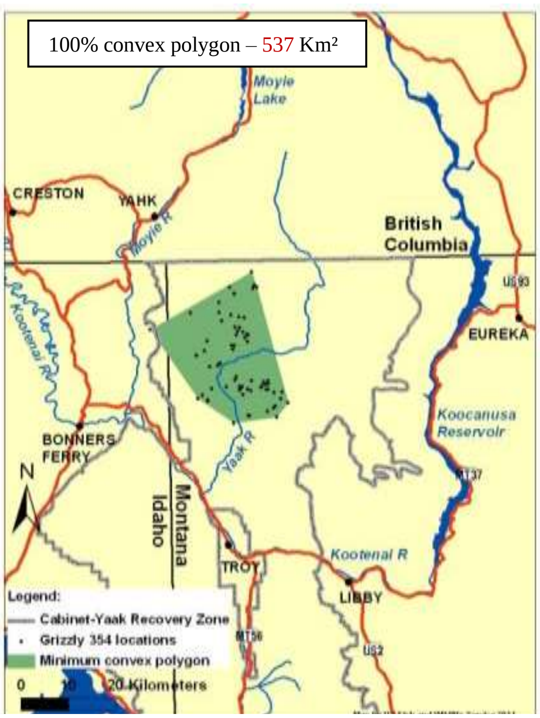


Figure A23. Radio locations and minimum convex (shaded) life range of female grizzly bear 354 in the Yaak River, 1997–1999.

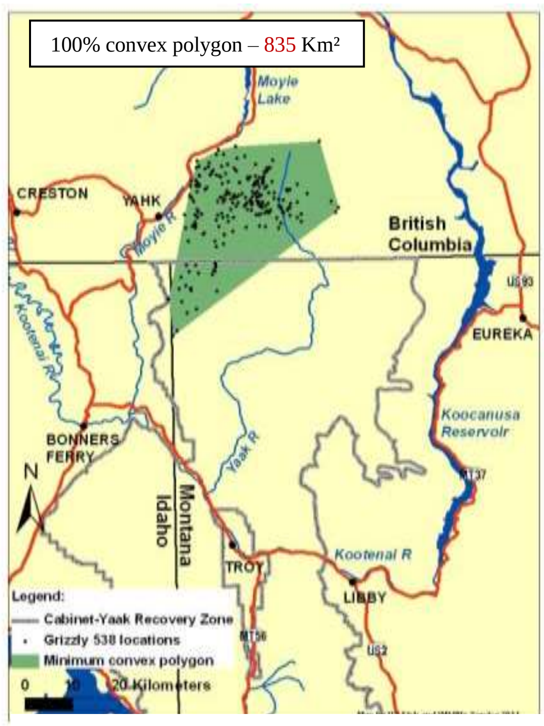


Figure A24. Radio locations and minimum convex (shaded) life range of female grizzly bear 538 in the Yaak River, 1997–2002.

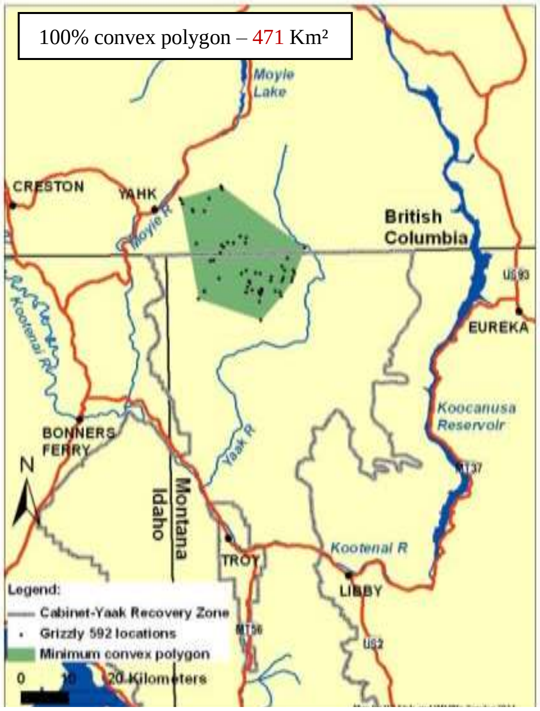


Figure A25. Radio locations and minimum convex (shaded) life range of female grizzly bear 592 in the Yaak River, 1999–2000.

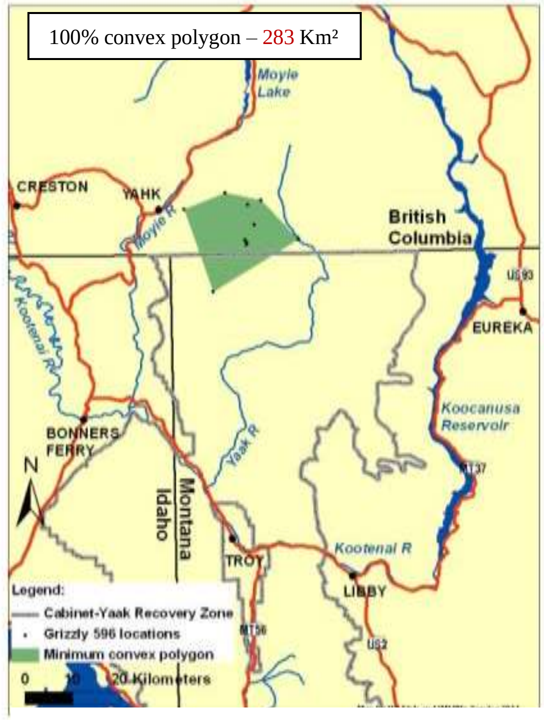


Figure A26. Radio locations and minimum convex (shaded) life range of female grizzly bear 596 in the Yaak River, 1999.

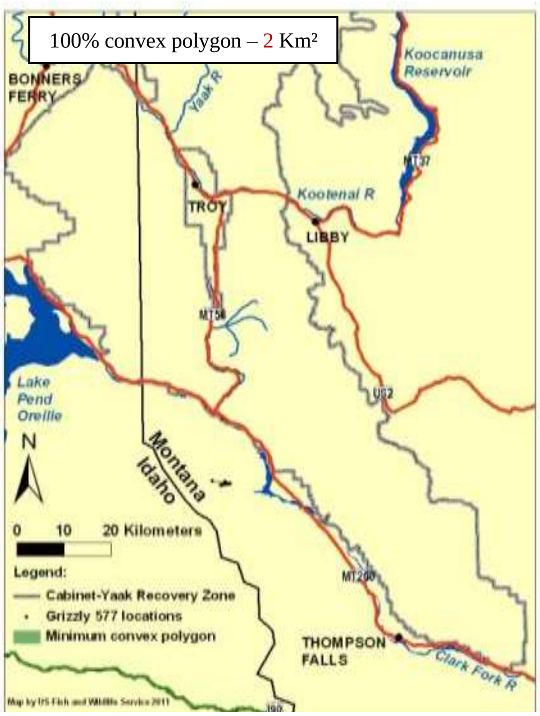


Figure A27. Radio locations and minimum convex (shaded) life range of female grizzly bear 577 in the Cabinet Mountains, 2002.

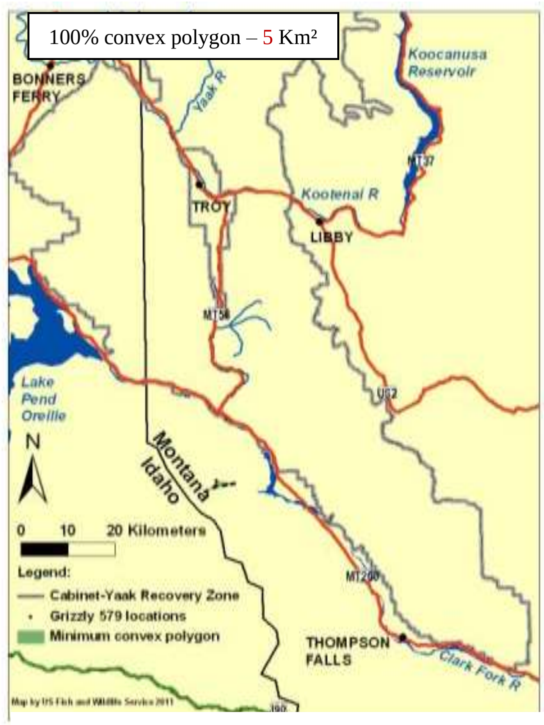


Figure A28. Radio locations and minimum convex (shaded) life range of male grizzly bear 579 in the Cabinet Mountains, 2002.

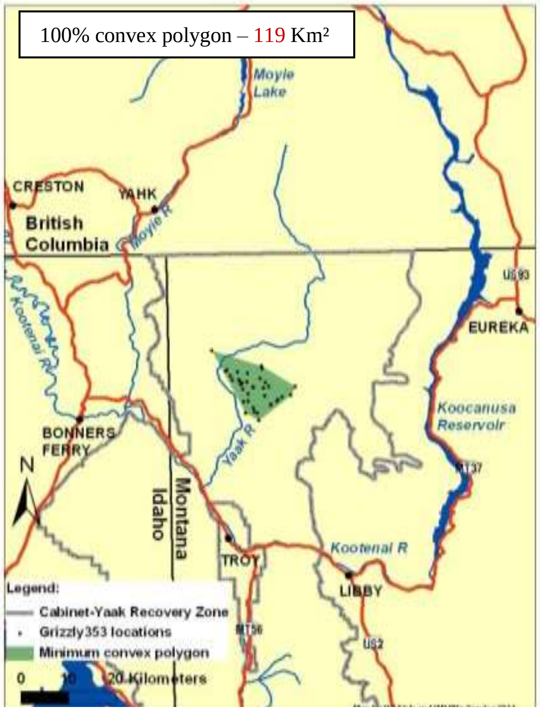


Figure A29. Radio locations and minimum convex (shaded) life range of female grizzly bear 353 in the Yaak River, 2002.

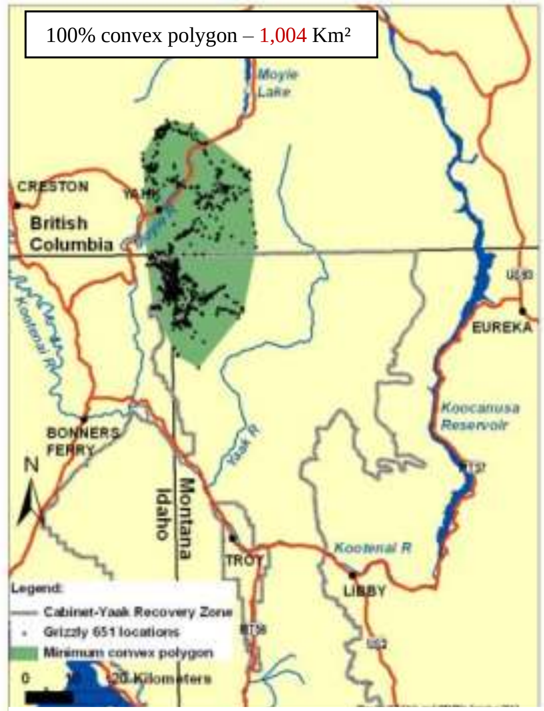


Figure A30. Radio locations and minimum convex (shaded) life range of male grizzly bear 651 in the Yaak River, 2002–2006.

Figure A31. Radio locations and minimum convex (shaded) life range of male grizzly bear 787 in the Yaak River, 2003–2004.

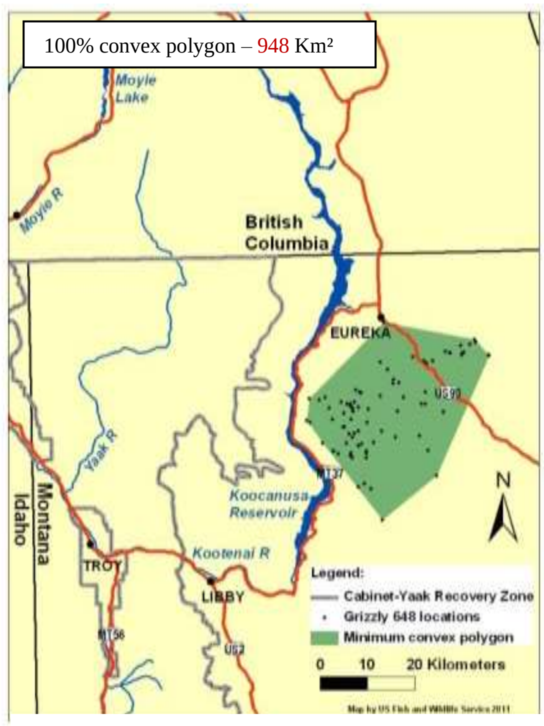


Figure A32. Radio locations and minimum convex (shaded) life range of female grizzly bear 648 in the Salish Mountains, 2003–2005.

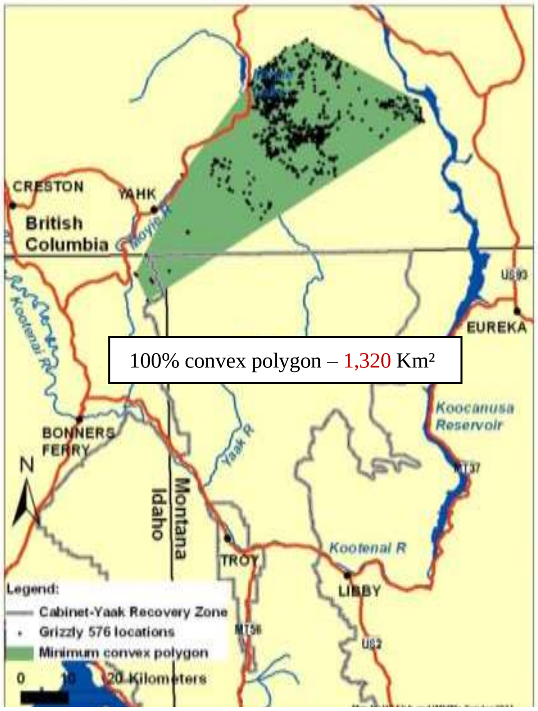


Figure A33. Radio locations and minimum convex (shaded) life range of male grizzly bear 576 in the Yaak River, 2004–2006.

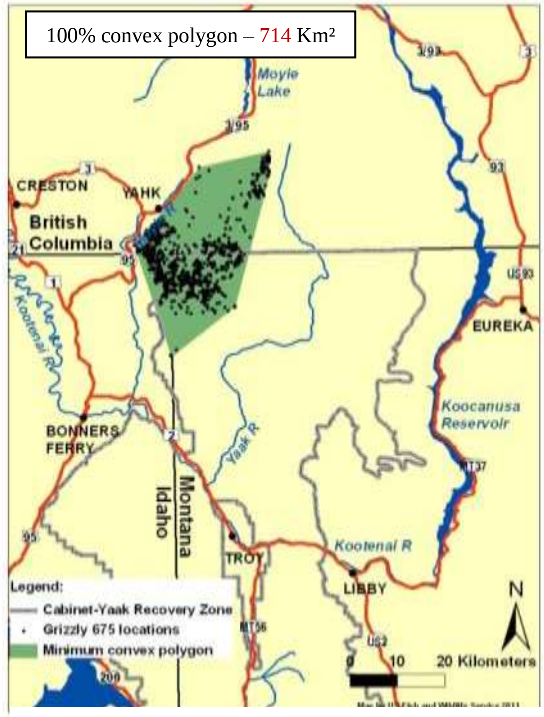


Figure A34. Radio locations and minimum convex (shaded) life range of female grizzly bear 675 in the Yaak River, 2004–2010.

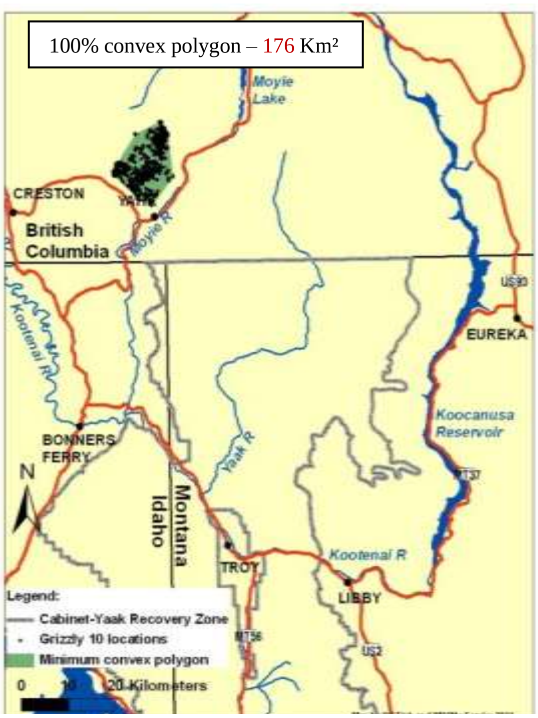


Figure A35. Radio locations and minimum convex (shaded) life range of female grizzly bear 10 in the Purcell Mountains, 2004.

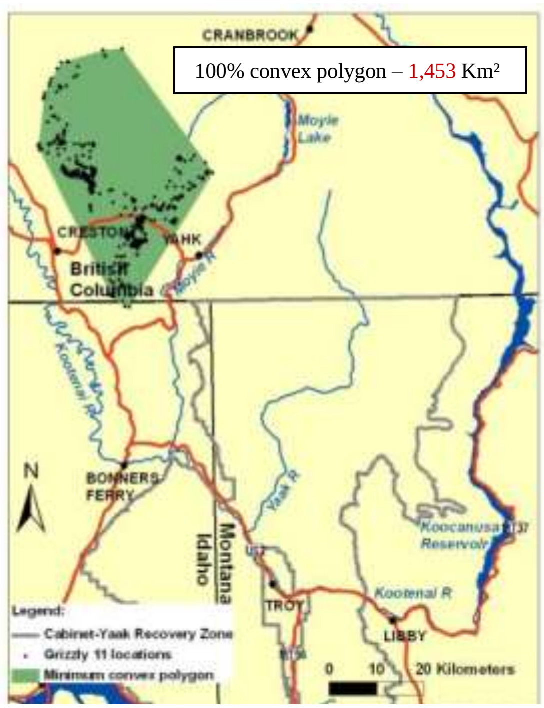


Figure A36. Radio locations and minimum convex (shaded) life range of male grizzly bear 11 in the Purcell Mountains, 2004.

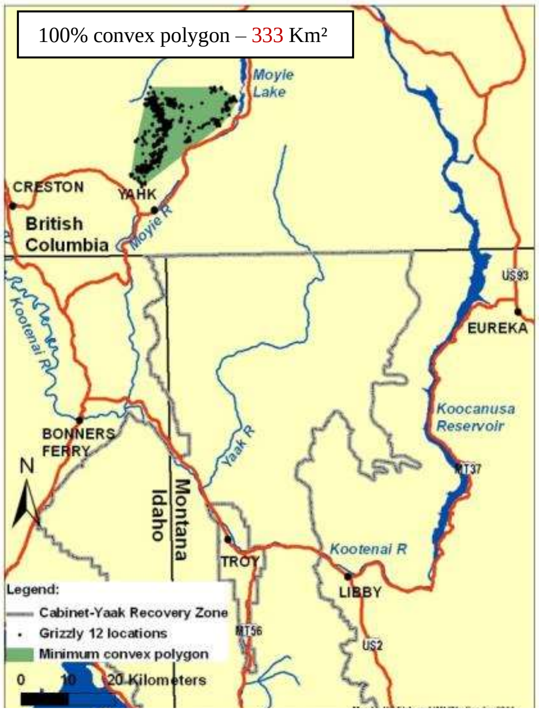


Figure A37. Radio locations and minimum convex (shaded) life range of female grizzly bear 12 in the Purcell Mountains, 2004.

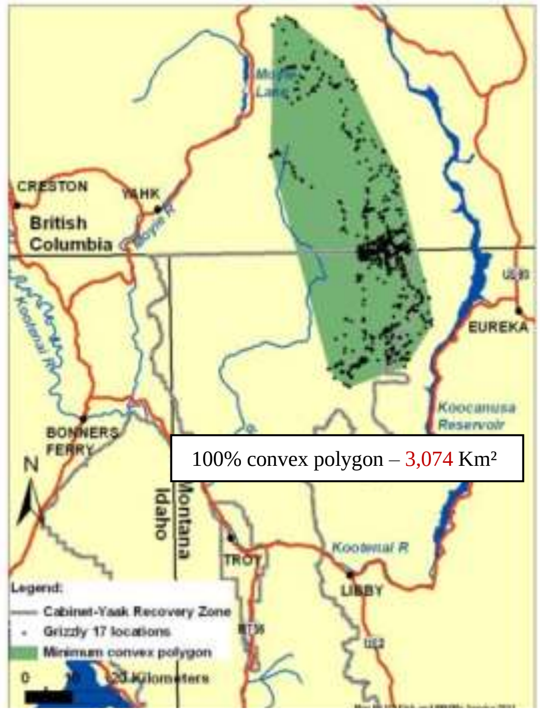


Figure A38. Radio locations and minimum convex (shaded) life range of male grizzly bear 17 in the Purcell Mountains, 2004.

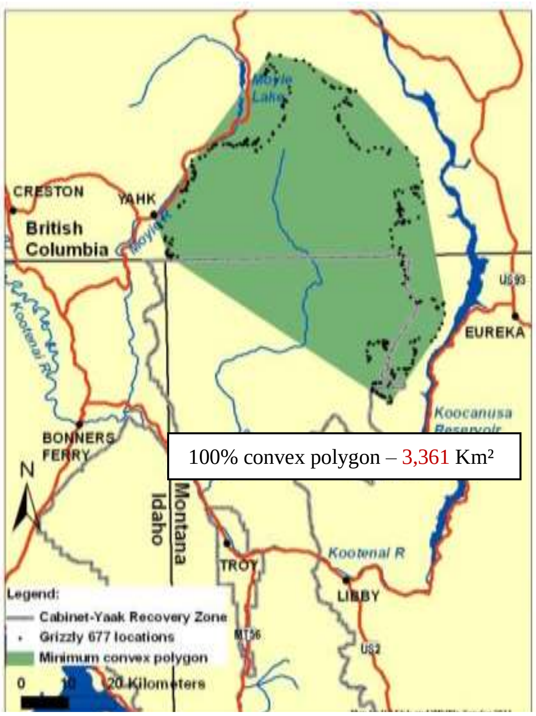


Figure A39. Radio locations and minimum convex (shaded) life range of male grizzly bear 677 in the Purcell Mountains, 2005.

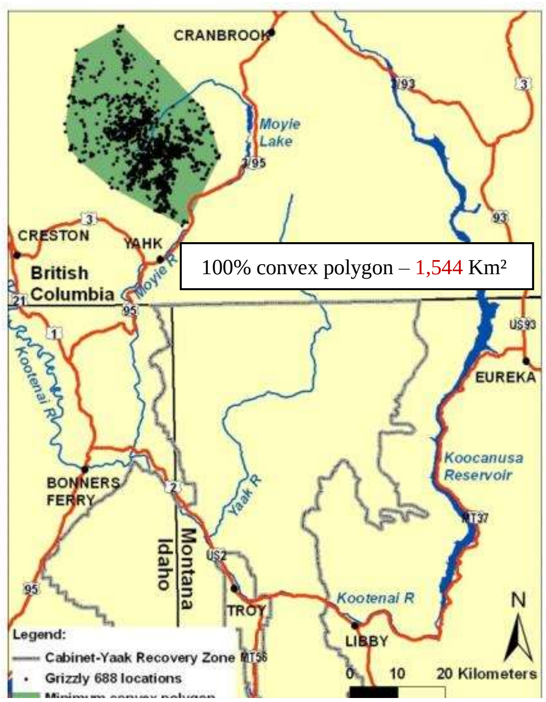


Figure A40. Radio locations and minimum convex (shaded) life range of male grizzly bear 688 in the Purcell Mountains, 2005–2006.

Figure A41. Radio locations and minimum convex (shaded) life range of female grizzly bear 694 in the Yaak River, 2005.

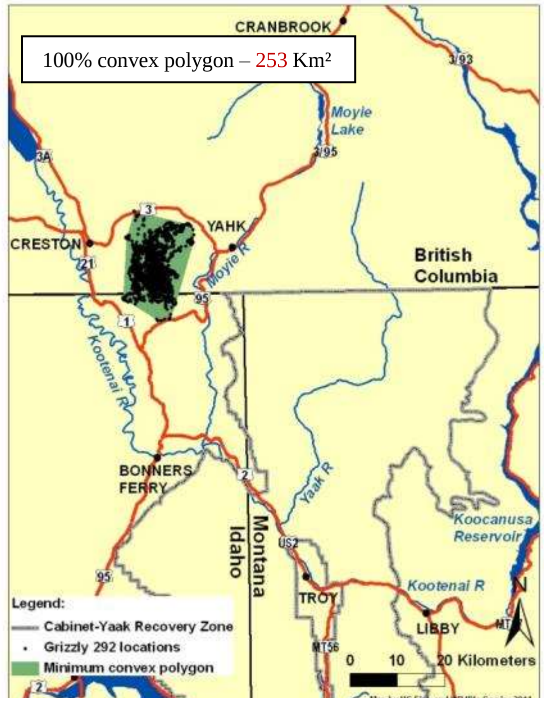


Figure A42. Radio locations and minimum convex (shaded) life range of female grizzly bear 292 in the Purcell Mountains, 2005.

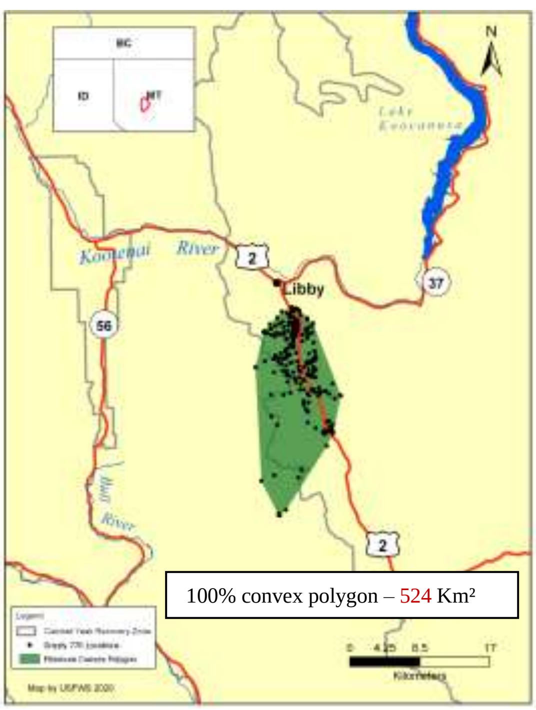


Figure A43. Radio locations and minimum convex (shaded) life range of male grizzly bear 770 in the Cabinet Mountains, 2005–2006, 2019.

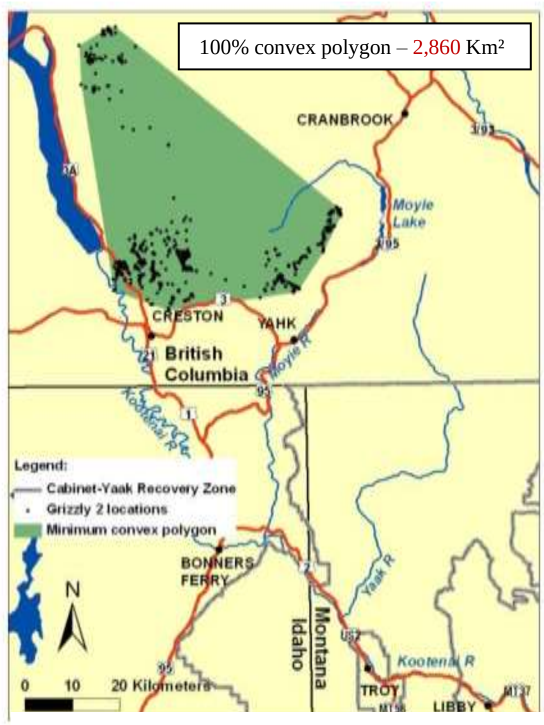


Figure A44. Radio locations and minimum convex (shaded) life ranges of male grizzly bear 2 in the Purcell Mountains, 2005.

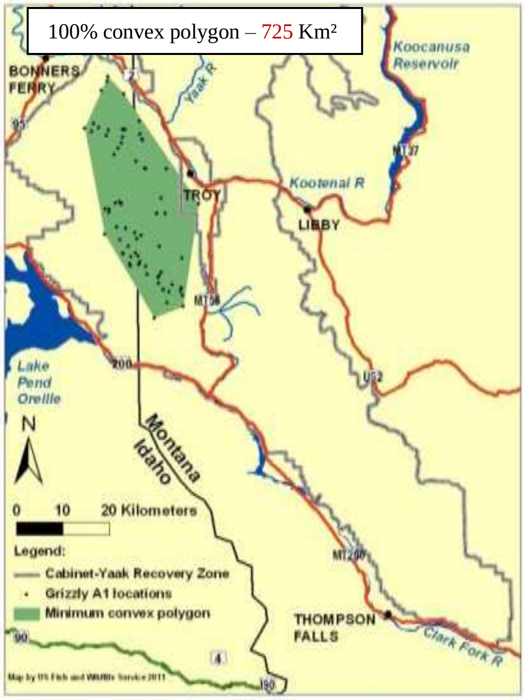


Figure A45. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear A1 in the Cabinet Mountains, 2005–2007.

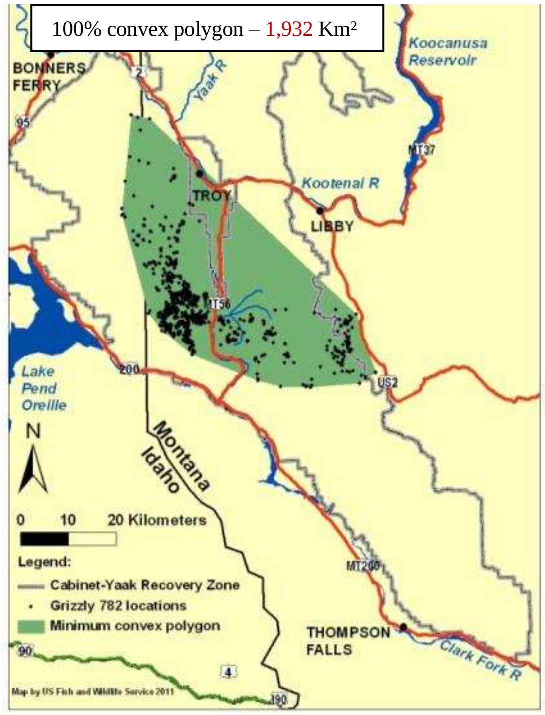


Figure A46. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 782 in the Cabinet Mountains, 2006–2007.

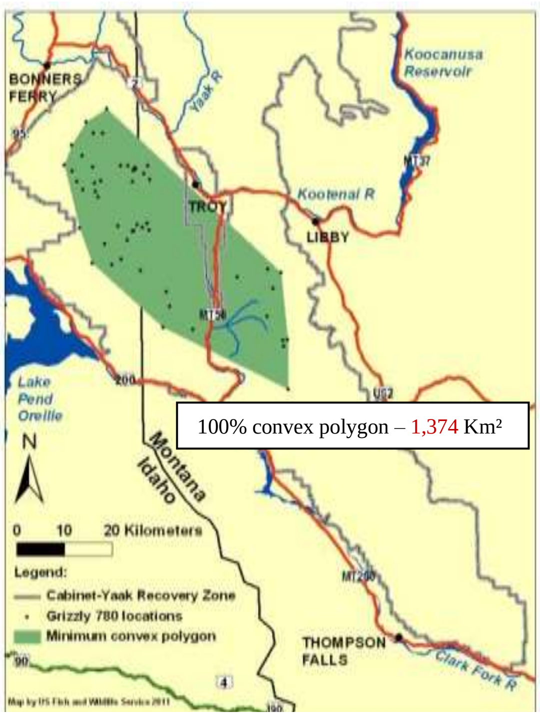


Figure A47. Radio locations and minimum convex (shaded) life range of male grizzly bear 780 in the Cabinet Mountains, 2006–2008.

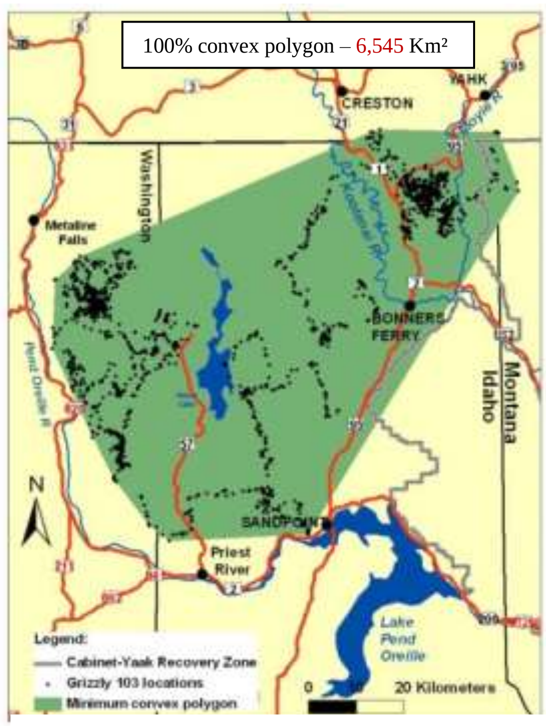


Figure A48. Radio locations and minimum convex (shaded) life range of male grizzly bear 103 in the Yaak River, 2006–2007.

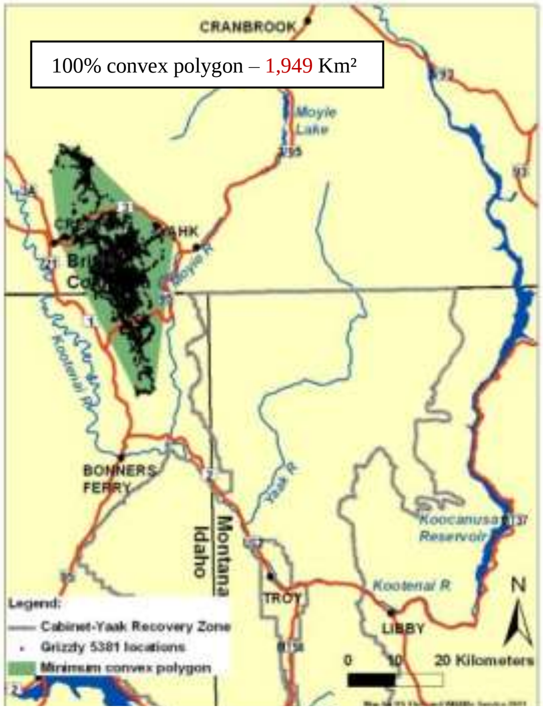


Figure A49. Radio locations and minimum convex (shaded) life range of male grizzly bear 5381 in the Purcell Mountains, 2006–2007.

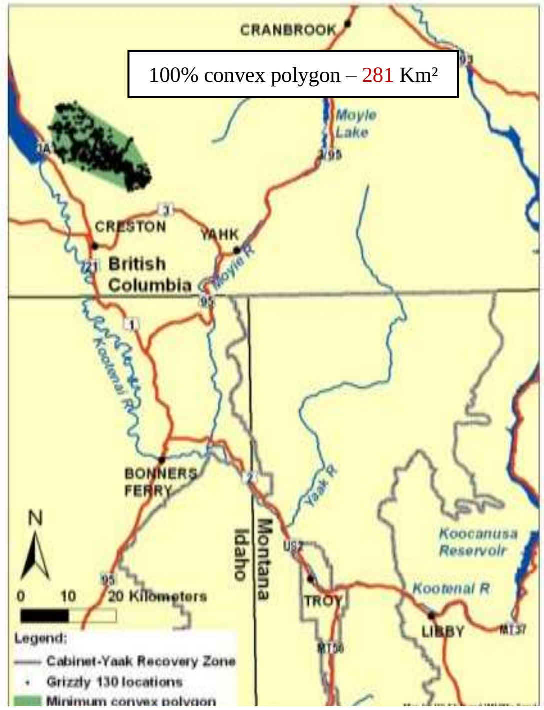


Figure A50. Radio locations and minimum convex (shaded) life range of female grizzly bear 130 in the Purcell Mountains, 2007–2008.

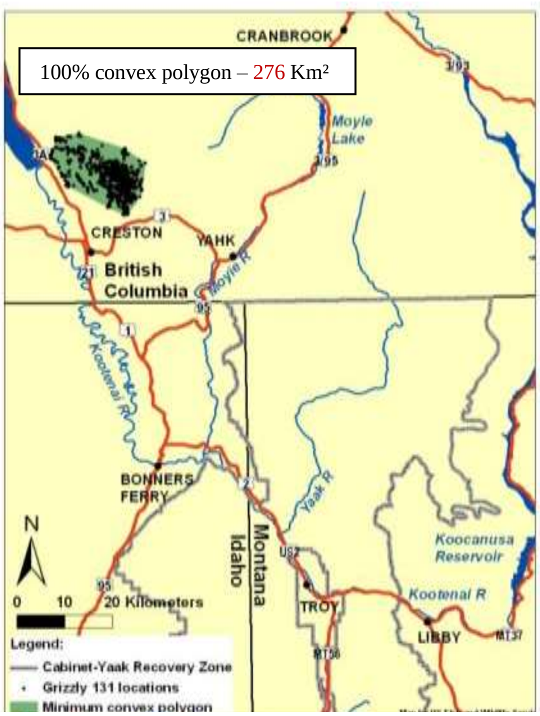


Figure A51. Radio locations and minimum convex (shaded) life range of female grizzly bear 131 in the Purcell Mountains, 2007–2008.

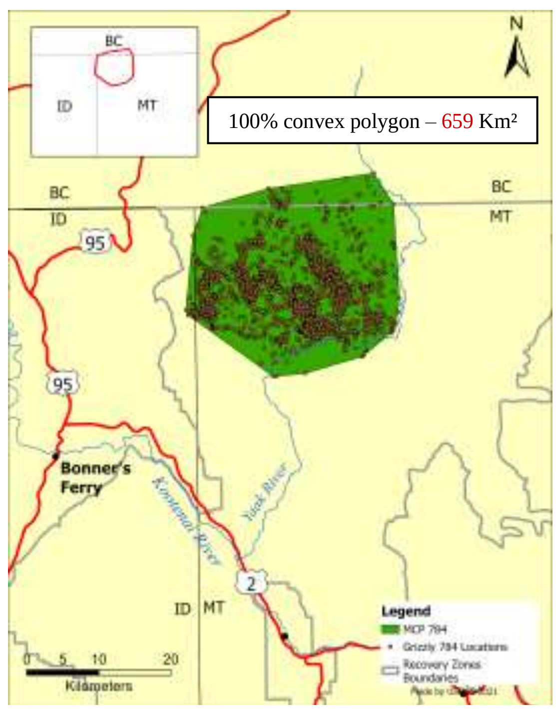


Figure A52. Radio locations and minimum convex (shaded) life range of female grizzly bear 784 in the Yaak River, 2007–2009, 2020–2022.

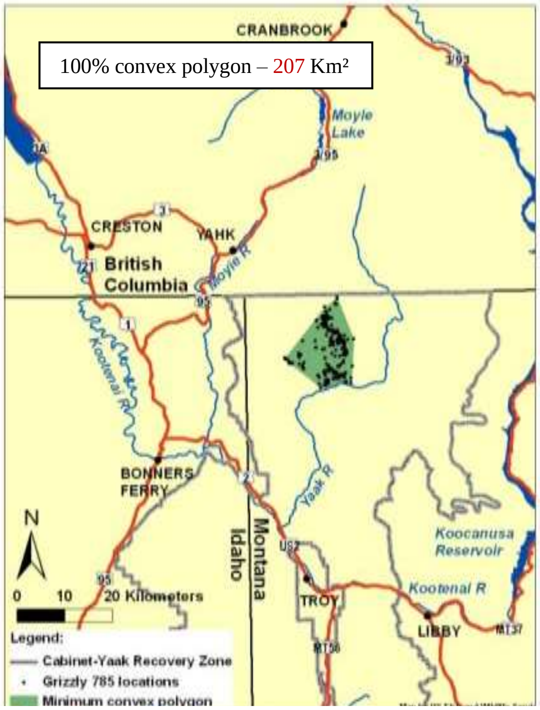


Figure A53. Radio locations and minimum convex (shaded) life range of female grizzly bear 785 in the Yaak River, 2007–2008.

Figure A54. Radio locations and minimum convex (shaded) life range of female grizzly bear 772 in the Cabinet Mountains, 2007.

Figure A55. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 635 in the Cabinet Mountains, 2008.

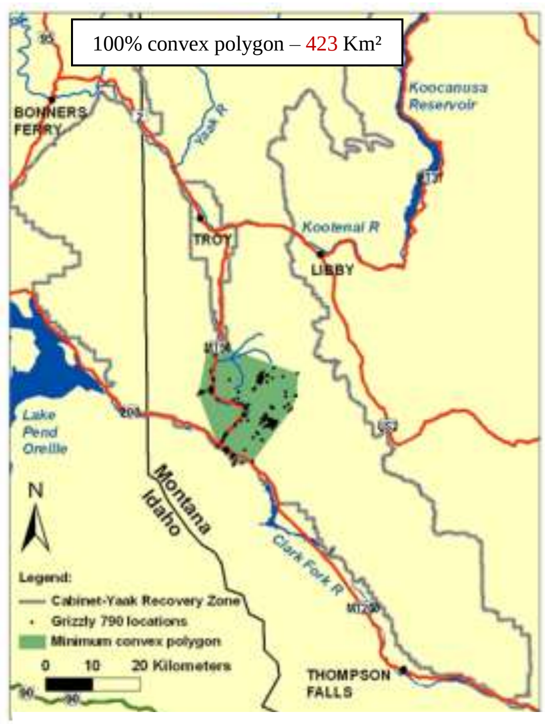


Figure A56. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 790 in the Cabinet Mountains, 2008.

Figure A57. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 715 in the Cabinet Mountains, 2009–2010.

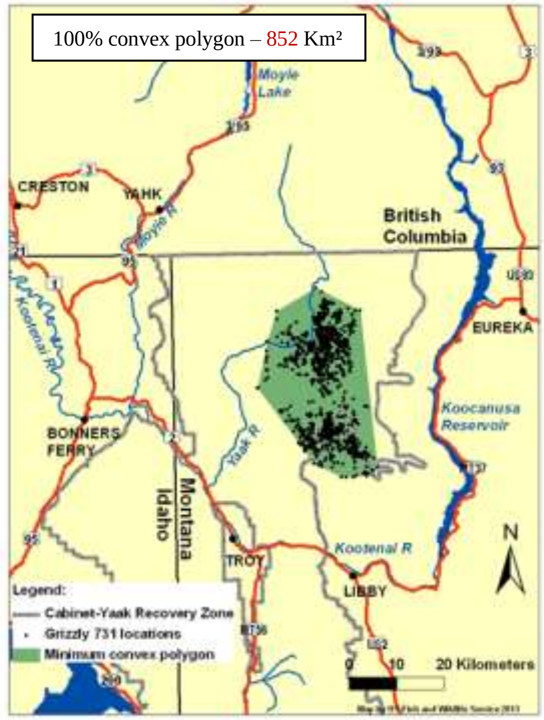


Figure A58. Radio locations and minimum convex (shaded) life range of female grizzly bear 731 in the Yaak River, 2009–2011.

Figure A59. Radio locations and minimum convex (shaded) life range of male grizzly bear 799 in the Cabinet Mountains, 2009–2010.

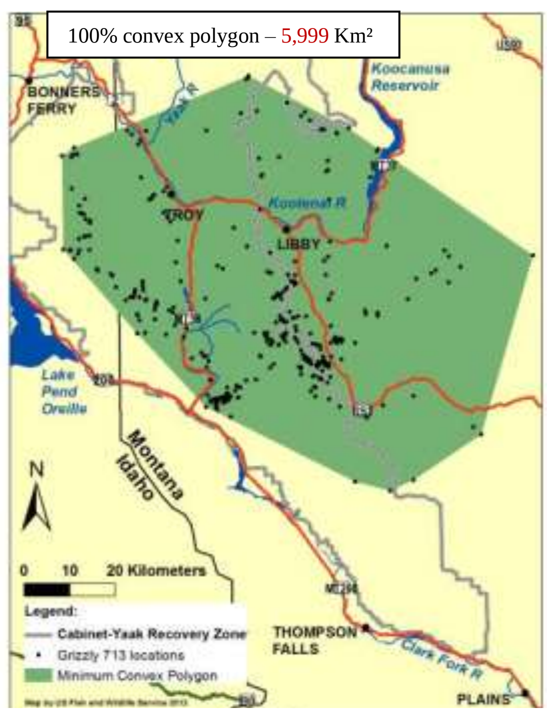


Figure A60. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 713 in the Cabinet Mountains, 2010–2011.

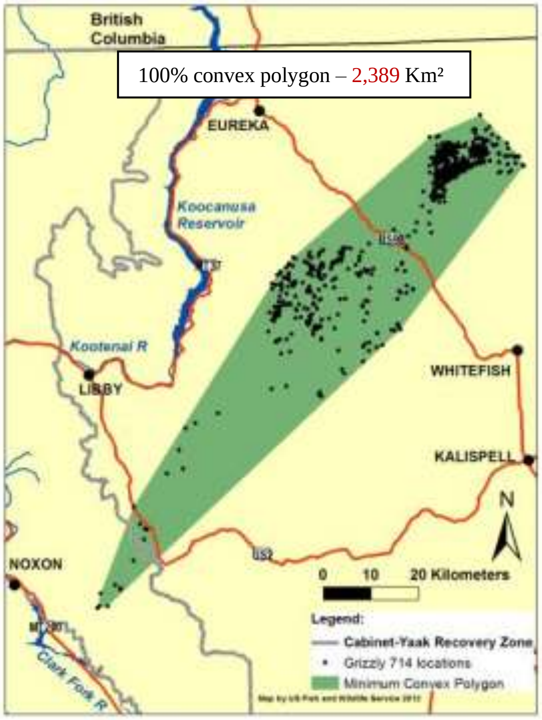


Figure A61. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 714 in the Cabinet Mountains, 2010–2012.

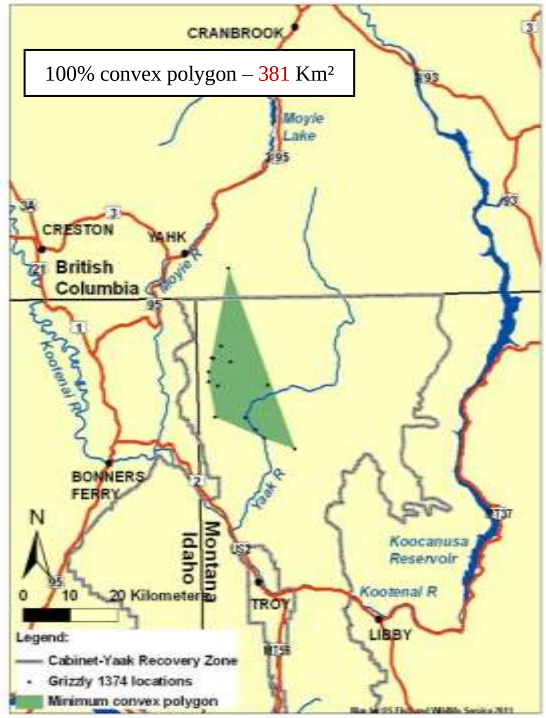


Figure A62. Radio locations and minimum convex (shaded) life range of male grizzly bear 1374 in the Yaak River, 2010.

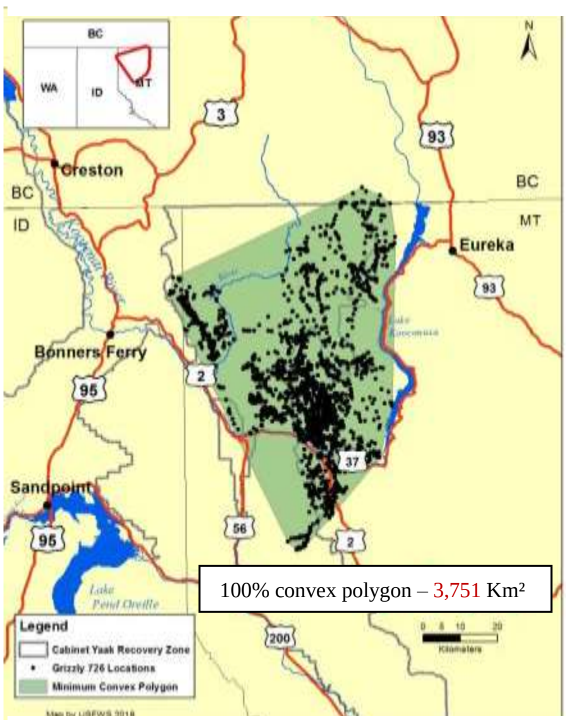


Figure A63. Radio locations and minimum convex (shaded) life range of male grizzly bear 726 in the Yaak River, 2011–2012, 2015–2017.

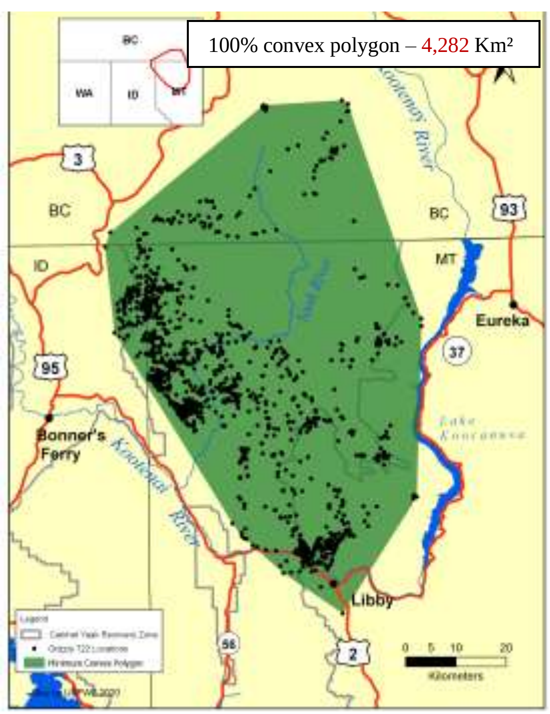


Figure A64. Radio locations and minimum convex (shaded) life range of male grizzly bear 722 in the Yaak River, 2011–2012, 2014, 2016–2019.

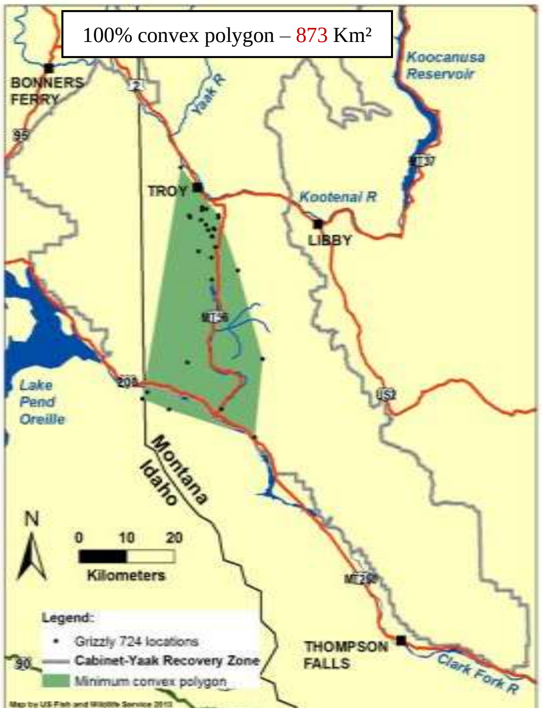


Figure A65. Radio locations and minimum convex (shaded) life range of management male grizzly bear 724 in the Cabinet Mountains, 2011–2012.

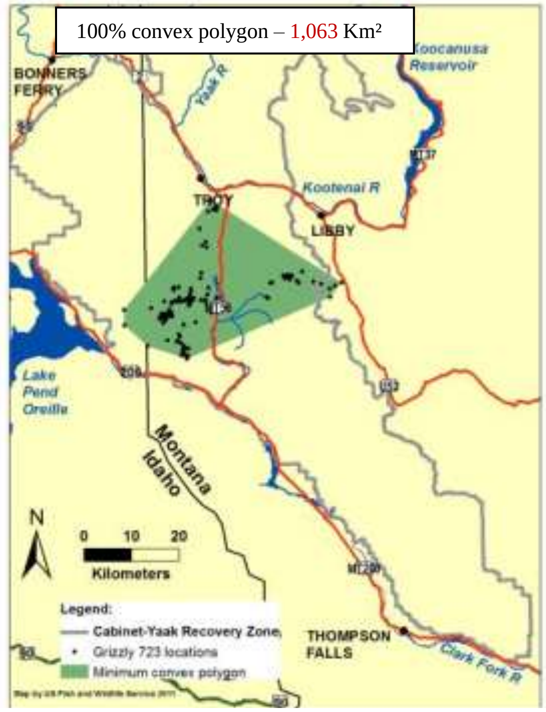


Figure A66. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 723 in the Cabinet Mountains, 2011–2012.

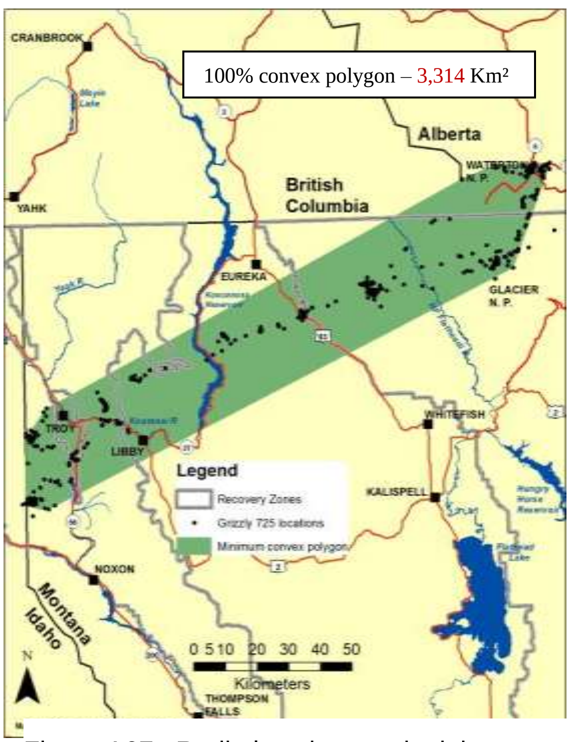


Figure A67. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 725 in the Cabinet Mountains, 2011–2013.

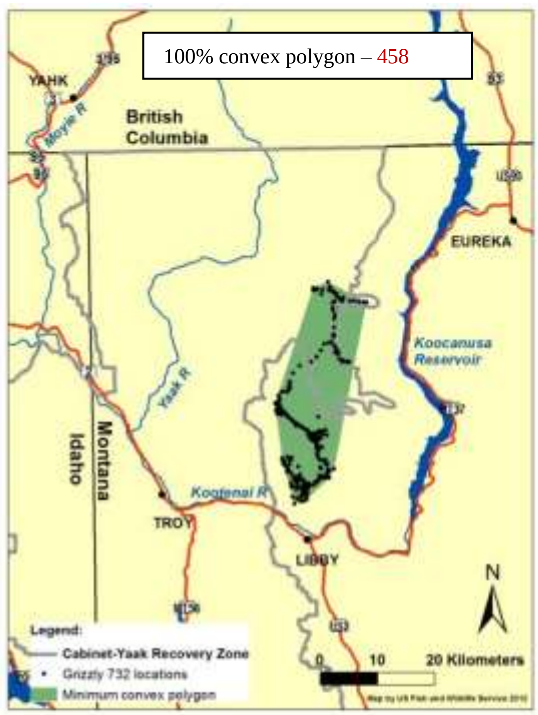


Figure A68. Radio locations and minimum convex (shaded) life range of management male grizzly bear 732 in the Yaak River, 2011.

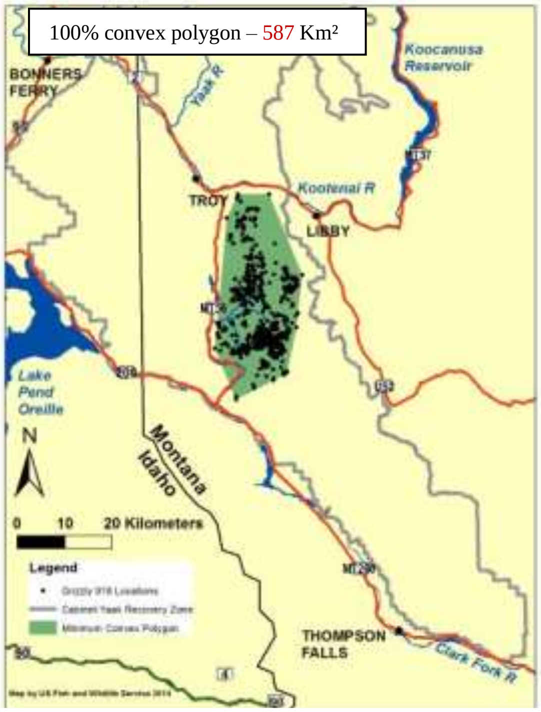


Figure A69. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 918 in the Cabinet Mountains, 2012–2014.

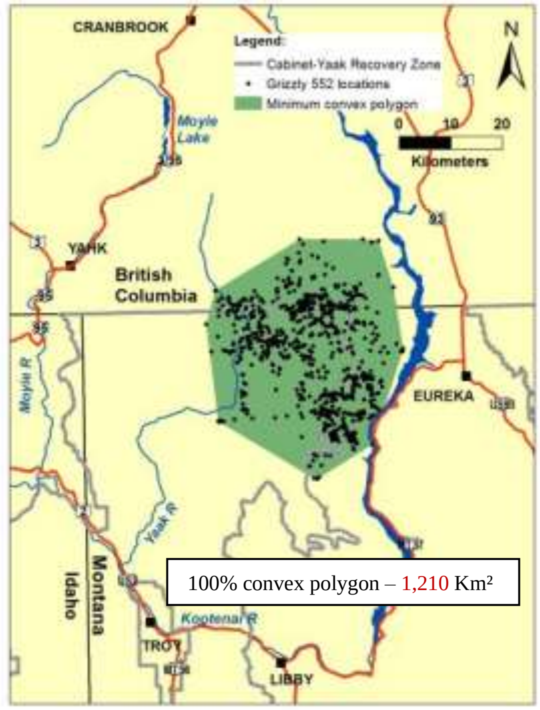


Figure A70. Radio locations and minimum convex (shaded) life range of female grizzly bear 552 in the Yaak River, 2012–2015.

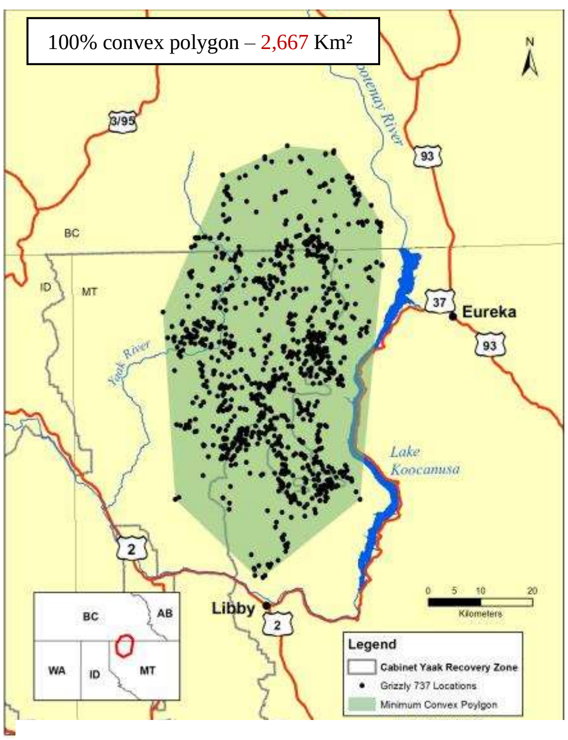


Figure A71. Radio locations and minimum convex (shaded) life range of male grizzly bear 737 in the Yaak River, 2010–2013.

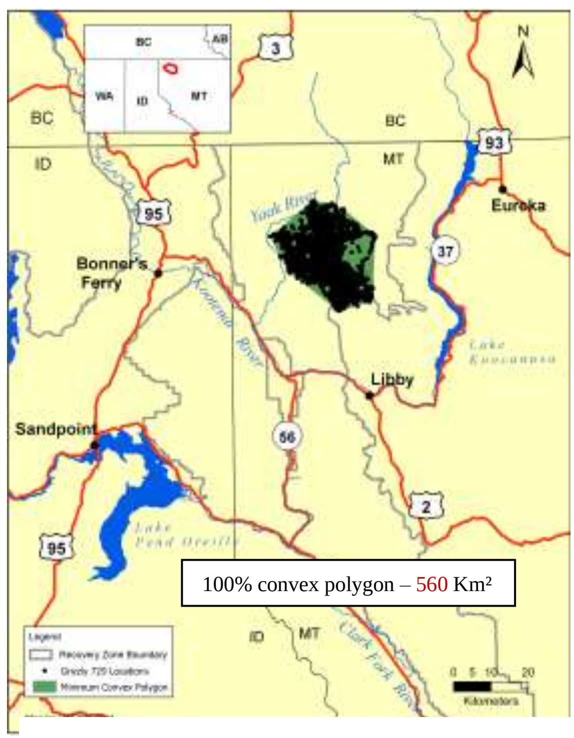


Figure A72. Radio locations and minimum convex (shaded) life range of female grizzly bear 729 in the Yaak River, 2013–2017, 2020.

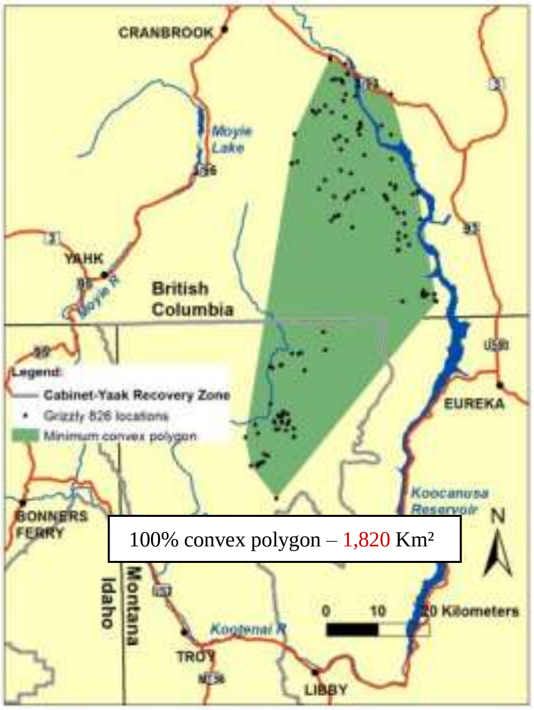


Figure A73. Radio locations and minimum convex (shaded) life range of male grizzly bear 826 in the Yaak River, 2013.

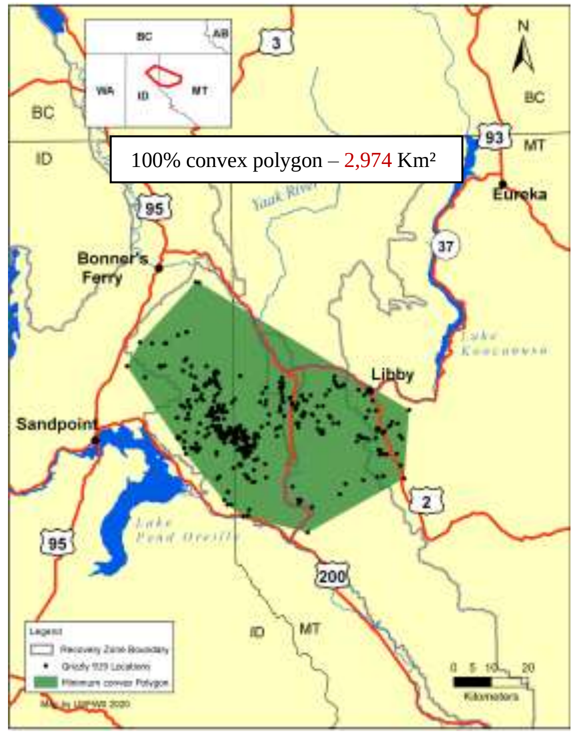


Figure A74. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 919 in the Cabinet Mountains, 2013–2014.

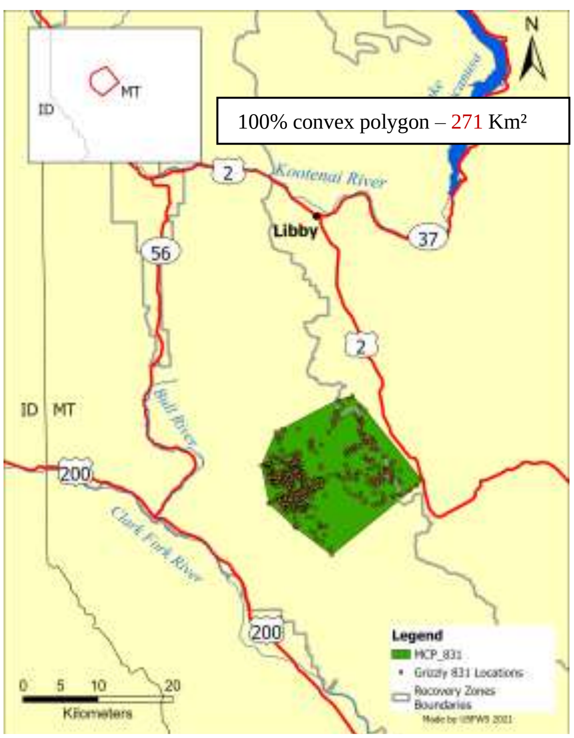


Figure A75. Radio locations and minimum convex (shaded) life range of female grizzly bear 831 in the Cabinet Mountains, 2014, 2022.

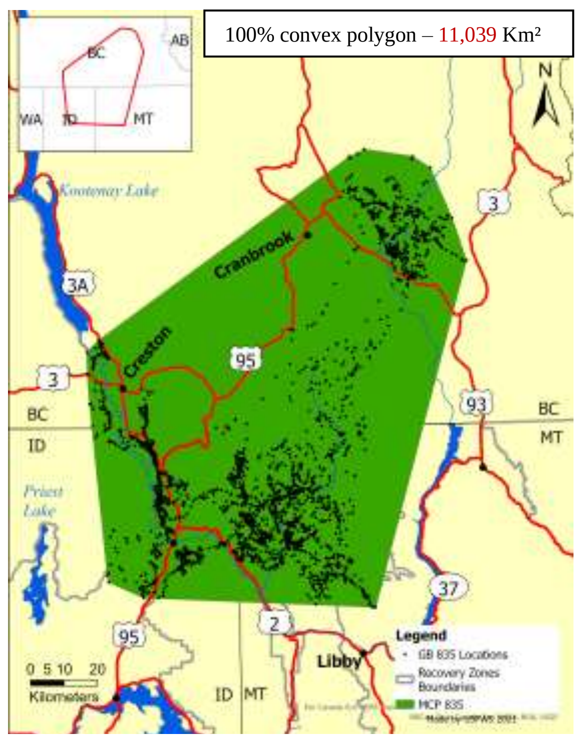


Figure A76. Radio locations and minimum convex (shaded) life range of male grizzly bear 835 in the Yaak River, 2014–2016, 2019–2022.

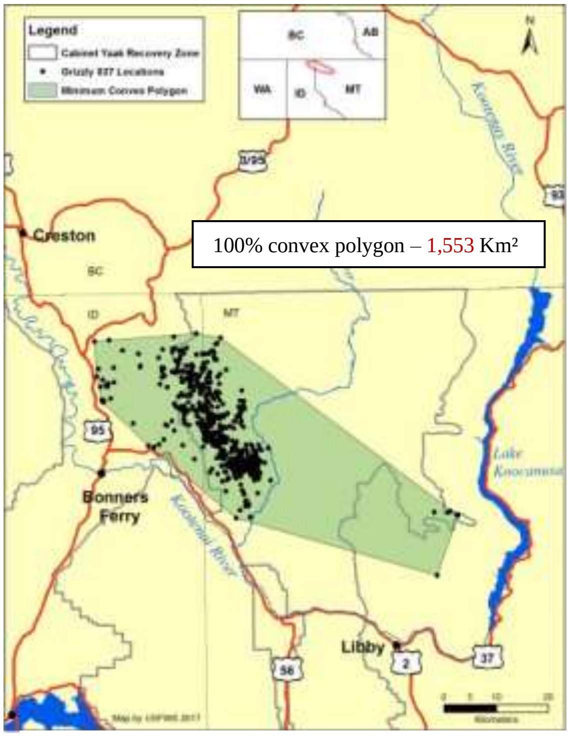


Figure A77. Radio locations and minimum convex (shaded) life range of male grizzly bear 837 in the Cabinet Mountains, 2014–2016.

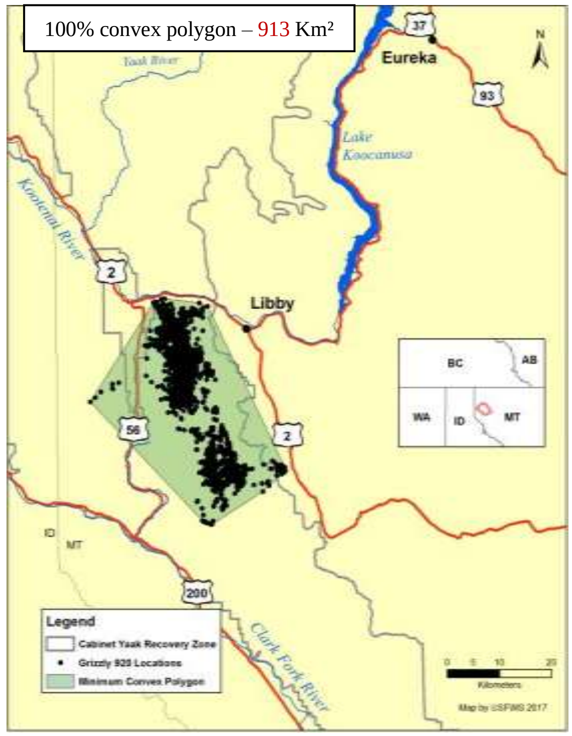


Figure A78. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 920 in the Cabinet Mountains, 2014–2016.

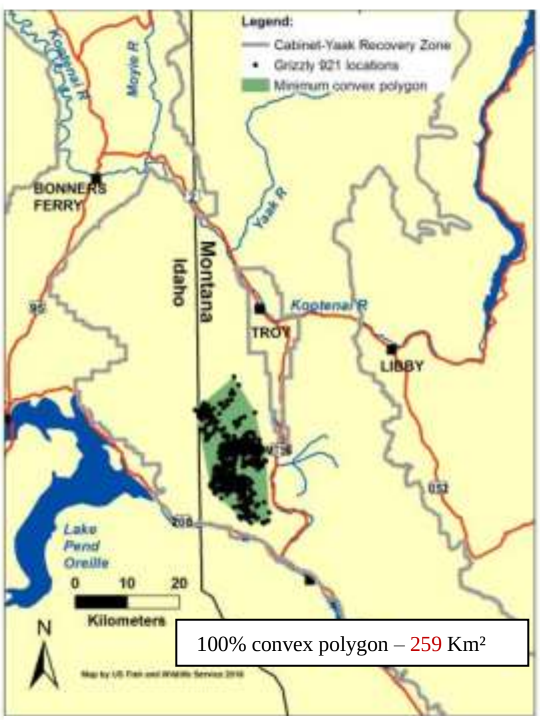


Figure A79. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 921 in the Cabinet Mountains, 2014–2015.

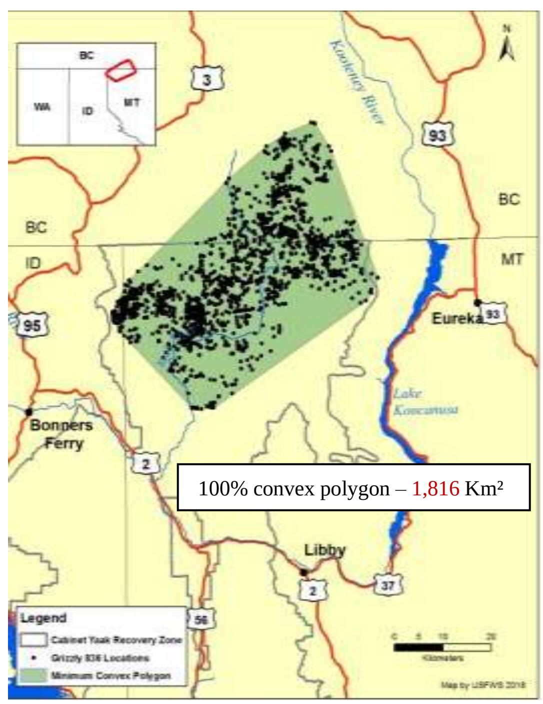


Figure A80. Radio locations and minimum convex (shaded) life range of female grizzly bear 836 in the Yaak River, 2014–2017.

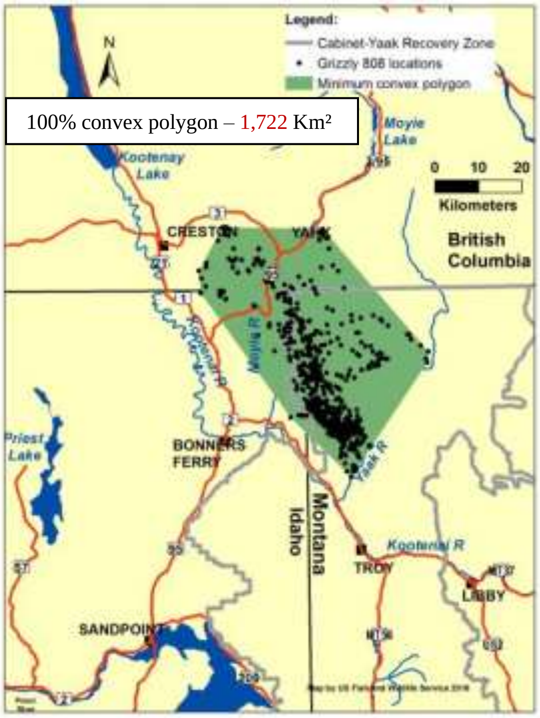


Figure A81. Radio locations and minimum convex (shaded) life range of male grizzly bear 808 in the Yaak River, 2014–2015.

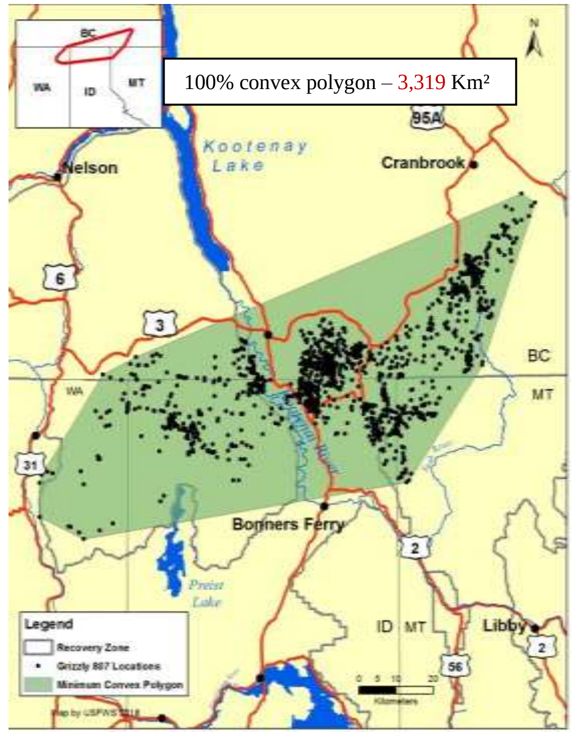


Figure A82. Radio locations and minimum convex (shaded) life range of male grizzly bear 807 in the Yaak River and Selkirk Mountains, 2014–2017.

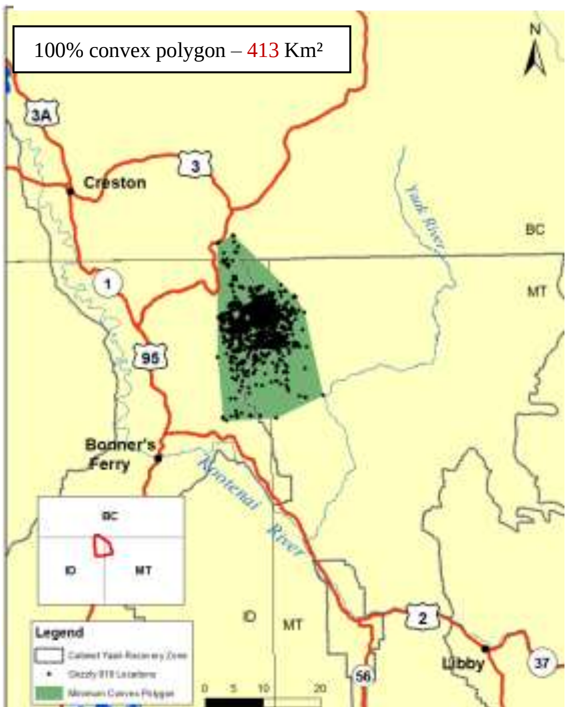


Figure A83. Radio locations and minimum convex (shaded) life range of female grizzly bear 810 in the Yaak River, 2015–2018.

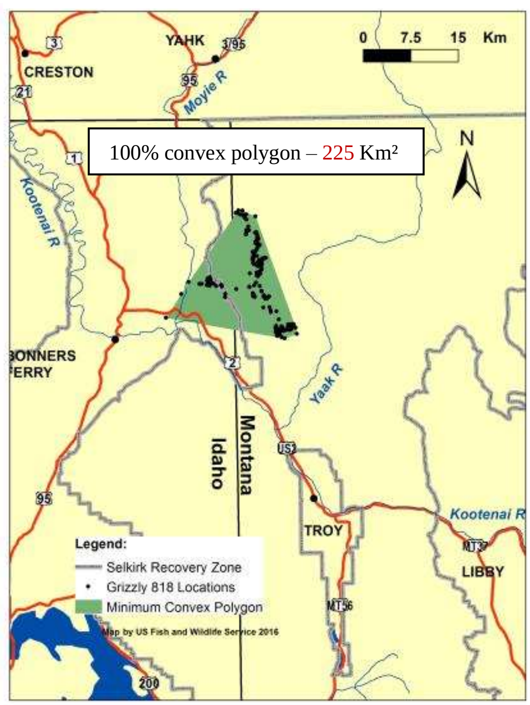


Figure A84. Radio locations and minimum convex (shaded) life range of male grizzly bear 818 in the Yaak River, 2015.

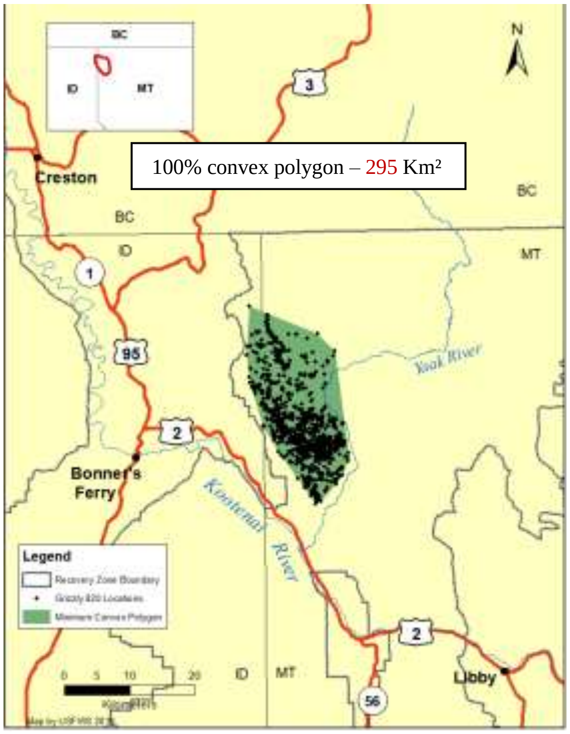


Figure A85. Radio locations and minimum convex (shaded) life range of female grizzly bear 820 in the Yaak River, 2015–2018.

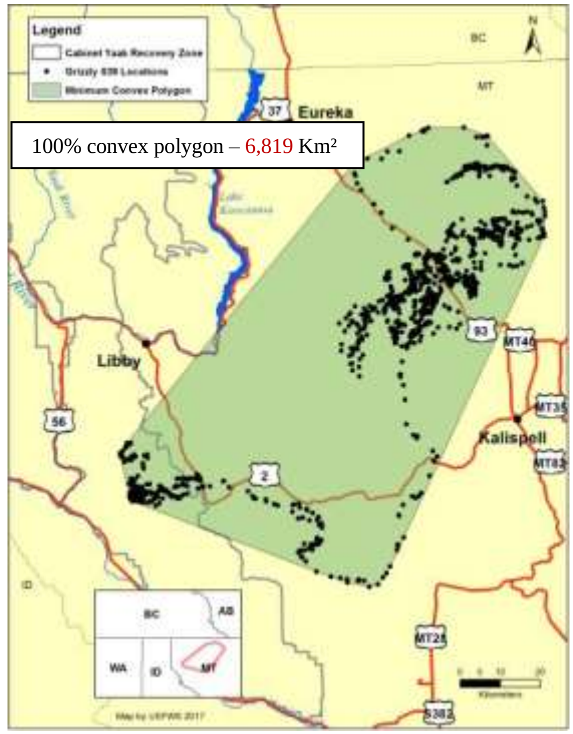


Figure A86. Radio locations and minimum convex (shaded) life range of male grizzly bear 839 in the Cabinet Mountains, 2015–2016.

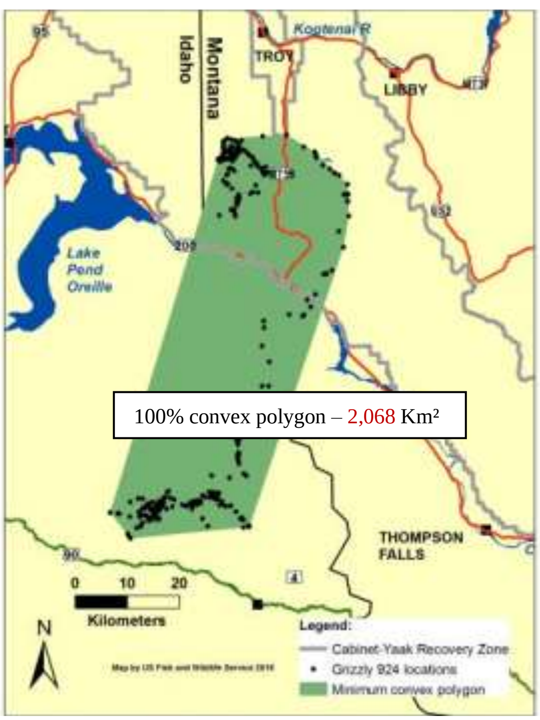


Figure A87. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 924 in the Cabinet Mountains, 2015.

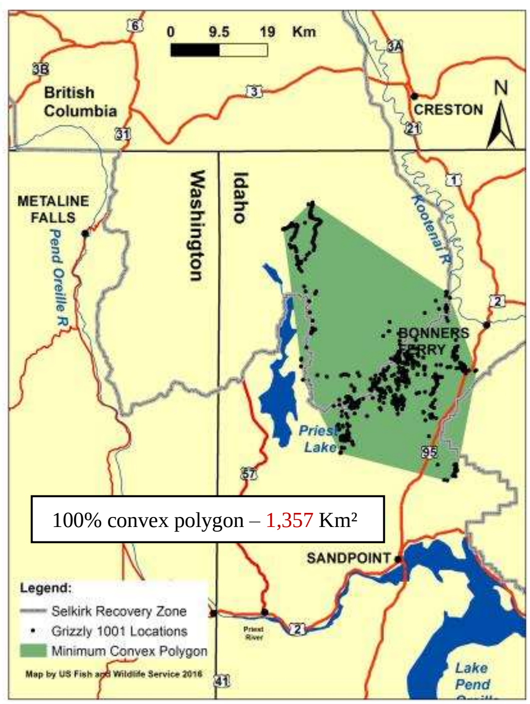


Figure A88. Radio locations and minimum convex (shaded) life range of male grizzly bear 1001 in the Selkirk and Cabinet Mountains, 2015.

Figure A89. Radio locations and minimum convex (shaded) life range of male grizzly bear 821 in the Yaak River, 2016–2017.

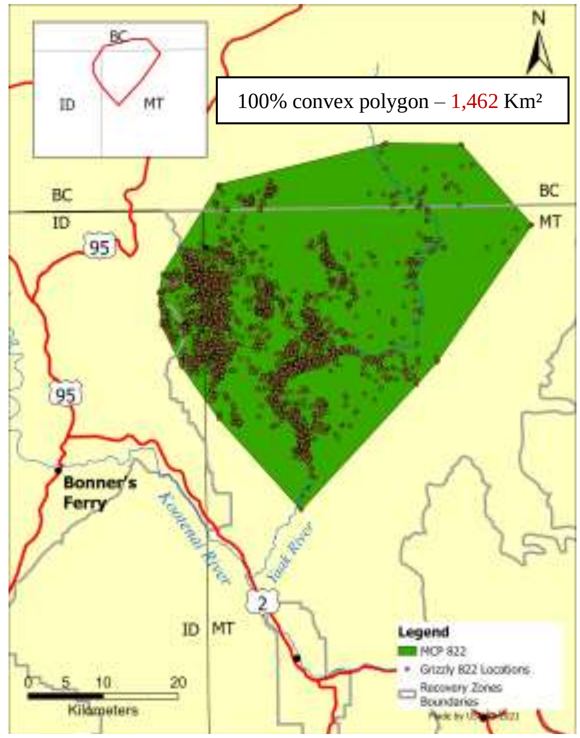


Figure A90. Radio locations and minimum convex (shaded) life range of male grizzly bear 822 in the Yaak River, 2016, 2019–2022.

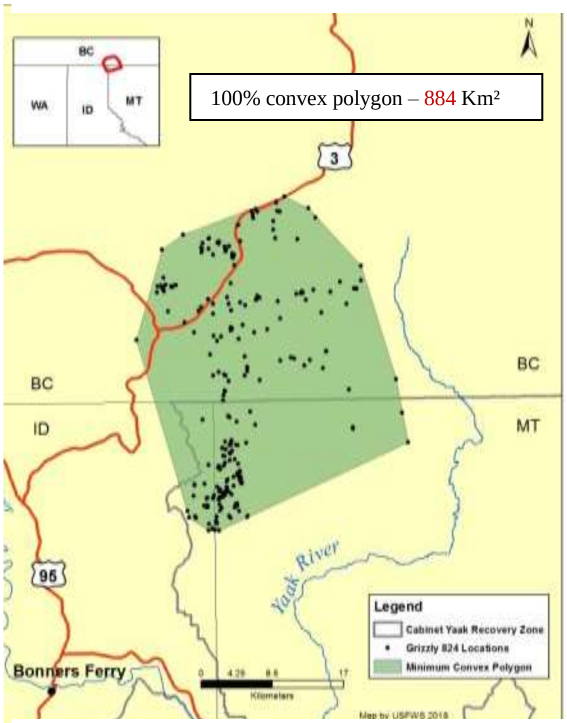


Figure A91. Radio locations and minimum convex (shaded) life range of male grizzly bear 824 in the Yaak River, 2016–2017.

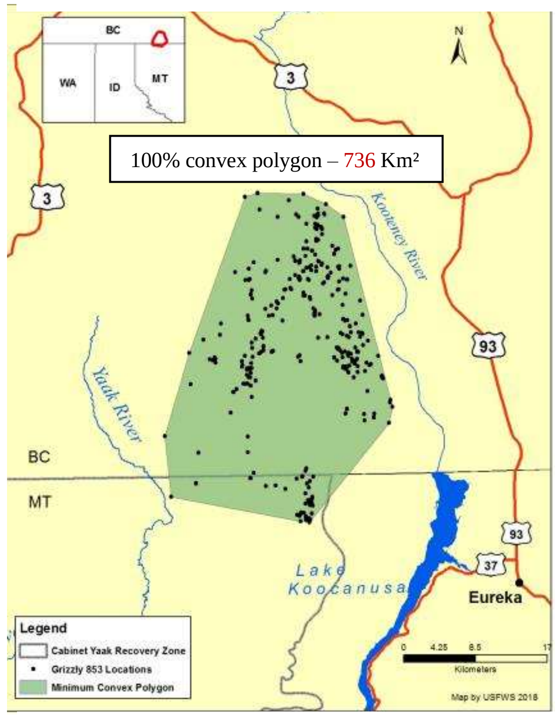


Figure A92. Radio locations and minimum convex (shaded) life range of male grizzly bear 853 in the Yaak River, 2016–2017.

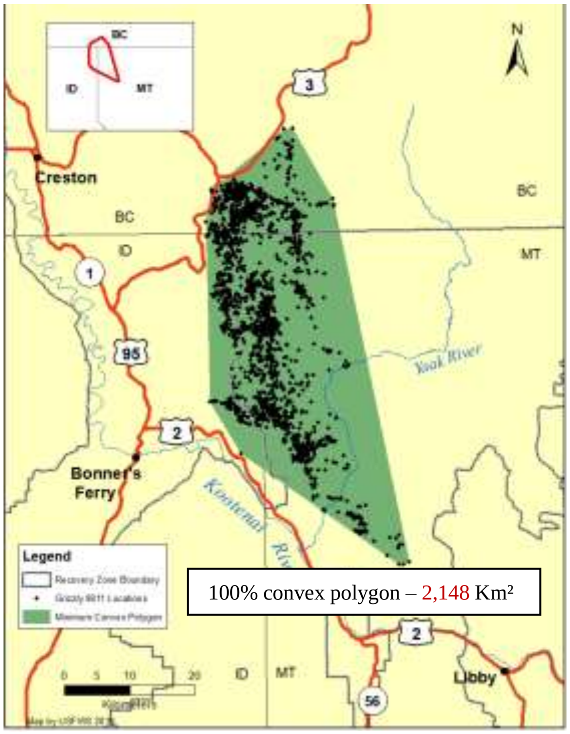


Figure A93. Radio locations and minimum convex (shaded) life range of male grizzly bear 9811 in the Yaak River, 2016–2018.

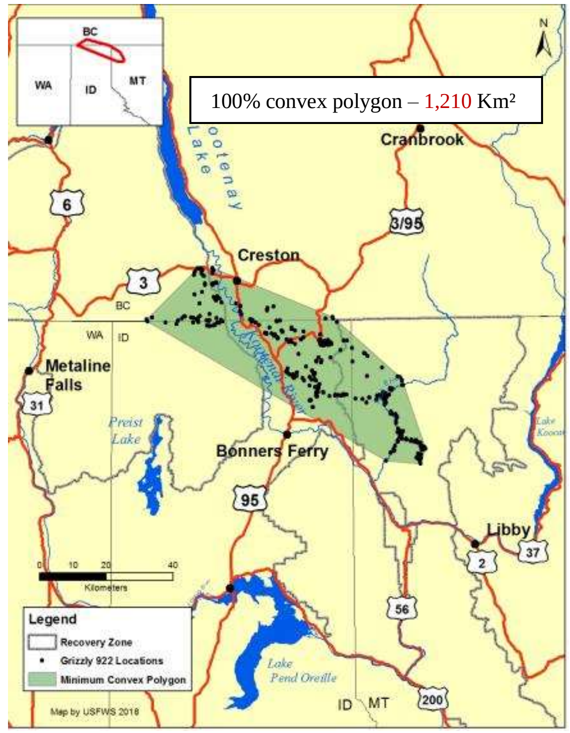


Figure A94. Radio locations and minimum convex (shaded) life range of male grizzly bear 922 in the Yaak River, 2016–2017.

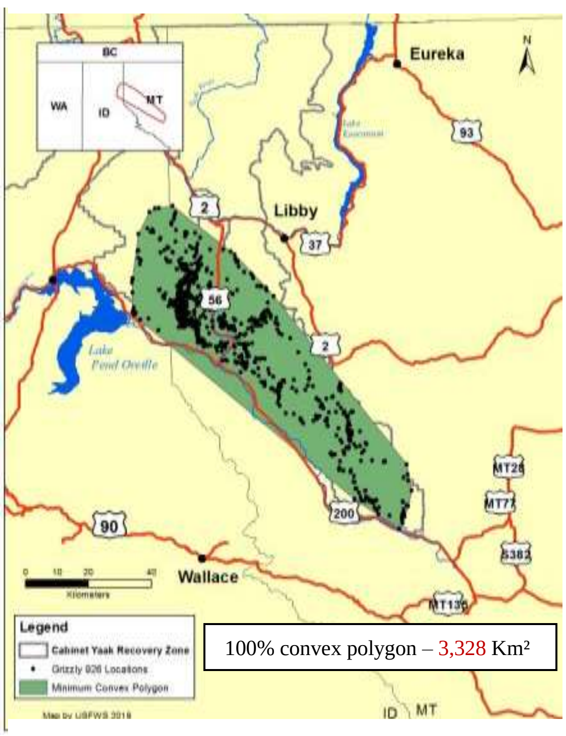


Figure A95. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 926 in the Cabinet Mountains, 2016–2017.

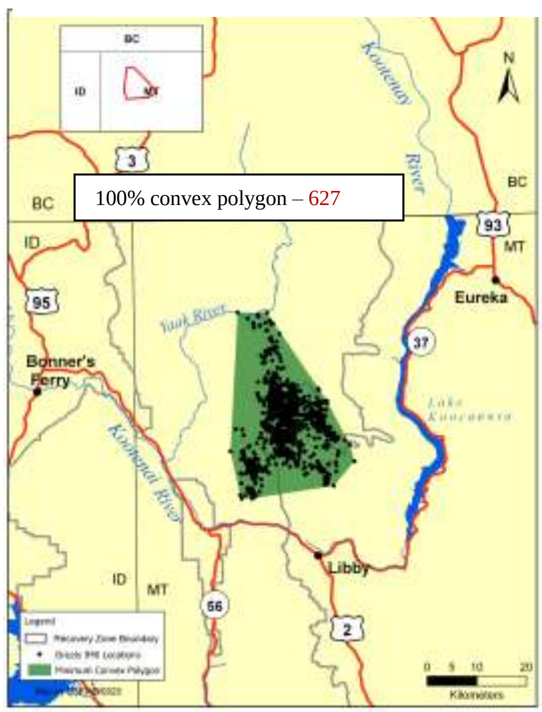


Figure A96. Radio locations and minimum convex (shaded) life range of female grizzly bear 840 in the Yaak River, 2016–2019.

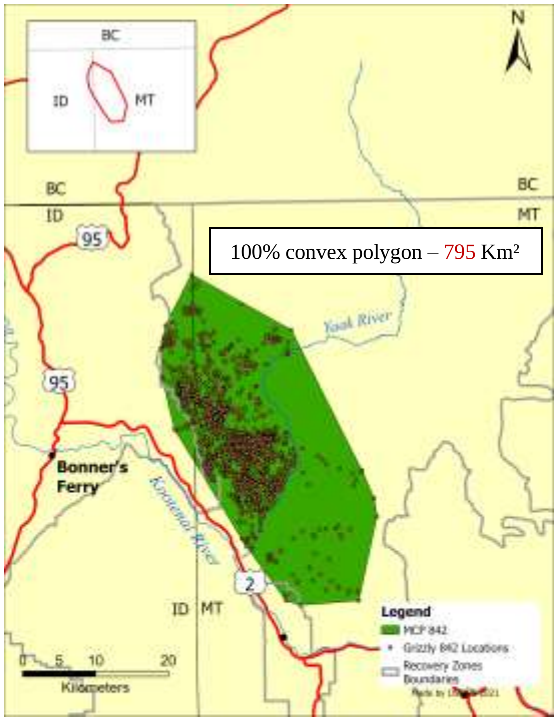
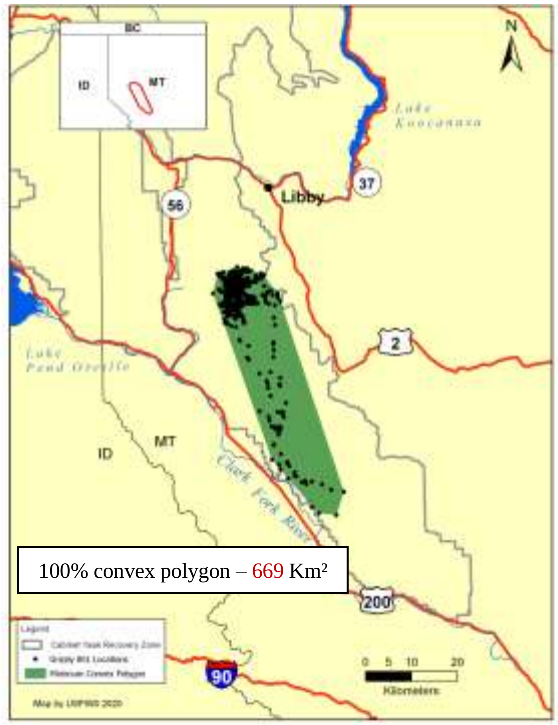


Figure A97. Radio locations and minimum convex (shaded) life range of female grizzly bear 842 in the Yaak River, 2017–2019, 2021-2022.



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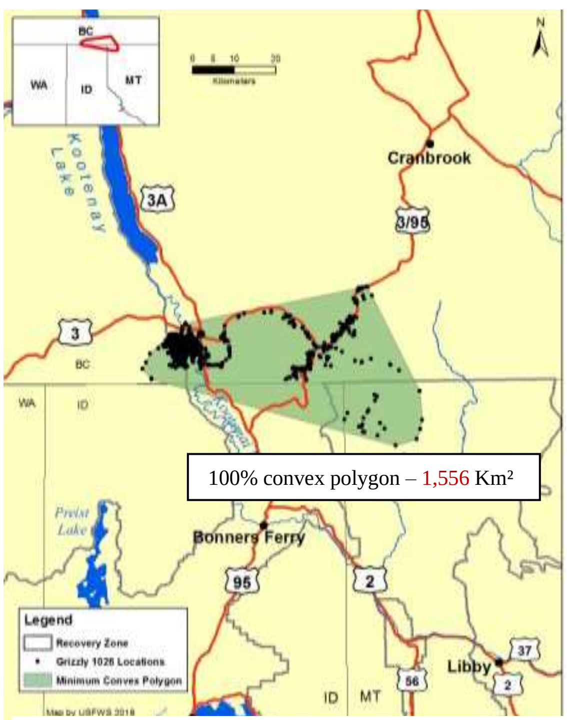

Figure A99. Radio locations and minimum convex (shaded) life range of management female grizzly bear 1026 in the Yaak River, 2017.

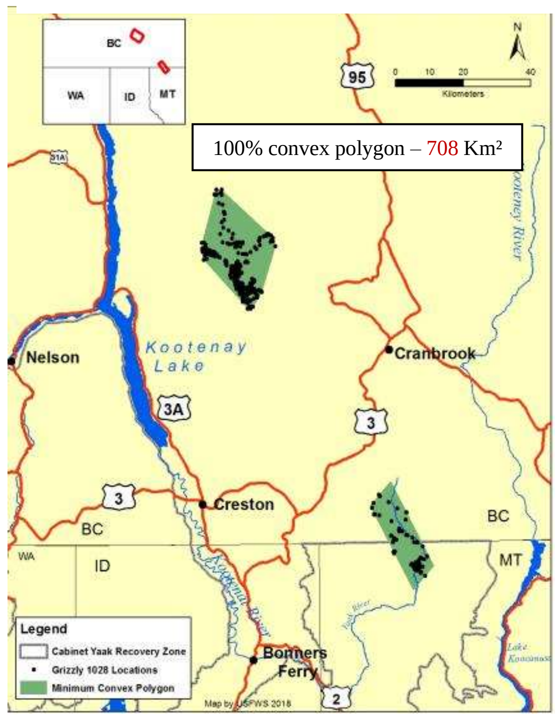

Figure A100. Radio locations and minimum convex (shaded) life range of management female grizzly bear 1028 in the Yaak River, 2017.

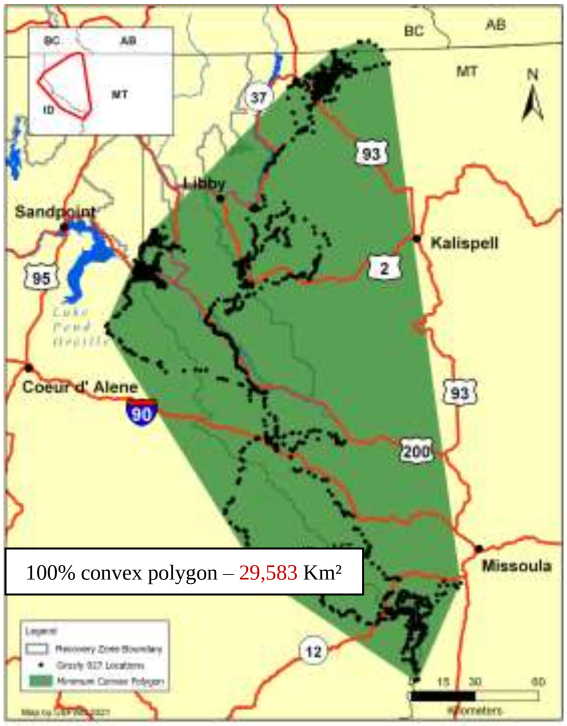

Figure A101. Radio locations and minimum convex (shaded) life range of augmentaiton male grizzly bear 927 in the Cabinet Mountains, 2018–2020

Figure A102. Radio locations and minimum convex (shaded) life range of male grizzly bear 1006 in the Selkirk, Purcell, and Cabinet Mountains, 2017–2018.

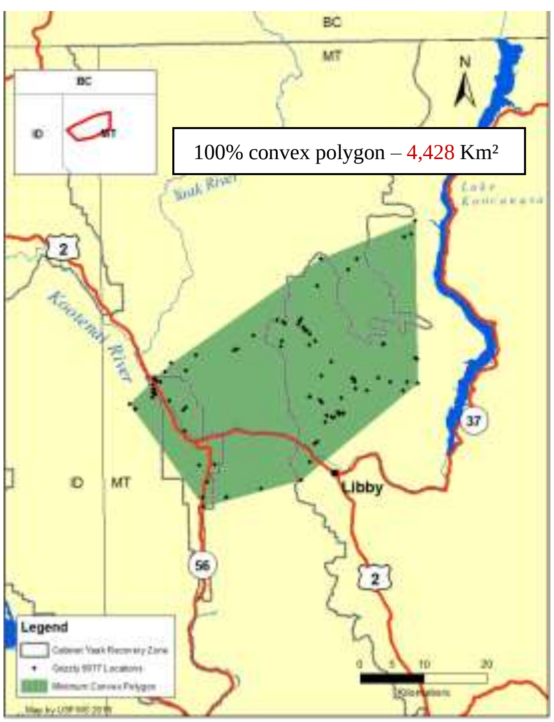

Figure A103. Radio locations and minimum convex (shaded) life range of management male grizzly bear 9077 in the Yaak River, 2018.

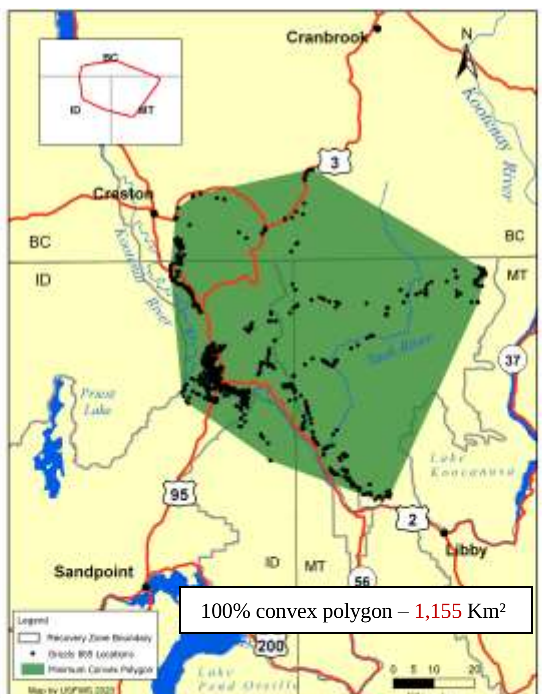

Figure A104. Radio locations and minimum convex (shaded) life range of management male grizzly bear 865 in the Kootenai and Yaak River, 2018–2019.

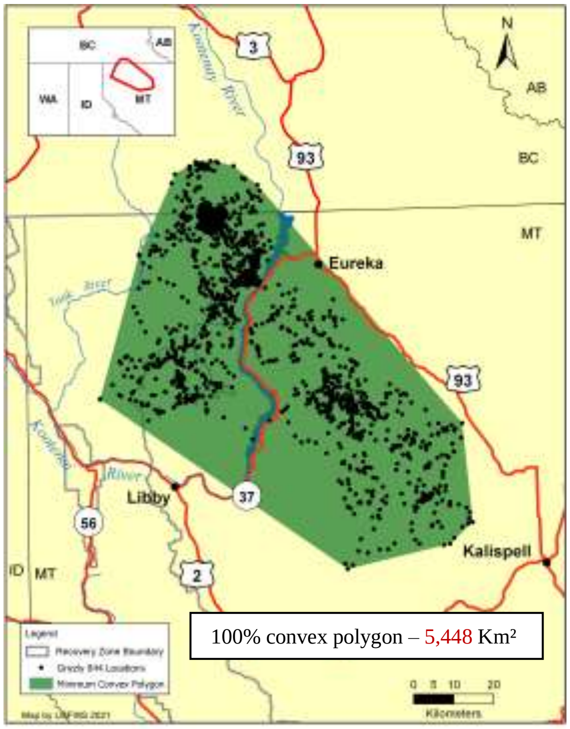

Figure A105. Radio locations and minimum convex (shaded) life range of augmentaiton male grizzly bear 844 in the Yaak River, 2019–2020.

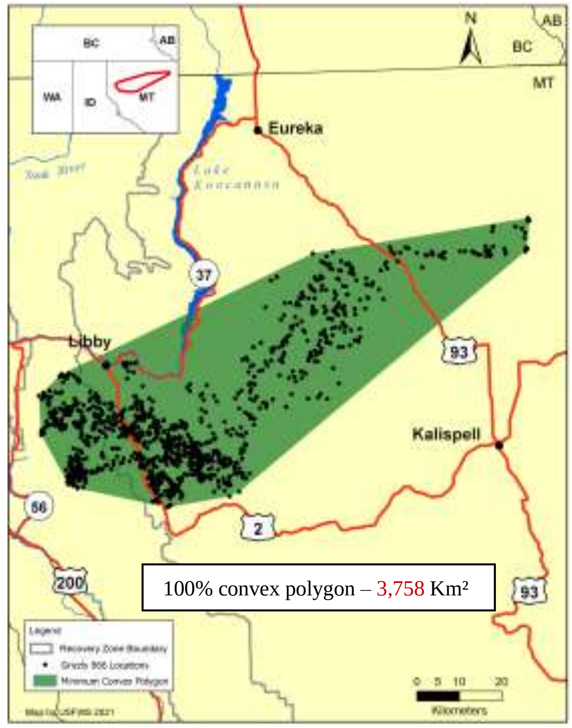

Figure A106. Radio locations and minimum convex (shaded) life range of male grizzly bear 866 in the Cabinet Mountains, 2019–2020.

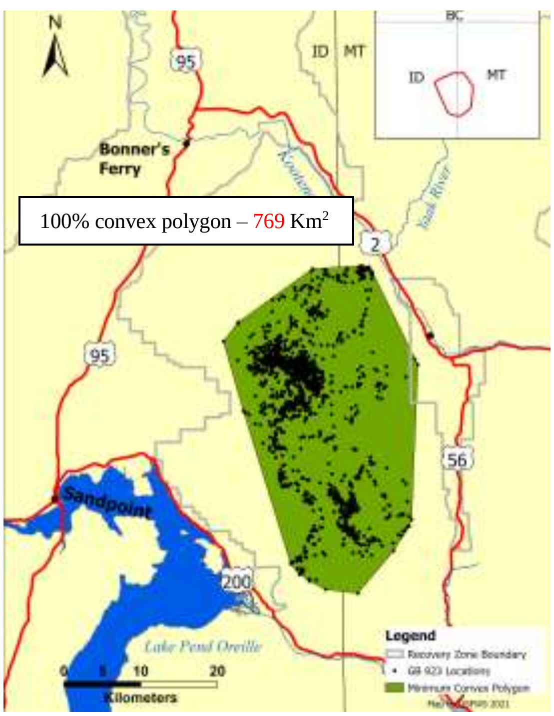

Figure A107. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 923 in the Cabinet Mountains, 2019–2021.

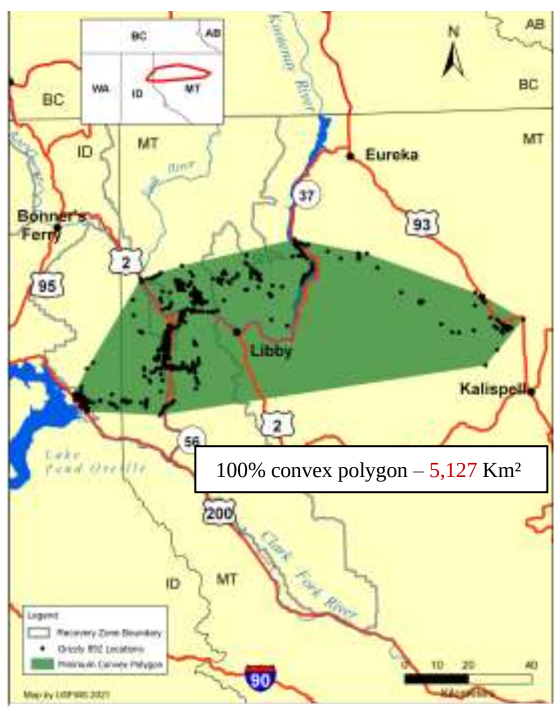

Figure A108. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 892 in the Cabinet Mountains, 2019–2020.

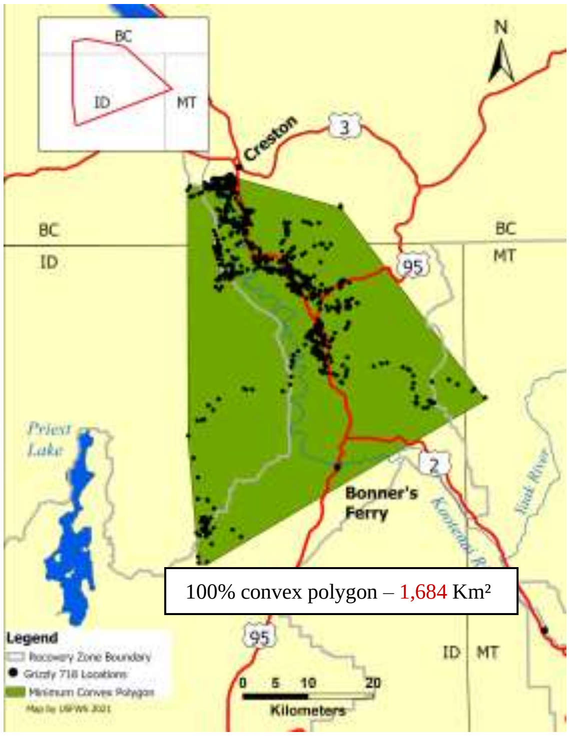

Figure A109. Radio locations and minimum convex (shaded) life range of male grizzly bear 718 in the Yaak River, 2021

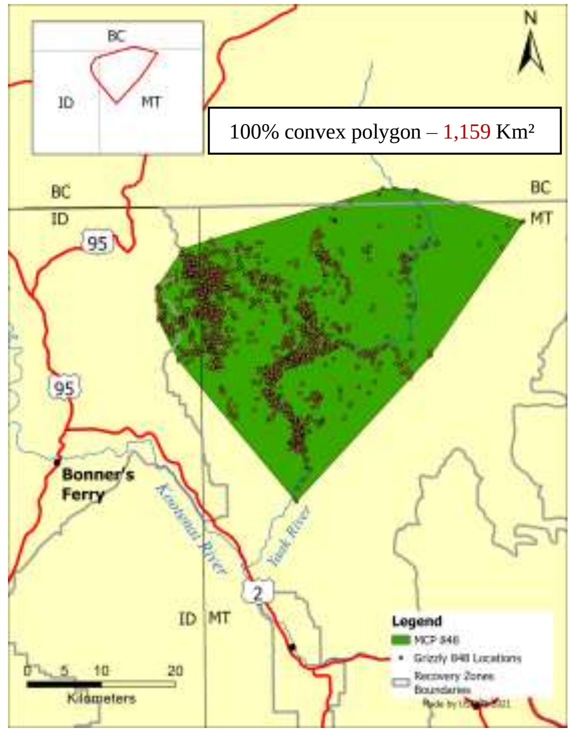

Figure A110. Radio locations and minimum convex (shaded) life range of male grizzly bear 848 in the Yaak River, 2021-2022.

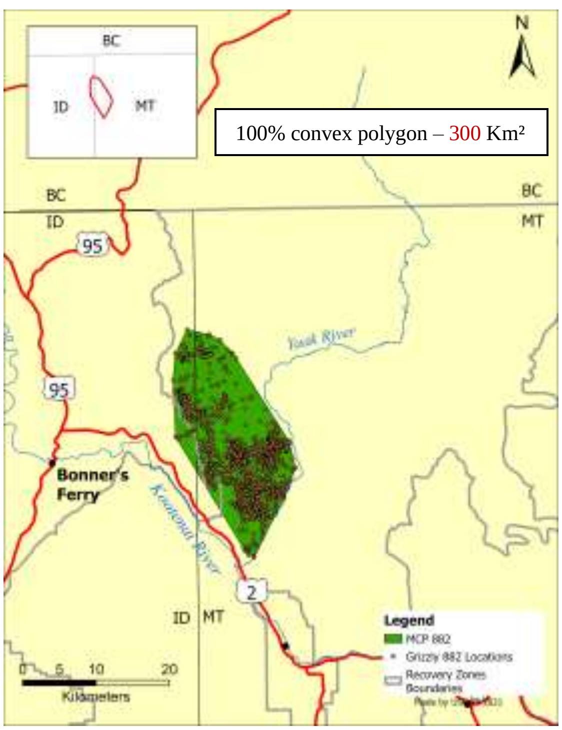

Figure A111. Radio locations and minimum convex (shaded) life range of male grizzly bear 882 in the Yaak River, 2021-2022.

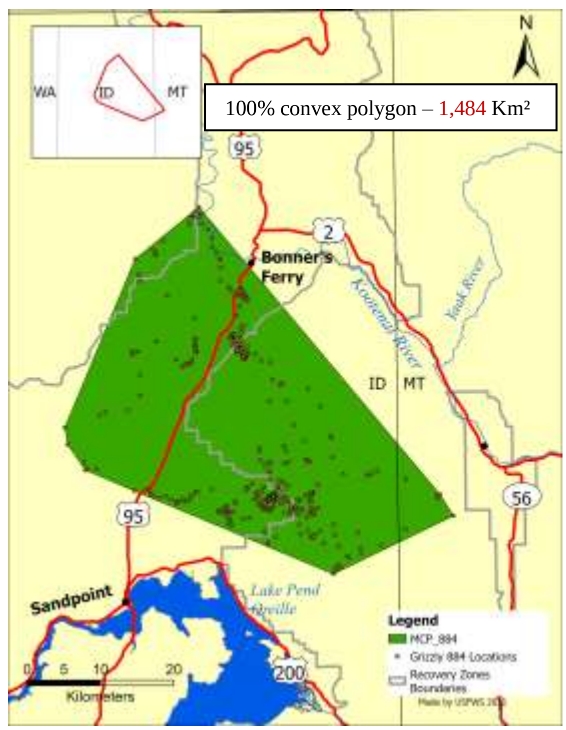

Figure A112. Radio locations and minimum convex (shaded) life range of male grizzly bear 884 in the Cabinet Mountains, 2021-2022.

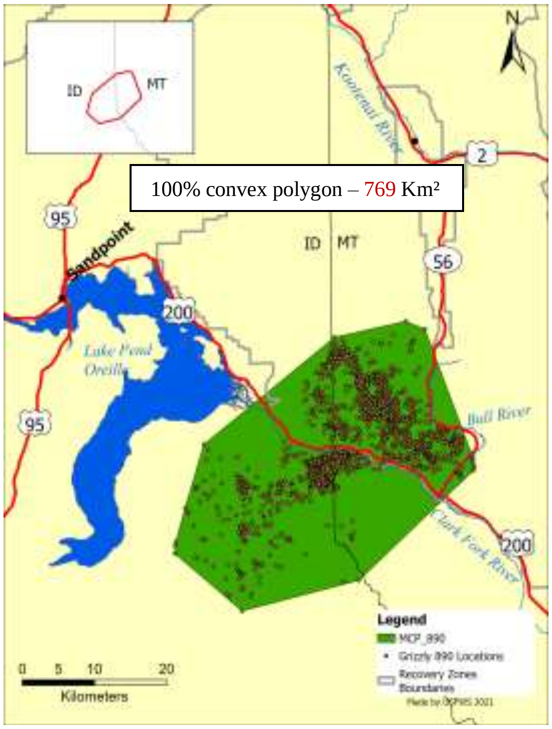

Figure A113. Radio locations and minimum convex (shaded) life range of feale grizzly bear 890 in the Cabinet Mountains, 2021-2022.

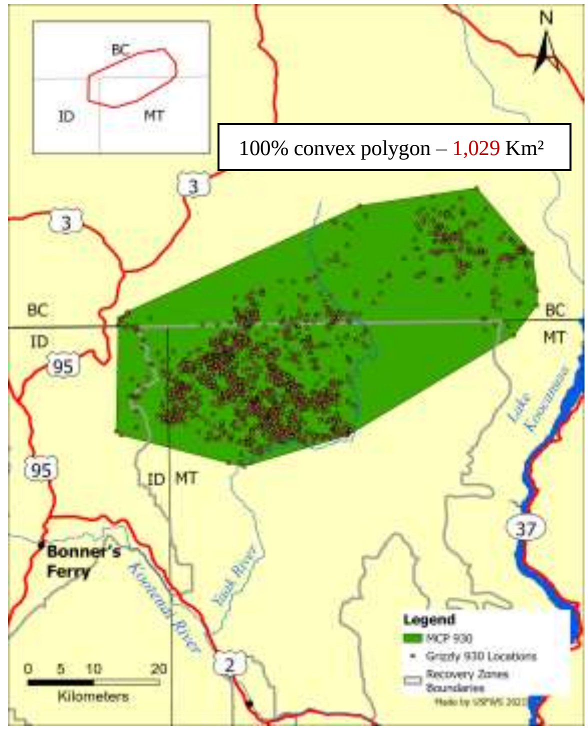

Figure A114. Radio locations and minimum convex (shaded) life range of male grizzly bear 930 in the Yaak River, 2021-2022.

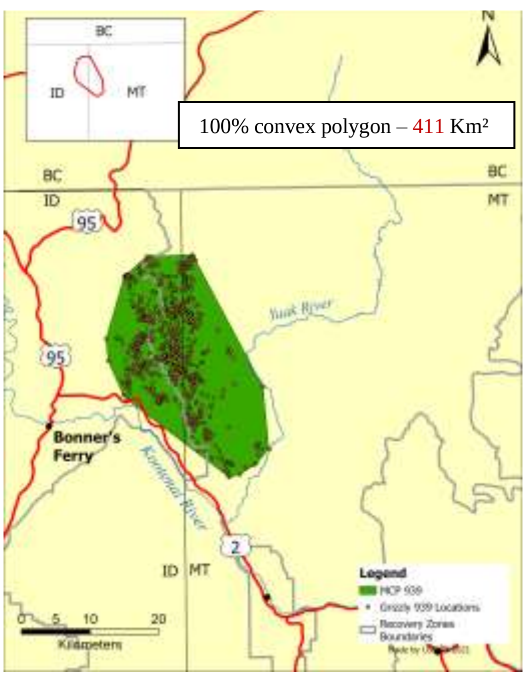

Figure A115. Radio locations and minimum convex (shaded) life range of female grizzly bear 939 in the Yaak River, 2021-2022.

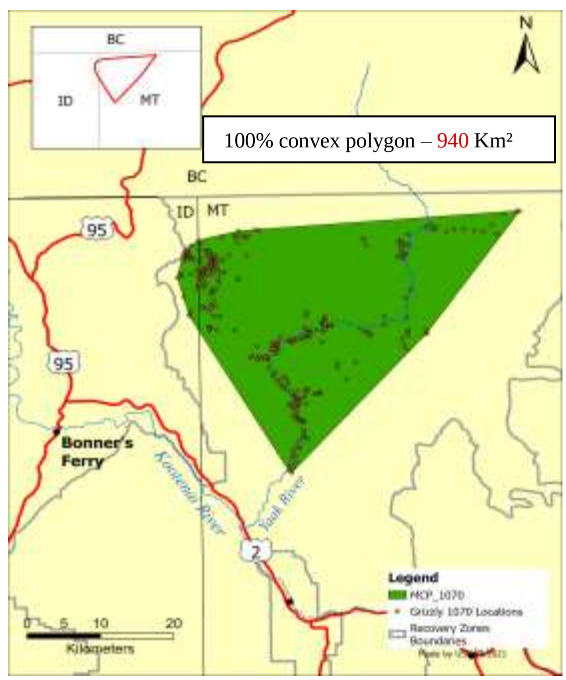

Figure A116. Radio locations and minimum convex (shaded) life range of female grizzly bear 1070 in Yaak River, 2022.

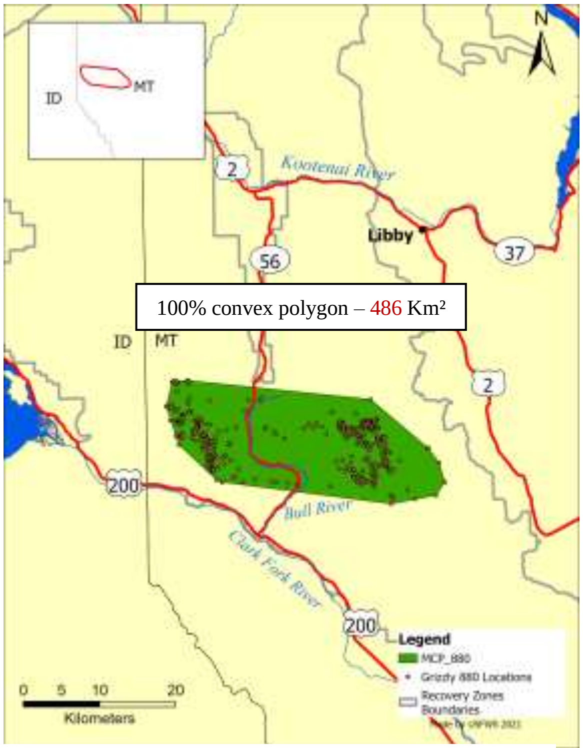

Figure A117. Radio locations and minimum convex (shaded) life range of male grizzly bear 880 in Cabinet Mountains, 2022.

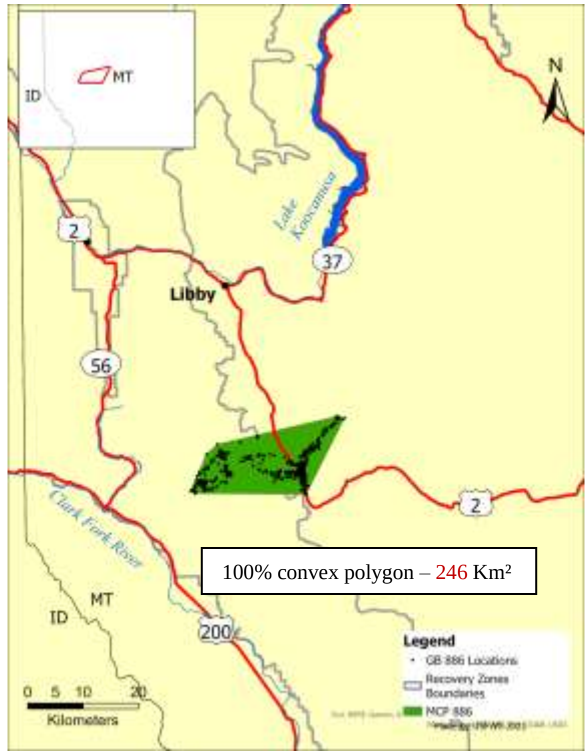

Figure A118. Radio locations and minimum convex (shaded) life range of female grizzly bear 886 in Cabinet Mountains, 2022.

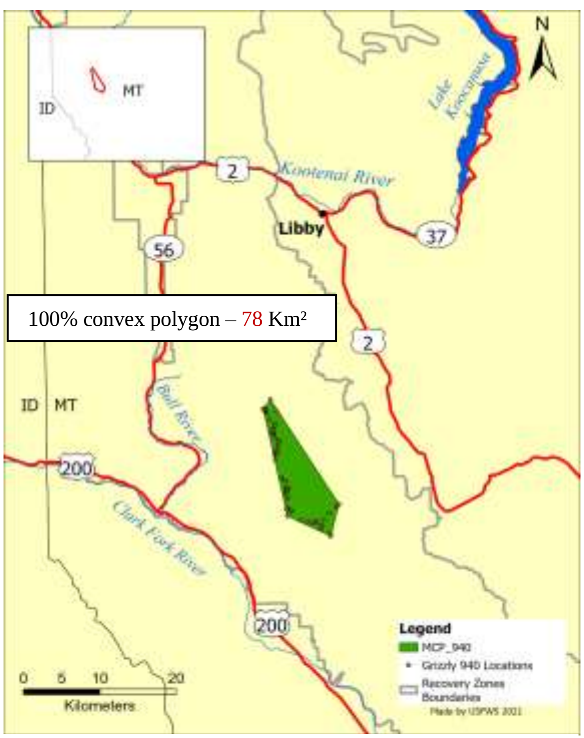

Figure A119. Radio locations and minimum convex (shaded) life range of male grizzly bear 940 in Cabinet Mountains, 2022.

APPENDIX 6. Fine scale habitat modeling for the South Selkirk and Cabinet-Yaak ecosystems

Trans-border Grizzly Bear Project and the US Fish & Wildlife Service
Michael Proctor TBGBP and Wayne Kasworm USFWS

BACKGROUND

This document describes the methods and appropriate interpretation for fine scale habitat modeling of sex-, season- and ecosystem-specific habitat use modeling for grizzly bears. We modeled habitat use for females and males, in each of 3 seasons (spring, summer, fall) in each of 4 ecosystems, South Purcells in Canada, the international South Selkirks and Yaak, and the US Cabinets. Here we present the female results. Females receive priority in grizzly bear conservation management because they are the reproductive engine of a population, they tend to have smaller home ranges and move significantly less than males. Management that secures important female habitat and food resources may be most efficient for conservation purposes. Males are important as well and, in some instances, can dominate the very best of food resources.

METHODS

We assessed habitat use for female and male bears separately at the scale of each of several ecosystems, including the South Selkirk (international), the Yaak (international), the Cabinets (USA) and the South Purcell (north of Hwy 3 in Canada). We modelled habitat in each of the 3 non-denning seasons (Spring, den emergence – July 14; Summer berry season, July 15 – Sept 15; and Fall, Sept 16 – October 30). Methods below are very similar to those employed by Proctor *et al*. 2015.

Grizzly bear GPS location data

We deployed GPS-telemetry collars on 38 female grizzly bears in 2004–2015 (22 in the international S Selkirks, 10 in the International Yaak and 6 in the Canadian South Purcells). Bears were captured with Aldrich foot snares and occasionally with culvert traps. We used Telonics Inc. (Mesa, Arizona, USA) Spread Spectrum radio-collars (and occasionally store-on-board collars) and remotely downloaded bear locations on a periodic basis.

Most bears were collared in May or June and were monitored for 1–3 years but usually monitoring spanned at least 2 non-denning periods (i.e., spring summer, fall). Locations were attempted every 1–4 hours depending on collar size (smaller bears carried smaller collars with less battery life), and age of bears (subadult bears carried collars designed to drop off earlier so as to not interfere with neck growth). Because we used only 2D and 3D fixes, overall fix success (the proportion of 2D and 3D fixes relative to fix attempts) was 84%. We also assessed potential location bias for canopy closure, which was the variable with the most potential for low fix success rate (Frair *et al*. 2004). We placed 13 GPS radio collars at ground level in conifer forest with canopy cover from 0 to 75% canopy and found no relationship between fix rate and canopy closure ($R^2 = 0.07$; regression significance, $P = 0.64$).

Because unequal observations among animals can lead to biased population level estimates (Gillies *et al*. 2006) and most bears had 1500–2000 locations, we used a maximum of 1600 locations from most bears by removing every n^{th} location from any one bear with > 1600 locations.

Grizzly Bear Habitat Modeling

Female grizzly bear GPS telemetry data were divided into 2 groups for each season and ecosystem. An 80% random sample was used for model training, while the remaining 20% random samples of bear locations were withheld for model evaluation (Boyce *et al*. 2002, Nielsen *et al*. 2002). We used the GPS telemetry locations and a similar number of available (random) locations from within the composite home ranges of all grizzly bears to develop a resource selection function (RSF, Boyce and McDonald 1999, Manly *et al*. 2002, Nielsen *et al*. 2002). We estimated the parameters of the exponential RSF using logistic regression (Manly *et al*. 2002) and predictions from the RSF were transformed using the logistic function to normalize the right skewing of exponential RSF values and then mapped at a 100-m scale in ArcGIS 10.1 (ESRI, Redlands, CA). Logistic regression was performed using the statistical software package STATA (Intercooled 9.2, College Station, Texas, USA).

Model building was based on the principles of Hosmer and Lemeshow (1989) and more recently referred to as purposeful selection of variables (Bursac *et al*. 2008). We did not use an Information Theoretic approach (Burhnam and Anderson 1998) because our goal was predictive ability of grizzly bear habitat use and not testing of broader competing hypotheses (Nielsen *et al*. 2010). All predictor variables were tested for pairwise correlations (Chatterjee *et al*. 2000) and only terrain ruggedness and compound topographic index were correlated. All variables and their quadratic relationships were fit individually (uni-variable analyses) and ranked for their significance and explanatory power (pseudo R^2). Multi-variable models were then built by adding non-correlated variables in a forward stepwise fashion starting from higher to lower pseudo R^2. Models were compared sequentially after each variable addition; variable significance and explanatory power (pseudo R^2) were used to compare models and decide if a variable improved model predictability. When a variable increased the pseudo R^2 by at least 5%, we retained that variable in the model; when a variable increased the pseudo R^2 < 5% we did not retain it to favor a parsimonious model.

We used the Huber-White sandwich estimator in the robust cluster option in Stata to calculate standard errors because non-independent locations can lead to biased standard errors and overestimated significance of model parameters (White 1980, Nielsen *et al*. 2002, 2004b). Because the bears were the unit of replication, they were used to denote the cluster thus avoiding autocorrelation and/or pseudoreplication of locations within individual bears. We assessed the Receiver Operator Characteristic (ROC), a standard technique for summarizing classifier performance (i.e., how well did the model predict habitat and non-habitat correctly) for our most parsimonious models.

Environmental Variables

We used variables that were most consistently measured across the study area and between Canada and the USA including human-use, terrain, forest cover, and other ecological variables (Table 1). Ecosystem characteristics and human uses in the adjacent south Selkirk and south Purcell Mountains are similar (Meidinger and Pojar 1991) allowing development and prediction of models to these areas. Lowlands are dominated by Cedar-Hemlock (*Thuja plicata - Tsuga heterophylla*) forests and upland forests are dominated by Engelmann Spruce - Sub Alpine Fir (*Picea engelmanni – Abies lasiocarpa*). Douglas fir (*Psuedotsuga mensiezii*) forests are somewhat more common in the southern portions of the Purcell range (Meidinger and Pojar 1991). Human uses are relatively similar across the region and include timber harvest, some mining, ungulate hunting, and other forms of recreation.

Baseline Thematic Mapping land-cover variables (recently logged, alpine, avalanche, and riparian), Vegetation Resource Inventory variables (dominant tree species forest cover types, canopy cover), and backcountry resource roads (i.e., associated with timber harvest, mining) were obtained from the BC Ministry of Forests, Lands, and Natural Resource

Operations in Canada. Land-cover information for the USA was from the US Forest Service. Alpine, avalanche, burned, and riparian habitats contain a variety of grizzly bear food resources (Mace *et al*. 1996, McLellan and Hovey 1995, McLellan and Hovey 2001b). Forest cover variables (Table 1) were used because they often have been found to influence grizzly bear habitat selection (Zager *et al*. 1983, Waller and Mace 1997, Apps *et al*. 2004, Nielsen *et al*. 2004a). Greenness, an index of leafy green productivity, correlates with a diverse set of bear food resources and is often found to be a good predictor of grizzly bear habitat use (Mace *et al*. 1996, Nielsen *et al*. 2002). Greenness was derived from 2005 Landsat imagery using a Tassled Cap transformation (Crist and Ciccone 1984, Manley *et al*. 1992). Terrain variables of elevation, compound topographic index (CTI), solar radiation, and terrain ruggedness were derived from a digital elevation model (DEM) in ArcGIS. CTI is an index of soil wetness estimated from a DEM in a GIS using the script from Rho (2002). Solar radiation was estimated for the summer solstice (day 172), again using a DEM, and in this case the ArcInfo AML from Kumar (1997) that was modified by Zimmerman (2000) called shortwavc.aml. Finally, terrain ruggedness was estimated from the DEM based on methods from Riley *et al*. (1999) and scripted as an ArcInfo AML called TRI.aml (terrain ruggedness index) by Evans (2004). These terrain variables have been shown to influence the distribution of grizzly bear foods (Apps *et al*. 2004, Nielsen *et al*. 2004a, 2010) and also affect local human use. We included elevation as a variable because grizzly bears in our region use high country extensively, which may be for a variety of reasons (e.g., high elevation habitat types, thinner forest cover with more edible ground-based vegetation, human avoidance). Highway and human developments were digitized from 1:50,000 topographic maps and ortho-photos. Highway, human developments, and backcountry roads were buffered by 500 m on either side to reflect their influence on grizzly bear habitat use (Mace *et al*. 1996). The human-use variables have been demonstrated repeatedly to correlate with habitat selection by grizzly bears (Mace *et al*. 1996, 1999, Nielsen *et al*. 2002, Apps *et al*. 2004). Although none of the predictors were direct measures of food resources or human activities, each factor was thought to correlate with resources and behaviors used by bears or activity of humans (Mace *et al*. 1996, Nielsen *et al*. 2002, 2006, 2009, Apps *et al*. 2004).

RESULTS

Best models for each season and ecosystem were dominated by greater than expected use for canopy openness and high level of greenness and less than expected use of high road densities (Table 1). Model predictive ability was greatest in the International South Selkirk area in all 3 seasons, as predictions of habitat use and non-use were all > 0.8 (ROC, Receiver Operator Characteristic measures how well the model predicts habitat use GPS Locations that were in model predicted use areas vs non-used areas). Because we had very few resident females in the Cabinet population, most were augmented bears from the Rocky Mt region, and the ecology is similar to the S Selkirk region (Proctor *et al*. 2015), we applied our South Selkirk model to the Cabinet area. These models are similar to the all-season both-sex Resource Selection Function model derived to predict linkage habitat within Proctor *et al*. (2015). That model was dominated by canopy openness, greenness, riparian, alpine, and elevation.

In the S Selkirk, S Purcell, and Cabinet area, our models were the most predictive with ROC scores usually > 0.75 and even > 0.80 (0.7 is considered a good predictive model). Models for the international Yaak were less predictive, especially in spring and fall (ROC scores were 0.66 and 0.59 respectively).

Where we had a huckleberry patch model available in the South Purcell area of Canada, it dominated the model along with greenness. We have a huckleberry patch model throughout this region within Canada. Therefore, we did not include it in international models in the S Selkirk, Yaak, or Cabinet areas. Canopy openness is a powerful predictor of huckleberry patches and in models without huckleberry patches, canopy openness plays a similar predictive role.

DISCUSSION

We envision the usefulness of these habitat models for planning timber harvest, road building, road closing, road decommissioning, and prescribed burns. As canopy openness and greenness are two of the better predictors of female habitat use (Mace *et al*. 1996, Nielsen et al. 2002), certain timber harvest and prescribed burning practices may have some potential to improve grizzly bear habitat through opening canopy and promoting deciduous and herbaceous bear foods. In contrast, it might be desirable to plan access controls in areas where habitat quality and use is high, to provide security for female grizzly bears. In that regard, these models may be used to decide where roads might be closed, decommissioned, or left open.

It must also be kept in mind that grizzly bear habitat is dynamic spatially and temporally. Some open-canopy habitats that resulted from past timber harvest may change over time as those canopies fill in with forest regrowth. The same applies to habitat created from past burns. Also, some habitat may have a longer-term state of canopy openness (some higher elevation forests) that may remain desirable over longer time periods. Foresters' on-the-ground knowledge may be able to differentiate these types of habitats and their dynamic potential. Future iterations of these models can be run with updated canopy cover and greenness layers as they are derived from remote sensing.

Note that Riparian habitat was a strong predictor in the South Selkirk (and Cabinet) model. This result was driven by the heavy use of female grizzly bears in the Kootenay River Valley just north of the Canada-US border in the Creston Valley in all 3 seasons. If populations continue to grow, the Kootenay River Valley or other main river valleys may see some increased habitat use by female grizzly bears at least seasonally within the US. We also think that the bears in the Creston Valley are getting a measure of agricultural foods that might be holding them in the valley even in the summer. In Canada and the US, there are developing programs to secure many of these agricultural products from the bears, but it may never all be secured and there will tend to be some bears spending time in these valley bottoms. On the other hand, this is somewhat desirable from the standpoint of female connectivity between the Selkirk and Purcell and Cabinet ranges (Proctor *et al*. 2012, 2015). Subadult female dispersal is usually of a short distance (McLellan and Hovey 2001, Proctor *et al*. 2004) so for female connectivity to develop, it is likely necessary that female grizzly bears spend a portion of their lives in valley bottoms. Conflict reduction efforts become especially important in that regard.

As we modeled each ecosystem separately, thresholds between ecosystems varied. Model outputs have ecosystem-specific thresholds for greater than expected use of specific habitats vs. less than expected use built in. For most planning we would expect use of the summer models or occasionally the spring models. Fall modeling probably represents a time when berry feeding has passed, and bears may be preparing for denning by looking for protein in the form of wounded animals and gut piles from hunters.

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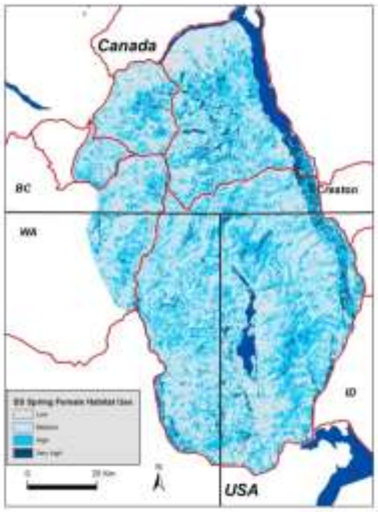
Table 1. Best female grizzly bear seasonal habitat use models for the Selkirk, S Purcell, Yaak, and Cabinet ecosystems. Huckleberry patch models were only available in the S Purcell area.

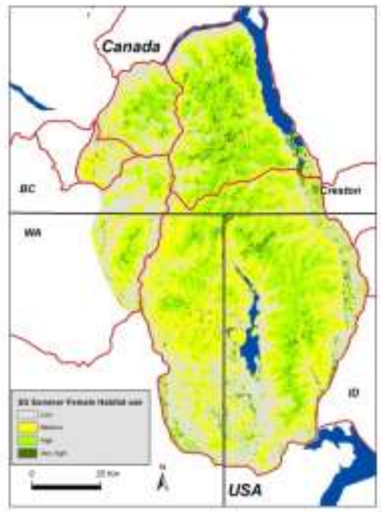
	Female	Female	Female	Female	Female	Female	Female	Female	Female	Female	Female	Female	Female	Female	Female
	Selkirk	Selkirk	Selkirk	Yaak	Yaak	Yaak	Cabinet	Cabinet	Cabinet	Purcell	Purcell	Purcell	Canada	Canada	Canada
VARIABLES	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall
canopy cover	-	+	+	-	+	+	-	+	+	+			-		
canopy cover^2		-	-		-	-		-	-						
greenness	+	+	+		+		+	+	+	+	+	+	+	+	+
road density	-	-	-	-			-	-	-				-	-	-
riparian	+	+	+				+	+	+					+	
forest age 100-250											-	-			
forest age 1-20					+										
forest age 20-60						-									
forest age 60-80											+				
alpine					+	+						+		+	+
avalanche	+						+						+		
deciduous forest				+	+	+				+					
elevation		+	+	+	+			+	+						
elevation^2			-	-	-				-						
Douglas fir forest			-	+					-						-
distance to road											+				
buildings				-	-										
distance to HuckPatch											-			-	-
HuckPatch X Dist2Road															+
highway			-			-			-						-
mortality risk				-								-			+
recently logged			-						-		-	-			
solar radiation										+		+			
terrain ruggedness										+				-	-
Pseudo R2	0.20	0.25	0.26	0.06	0.18	0.03	0.20	0.25	0.26	0.20	0.32	0.11	0.13	0.25	0.15
ROC AUC	0.80	0.82	0.83	0.66	0.78	0.59	0.80	0.82	0.83	0.79	0.86	0.73	0.75	0.82	0.80
Correct classified	73%	74%	80%	61%	70%	56%	73%	74%	80%	72%	78%	65%	74%	75%	76%

Figure 1a) Spring, b) Summer, and c) Fall female grizzly bear Habitat Use map.

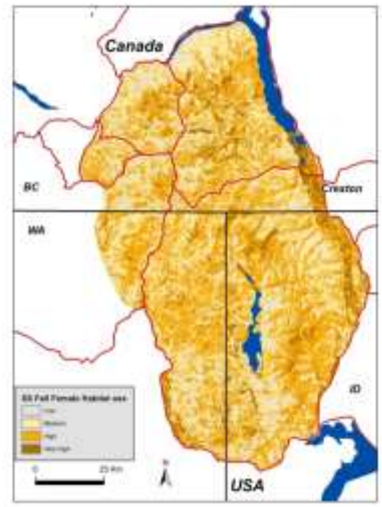
a) S Selkirks Spring



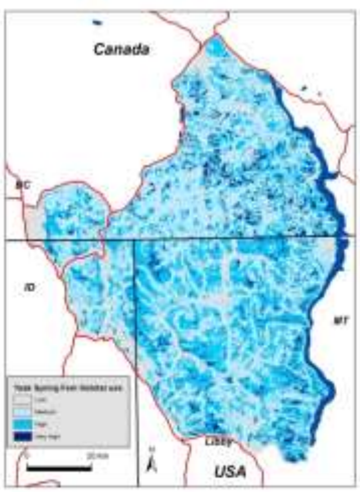
b) S Selkirks Summer



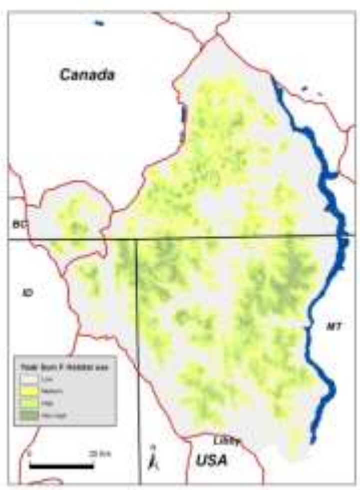
c) S Selkirks Fall



a) Yaak Spring



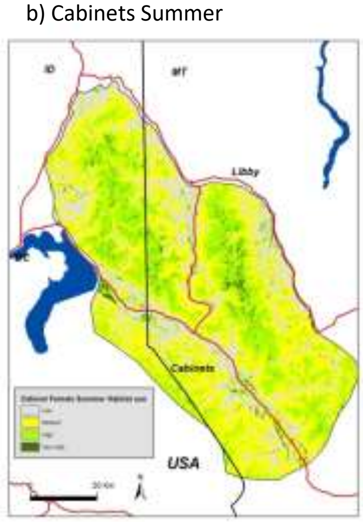
b) Yaak Summer



c) Yaak Fall

a) Cabinets Spring

b) Cabinets Summer



c) Cabinets Fall