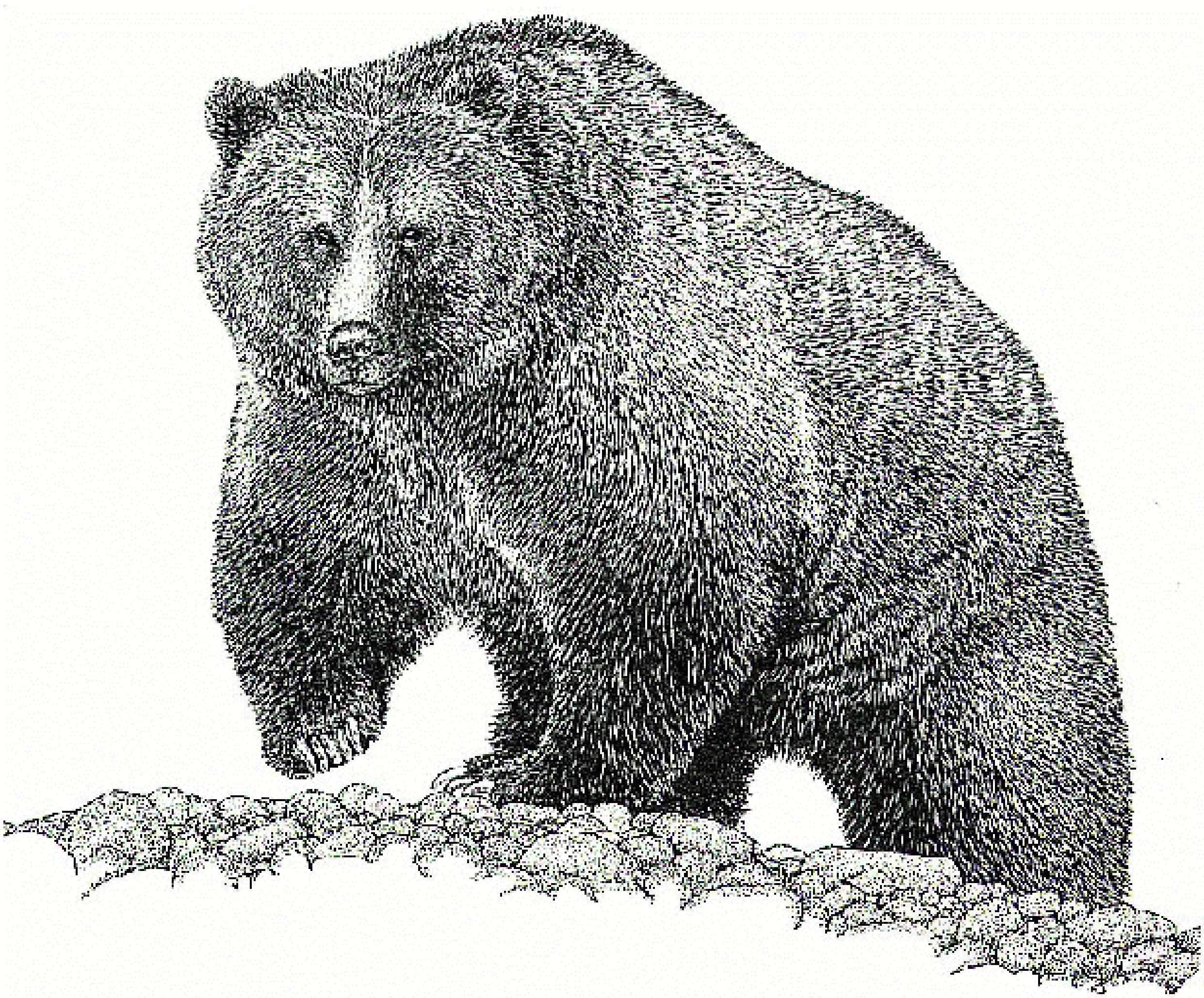
CABINET-YAAK GRIZZLY BEAR RECOVERY AREA 2015 RESEARCH AND MONITORING PROGRESS REPORT



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Abstract:

Grizzly bear 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 and moved to the Cabinet Mountains for release during 1990–94. Three of four transplanted bears remained within the target area for at least one year. Hair snag sampling and DNA analysis during 2000–04 identified one of the original transplanted bears. The animal was a 2 year-old female when released in 1993. Genetic analysis conducted in 2005 identified at least 3 first generation offspring and 2 second generation offspring from this individual. The success of the augmentation test program prompted additional augmentation in cooperation with Montana Fish Wildlife and Parks. Nine female bears and 5 male bears were moved from the Flathead River to the Cabinet Mountains during 2005–15. Three of these individuals died during their first year from human related causes. Two were illegally shot and one was struck by a train. Five bears left the target area for the augmentation effort. Research and monitoring in the Yaak River began in 1986. Sixty-two resident bears have been captured and monitored through telemetry in the Cabinet Mountains and Yaak River, 1986–2015.

Numbers of females with cubs in the Cabinet-Yaak grizzly bear recovery zone (CYGBRZ) varied from 1–4 per year and averaged 2.5 per year from 2010–15. Human caused mortality averaged 1.8 bears per year and 0.2 females per year from 2010-15. Eleven known or probable human caused mortalities of native grizzly bears have occurred in or within 10 miles of the CYGBRZ in the U.S. during 2010–15. Human caused mortalities during 2010–15 were one adult female (human, under investigation), 5 adult males (three human, under investigation, one bear mistaken as a black bear, and a self-defense), 4 subadult males (black bear mistaken identity, two self-defense, and one poaching), and one male cub (human, under investigation).Twelve of 22 bear management units had sightings of females with young during 2010–15.

One hundred seventy-six individuals were identified within the Cabinet-Yaak study area with 157 bears captured or genotyped and 20 unmarked individuals observed from 1983–2015. Sixty-eight of these animals are known or suspected to have died. Human causes were linked to 48 of these mortalities. Nineteen were believed to have died of natural causes. Mortality causes, timing, and locations were analyzed for 1983–2015. Sex and age specific survival and reproductive rates were updated and reported. The estimated finite rate of increase (λ) for 1983–2014 using Booter software with the unpaired litter size and birth interval data option was 1.011 (95% C.I. 0.924–1.084). Finite rate of change in the population was an annual 1.1% for the period. Subadult female survival and adult female survival accounted for most of the uncertainty in λ. The probability that the population was stable or increasing was 61%.

Capture, monitoring, and habitat use data were updated and reported for 1983–2015. Berry counts indicated markedly less than average production for huckleberry, serviceberry, buffaloberry, and mountain ash during 2015.

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). Seven areas were identified in the Recovery Plan, one of which was the Cabinet-Yaak Grizzly Bear Recovery Zone (CYGBRZ) of extreme northwestern Montana and northeast Idaho (Fig. 1). This area lies directly south of Canada and encompasses approximately 6800 km^2. The Kootenai River bisects the CYGBRZ, 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 is unknown but thought to be minimal.

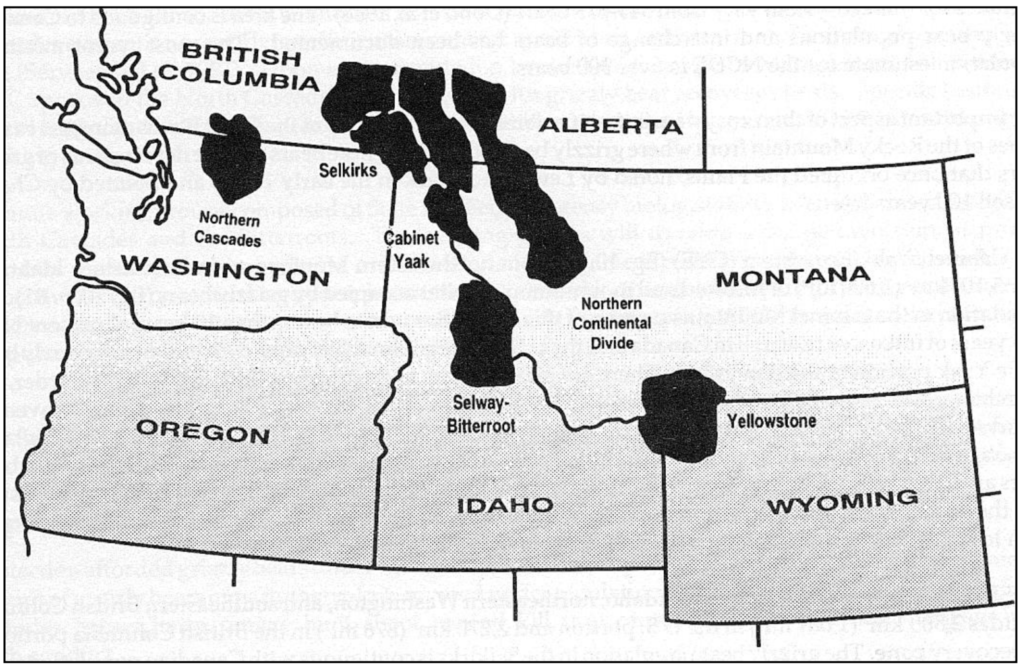


Figure 1. Grizzly bear recovery areas in the U.S., southern British Columbia, and Alberta, Canada.

Research on native 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 CYGBRZ. 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 CYGBRZ. 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 grizzlies using the area, the U.S. Forest Service and Montana Department of Fish, Wildlife, and Parks (MFWP) cooperated with the U.S. Fish and Wildlife Service in initiating a long term study. Field work began in June of 1989.

OBJECTIVES

A. Cabinet Mountains Population Augmentation:

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

B. Recovery Zone Research and Monitoring:

1. Document grizzly bear distribution in the Cabinet/Yaak Grizzly Bear Ecosystem.
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 habitats affected by man 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 CYGBRZ (48^{o} N, 116^{o} W) encompasses approximately 6,800 km^2 of northwest Montana and northern Idaho (Fig. 2). The Cabinet Mountains constitute about 58% of the CYGBRZ 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. However, we have yet to document any grizzly bear movement between these areas or grizzly bear use within these linkage zones. Approximately 90% of the recovery area is on public land administered by the Kootenai, Lolo, and Panhandle National Forests. Plum Creek Timber Company Inc. and Stimson Corp. are the main corporations 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, Libby, Noxon, Sandpoint, Troy, Thompson Falls, and Trout Creek are the primary communities adjacent to the Cabinet Mountains.

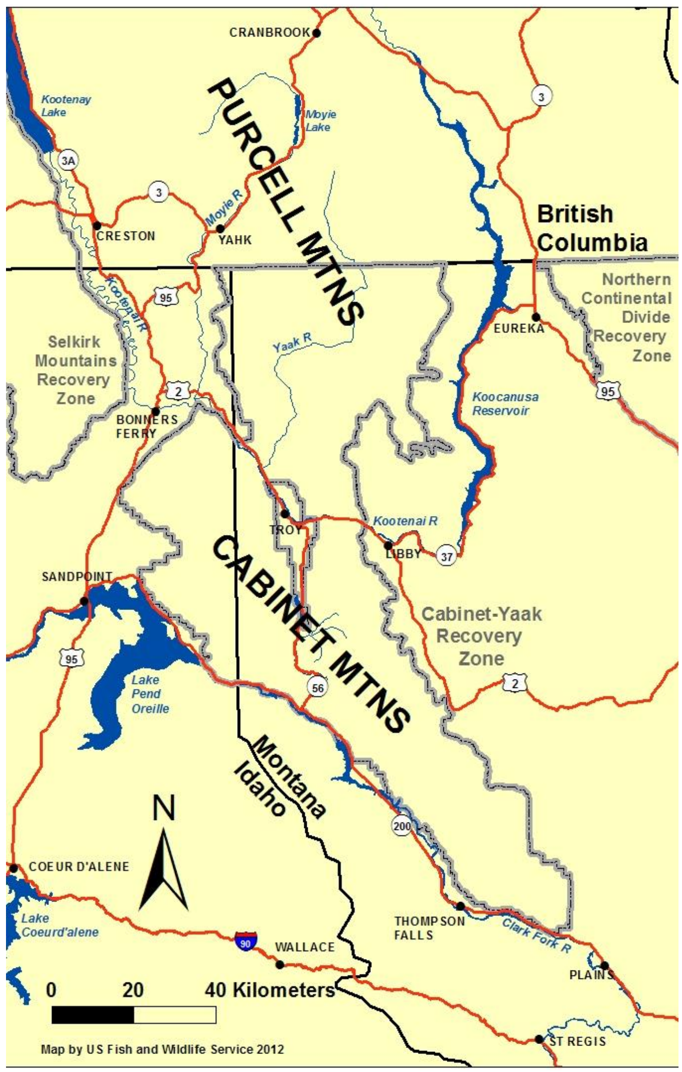


Figure 2. Cabinet-Yaak grizzly bear recovery zone.

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 2348 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 Pandhandle 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. Buffalo berry (*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 CYGBRZ. 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. During 1992 trapping was conducted south of the international border in the North Fork of the Flathead River. 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

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 these 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 and used in reports. Sightings that rate 1 or 2 may not always 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 1 or 2 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 second hand reports from other than the observer.

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 initial capture and expected 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 by 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. Cubs were defined as bears < 1.0 year old.

Bears captured and relocated to the Cabinet Mountains as part of population augmentation were not included in the population trend calculation (Appendix Table 1). 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.

Estimates of unreported mortality were based on the public reporting rate of radio collared animals >1 year of age (Cherry et al. 2002). The correction factor was applied to public reported mortalities. Correction was unnecessary for known removals (management removals, capture related mortalities, or mortalities of radio-collared bears).

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 was made 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:

$$(1) \quad 0 = \lambda^{a} - S_{a}\,\lambda^{a-1} - S_{c}S_{y}S_{s}^{a-2}\, m[1 - (S_{a} / \lambda)^{w-a+1}],$$

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 14 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, 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):

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

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).

Capture and Marking

Capture and handling of bears followed an approved Animal Use Protocol through the University of Montana, Missoula, MT (061-14CSCFC111714). Capture of black bears and grizzly bears was performed under state permits 2014-044 and federal permit TE704930-0. 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 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 1986–87, 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 1989–94 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 Cabinet-Yaak 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 4 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 British Columbia during 1990–94. Only unmarked female grizzly bears < 6 years old (or prior to first reproduction) and > 35 kg were deemed suitable for transplant. All other captured grizzly bears were released with some collared to aid an ongoing bear study in British Columbia. Capture efforts for bears transplanted in 2005–15 occurred primarily in the North Fork and South Fork of the Flathead River in the US by MFWP. No suitable bears were captured in 1992 or 2007.

Hair Sampling for DNA Analysis

This project originally sought evidence of grizzly bears in the Cabinet Mountains using DNA to understand the fates of 4 bears transplanted during 1990–94. 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 2002–15 in the CYGBRZ 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 Cabinet Mountains and Yaak drainage. A 5 km x 5 km grid (25 km^2) was used to distribute sample sites across the area in 2003 (n=184). Each grid cell contained a single sample point near the center of the cell. Actual site location was modified on the basis of 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. Remote cameras were used at some sites. Hair was collected and labeled to indicate: number and color of hairs collected, site location, date, and barb number. These data aided sorting hair to minimize lab costs. Samples collected as a part of this effort and other hair samples collected in the Cabinet Mountains in previous years that were 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 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 the US Geological Survey (USGS) study to estimate CYGBRZ grizzly bear population size (Kendall et al. 2015).

A USGS study established and sampled 1373 rub trees across the recovery area during 2012. The study made preliminary data available regarding the success of this effort by providing us the 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 2013–15. 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, British Columbia for DNA extraction and genotyping.

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 attempted a location fix every 1–2 hours and dropped collars were retrieved in October. 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 the XTools within ArcGIS.

Grizzly and black bears were collared during 2004–10 with GPS collars 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. Collars were equipped with a release mechanism to allow them to be retrieved in October prior to denning. 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 2008–2010, 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. We only considered scats associated with definite grizzly bear sign (tracks, hair, 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 hot and cold rinsed over 2 different size mesh screens (0.40 and 0.24 cm). The retained contents were identified to species with the aid of microscopes. We recorded plant part and visually estimated percent volume. We corrected scat volumes with correction factors that incorporate different digestibilities 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 buffalo berry 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 meter 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 2015. Buffaloberry sampling began in 1990 at 5 sites. Due to the dioecious (separate male and female plants) nature of buffalo berry all frame count transects were dropped in 2007 in favor of marking 10 plants per site and counting the berries on the marked plants. Two sites were sampled in 2015. Serviceberry productivity was estimated by counting berries on 10 marked plants at 5 sample sites beginning in 1990. Six sites were sampled in 2015. 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 2015.

Temperature and relative humidity data recorders (LogTag) 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).

RESULTS AND DISCUSSION

Grizzly Bear Observations and Recovery Plan Criteria

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. The file includes over 1,600 credible sightings, tracks, scats, digs, and hair dating from 1960 (Fig. 3) and 149 mortalities dating from 1949 (Appendix Table 2, Fig. 3). Credible sightings were those rating 4 or 5 on the 5 point scale (see page 9). Sixty-nine instances of grizzly bear mortality were detected inside or within 16 km of the CYGBRZ (including Canada) during 1982–2015 (Table 1). 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 has 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.

Fifty-four credible sightings were reported to this study that rated 4 or 5 (most credible) during 2015. Thirty-five of these sightings occurred in the Yaak portion of the recovery zone and 10 sightings occurred in the Cabinet Mountains portion of the recovery zone. Eight sightings came from outside the recovery zone in the U.S. and one sighting was from British Columbia (Table 2 and Fig. 3).

Cubs are offspring in the first 12 months of life and yearlings are offspring in their second 12 months. The recovery plan (USFWS 1993) indicates that females with cub sightings within 10 miles of the recovery zone count toward recovery goals. Four credible sightings of a female with cubs occurred during 2015 in BMUs 5 and 16 (Tables 2, 3, 4, 5, Fig. 4 and 5). There appeared to be 2 unduplicated females with cubs in the recovery area or within 10 miles during 2015. Sixteen credible sightings of a female with yearlings or 2-year-olds occurred in BMUs 6, 12, 13, 14, 15, 16, 17, British Columbia and Deer Ridge units. Unduplicated sightings of females with cubs (excluding Canada) varied from 1–4 per year and averaged 2.5 per year from 2010–15 (Tables 3, 4). Recovery plan criteria require a running 6 year average of 6.0 females with cubs per year.

Twelve of 22 BMUs in the recovery zone had sightings of females with young (cubs, yearlings, or 2-year-olds) during 2010–15 (Figs. 4, 5, Table 6). Occupied BMUs were: 2, 3, 5, 6, 7, 11, 12, 13, 14, 15, 16, and 17. Recovery plan criteria indicate the need for 18 of 22 BMUs to be occupied.

Eleven known or probable human caused mortalities of native grizzly bears have occurred in or within 10 miles of the CYGBRZ in the U.S. during 2010–15 (Table 1). Cabinet Mountains augmentation individuals were counted as mortalities when they were removed from the Northern Continental Divide Recovery Zone and are not counted again as mortalities in the CYGBRZ if they die during their first year (Appendix Table 2). Mortalities in Canada are not counted toward recovery goals (USFWS 1993) even though bears initially marked within the recovery zone have died in Canada. Bears originating in Canada that die in the US are counted. Eleven human caused mortalities include 1 female (Deer Ridge) and 10 males (BMUs 2, 11, 12, 13, 19, 22, Deer Ridge and West Kootenai units). Human caused mortalities during 2010–15 were one adult female (human, under investigation), 5 adult males (three human, under investigation, one bear mistaken as a black bear, and a self-defense), 4 subadult males (black bear mistaken identity, two self-defense, and one poaching), and one male cub (human, under investigation). Population levels were calculated by dividing observed females with cubs (7) minus any human-caused adult female mortality (0) from 2013–15 by 0.6 (sightability) then dividing 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 41 individuals. The recovery plan states; "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 1.6 bears per year. The female limit is 0.5 females per year (30% of 1.6). Average annual human caused mortality for 2010–15 was 1.8 bears/year and 0.2 females/year. These mortality levels for total bears were more than the calculated limit and female mortality was less than the calculated limit during 2010–15. 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." All tables and calculations are updated when 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), 1982–2015.

Mortality Date	Tag #	Sex	Age	Mortality Cause	Location	Open Road <500 m	Public Reported	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

Mortality Date	Tag #	Sex	Age	Mortality Cause	Location	Open Road <500 m	Public Reported	Owner[1]
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
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	PRIV
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	790[2]	F	3	Human, Poaching	Clark Fork River. MT	Yes	Yes	PRIV
10/20/2008	635[2]	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

Mortality Date	Tag #	Sex	Age	Mortality Cause	Location	Open Road <500 m	Public Reported	Owner[1]
October 2012[1]	5381	M	8	Human, Management	Duck Creek, BC	Yes	Yes	PRIV
10/26/2014	79575279	M	6	Human, Defense of life	Little Thompson River, MT	Yes	Yes	PRIV
5/15/2015	552-ygl[1]	Unk	1	Natural	Linklater Creek, BC	Unk	No	BC
5/23/2015	921[2]	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	924[2]	M	2	Human, Mistaken Identity	Beaver Creek, ID[3]	Yes	Yes	USFS
10/11/2015	1001	M	6	Human, Under Investigation	Grouse Creek, ID	Yes	No	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 this recovery zone. BC – British Columbia, MRL – Montana Rail Link, PRIV – Individual Private, PCT – Plum Creek Timber Company, and 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. Genetic origin of this bear was inconclusive.

Table 2. Credible grizzly bear sightings, credible female with young sightings, and known human caused mortality by bear management unit (BMU) or area, 2015.

BMU OR AREA	2015 Credible Grizzly Bear Sightings	2015 Sightings of Females with Cubs (Total)	2015 Sightings of Females with Cubs (Unduplicated)	2015 Sightings of Females with Yearlings or 2-year-olds (Total)	2015 Sightings of Females with Yearlings or 2 year-olds (unduplicated)	2015 Human Caused Mortality
4	1	0	0	0	0	0
5	7	3	1	2	1	0
11	1	0	0	0	0	0
12	3	0	0	1	1	2
13	8	0	0	6	1	0
14	5	0	0	1	1	0
15	4	0	0	1	0	0
16	10	1	1	3	1	0
17	4	0	0	1	0	0
19	1	0	0	0	0	1
20	1	0	0	0	0	0
BC Yahk GBPU[3]	1	0	0	1	0	2
CF	1	0	0	0	0	0
DR	0	0	0	0	0	0
Fisher	0	0	0	0	0	0
South Clark Fork	1	0	0	0	0	0
West Kootenai	5	0	0	0	0	0
West RZ	1	0	0	1	0	0
2015 TOTAL	54	4	2	17	5	5

[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 sighting 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 do not count toward recovery goals.

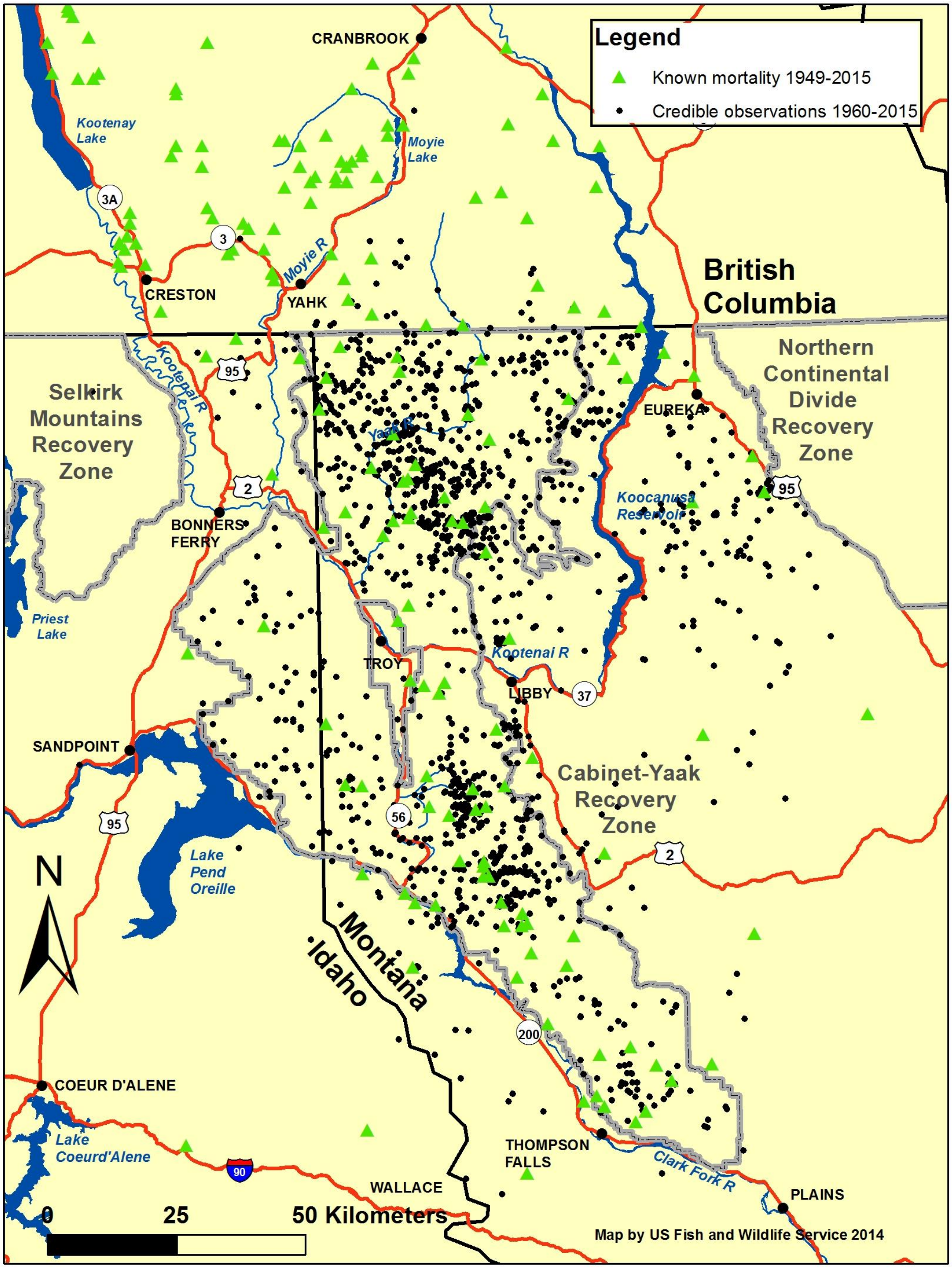


Figure 3. Grizzly bear observations (1960–2015) and known or probable mortalities from all causes (1949–2015) in the Cabinet-Yaak recovery area.

Table 3. Status of the Cabinet-Yaak recovery zone during 2010–2015 in relation to the demographic recovery targets from the grizzly bear recovery plan (USFWS 1993).

Recovery Criteria	Target	2015
Females w/cubs (6-yr avg)	6	2.5 (15/6)
Human Caused Mortality limit (4% of minimum estimate)[1]	1.6	1.8 (6 yr avg)
Female Human Caused mortality limit (30% of total mortality)[1]	0.5	0.2 (6 yr avg)
Distribution of females w/young	18 of 22	12 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, 1988–2015.

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[1]	30% ALL FEMALE HUMAN CAUSED MORTALITY LIMIT[1]	TOTAL HUMAN CAUSED MORTALITY 6 YEAR AVERAGE	FEMALE HUMAN CAUSED MORTALITY 6 YEAR AVERAGE
1988	1	1	1	1	0.0	0.0		
1989	0	0	1	1	0.0	0.0		
1990	1	0	0	1	0.0	0.0		
1991	1	0	0	0	0.0	0.0		
1992	1	0	0	0	0.0	0.0		
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

[1] Presently grizzly bear numbers are so small in this ecosystem that the mortality goal shall be zero known human-caused mortality.

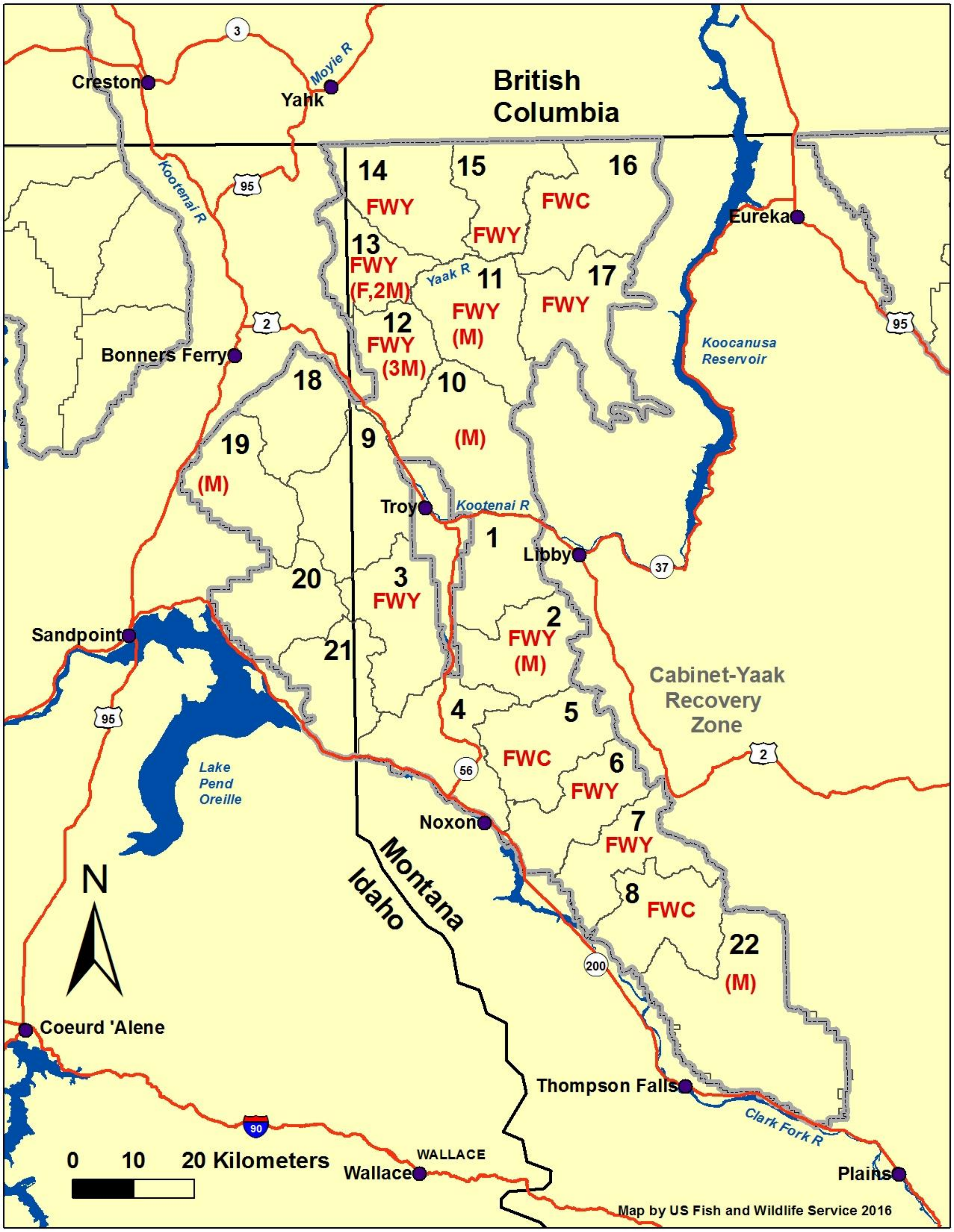


Figure 4. Female with young occupancy and known or probable mortality within Bear Management Units (BMUs) in the Cabinet-Yaak recovery zone 2010–2015. (FWY indicates occupancy of a female with young and sex of any mortality is indicated in parentheses).

Table 5. Credible observations of females with young in or within 10 miles of the Cabinet-Yaak recovery zone, 1988–2015. Canadian credible observations shown in parentheses.

Year	Total credible 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
1990	9	1	2	0	3
1991	4	1	1	1	2
1992	8	1	5	1	6
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)

[1]Credible sightings are those rated 4 or 5 on a 5 point scale (see page 8).

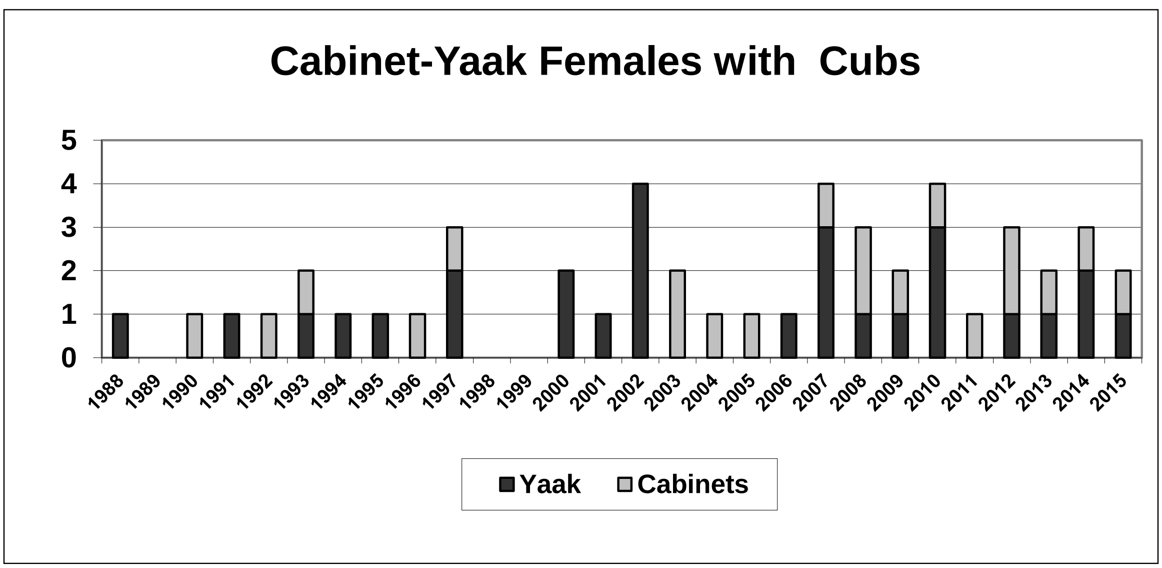


Figure 5. Credible observations of females with cubs in or within 10 miles of the Cabinet-Yaak recovery zone (excluding Canada), 1988–2015. Credible sightings are those rated 4 or 5 on a 5 point scale.

Table 6. Occupancy of bear management units by grizzly bear females with young in the Cabinet-Yaak recovery zone 1990–2015.

	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
1988	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N
1989	N	N	N	Y	N	N	Y	N	N	N	Y	N	Y	Y	Y	N	N	N	N	N	N	N
1990	N	Y	N	N	N	N	N	Y	N	N	Y	Y	N	Y	Y	N	N	N	N	N	N	Y
1991	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N
1992	N	N	N	N	N	Y	N	N	N	N	Y	N	Y	Y	N	N	Y	N	N	Y	N	N
1993	N	N	N	N	Y	Y	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N
1994	N	N	N	N	N	N	N	N	N	N	Y	N	N	Y	Y	N	N	N	N	Y	N	N
1995	N	N	N	N	N	N	N	N	N	N	Y	N	N	Y	Y	N	N	N	N	N	N	N
1996	N	N	N	N	N	Y	N	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	N	N
1997	N	Y	N	Y	N	Y	Y	N	N	N	Y	N	N	Y	Y	Y	N	N	N	N	Y	N
1998	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	N
1999	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N	N	N	N	N
2000	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N
2001	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	Y	N	N	N	N	N
2002	N	Y	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	N	Y	N	N	N	N	N
2003	N	Y	N	N	Y	Y	N	N	N	N	N	N	Y	N	N	Y	N	Y	N	N	Y	N
2004	N	Y	N	N	Y	Y	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N
2005	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N
2006	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N
2007	N	N	Y	Y	Y	Y	N	N	N	N	Y	N	Y	Y	N	N	Y	N	N	N	N	N
2008	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y	N	Y	N	N	N	N
2009	N	N	N	Y	Y	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N
2010	N	N	Y	N	Y	N	Y	N	N	N	Y	N	Y	Y	N	N	Y	N	N	N	N	N
2011	N	N	N	N	Y	N	N	N	N	N	Y	N	N	N	Y	N	Y	N	N	N	N	N
2012	N	Y	N	N	Y	N	N	N	N	N	Y	N	N	N	N	Y	Y	N	N	N	N	N
2013	N	N	N	N	Y	Y	N	N	N	N	Y	N	N	Y	Y	Y	Y	N	N	N	N	N
2014	N	N	N	N	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	N	N	N	N	N
2015	N	N	N	N	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N

Cabinet Mountains Population Augmentation

From 1990–94 four female grizzly bears were captured in the Flathead River Valley of British Columbia and released in the Cabinet Mountains to augment the population (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 bears and her cub died of unknown causes a year after release. The remaining three bears were monitored until collars loss. 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 native males.

In 2005 the augmentation program was reinitiated through capture by MFWP personnel and monitoring by this project. During 2005–15, 9 female and 5 male grizzly bears were released in the Cabinet Mountains (Table 7). A 2 year-old male was released in the West Cabinet Mountains on July 25, 2015. The bear remained in the West Cabinet Mountains during August when several forest fires were started by lightning storms. The animals moved south in late August crossing the Clark Fork River and moving into the Coeurd'Alene River to an area about 10 miles north of Wallace, Idaho. On September 29 the bear was killed by an Idaho black bear hunter in a case of mistaken identity.

Of 18 bears released through 2015, 6 are known to have left the target area (one was recaptured and brought back and one returned a year after leaving), three were killed within 4 months of release, and one was killed 16 years after release. One animal is known to have produced at least 10 first generation offspring, 13 second generation offspring, and one third generation offspring. Another female is known to have produced two offspring.

Table 7. Sex, age, capture date, capture location, release location, and fate of augmentation grizzly bears moved to the Cabinet Mountains, 1990–2015.

Bear	Sex	Age	Capture date	Capture Location	Cabinet Mts Release Location	Fate
218	F	5	7/21/1990	NF Flathead R, BC	EF Bull River	Denned in Cabinet Mts 1990, Lost collar August, 1991, observed July 1992.
258	F	6	7/21/1992	NF Flathead R, BC	EF Bull River	Denned in Cabinet Mts 1992 Produce 1 cub 1993, Natural mortality July 1993.
286	F	2	7/14/1993	NF Flathead R, BC	EF Bull River	Denned in Cabinet Mts 1993-95, Lost collar at den April 1995, hair snag 2004-2009, self-defense mortality November 2009.
311	F	3	7/12/1994	NF Flathead R, BC	EF Bull River	Lost collar July 1994, recaptured October 1995 south of Eureka, MT, released in EF Bull River, Signal lost November 1995.
A1	F	7-8	9/30/2005	NF Flathead R, MT	Spar Lake	Denned in West Cabinet Mts 2005 and 2006, Lost collar September 2007.
782	F	2	8/17/2006	SF Flathead R, MT	Spar Lake	Denned in West Cabinet Mts 2006-07, Lost collar August 2008.
635	F	4	7/23/2008	Stillwater R, MT	EF Bull River	Killed by train near Heron, MT October, 2008.
790	F	3	8/7/2008	Swan R, MT	EF Bull River	Illegally killed near Noxon, MT October, 2008.
715	F	10	9/17/2009	NF Flathead R, MT	Spar Lake	Denned in West Cabinet Mts 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	Denned in Cabinet Mts 2010, Lost collar September 2011.
714	F	4	7/24/2010	NF Flathead R, MT	Silverbutte Cr	Returned to NF Flathead July 2010. Lost collar October 2013.
725	F	2	7/25/2011	MF Flathead R, MT	Spar Lake	Moved to Glacier National Park, September 2011 and denned, returned to Cabinet Mts August 2012 and denned, ,moved to Glacier National Park and returned to Cabinet Mts, lost collar October 2013
723	M	2	8/18/2011	Whitefish R, MT	Spar Lake	Denned in Cabinet Mts 2011. Lost collar June 2012.
918	M	2	7/6/2012	Whitefish R, MT	EF Bull River	Denned in Cabinet Mts 2012 and 2013. Lost collar October 2014.
919	M	4	7/30/2013	NF Flathead R, MT	Spar Lake	Denned in Cabinet Mts 2013. Lost collar August 2014.
920	F	2	6/18/2014	NF Flathead R, MT	Spar Lake	Denned in Cabinet Mts 2014 and 2015.
921	F	2	6/18/2014	NF Flathead R, MT	Spar Lake	Denned in West Cabinet Mts 2014. Died of unknown cause May 2015.
924	M	2	7/25/2015	SF Flathead R, MT	Spar Lake	Mistaken identity mortality September 2015

Cabinet-Yaak Hair Sampling and DNA Analysis

Hair snag sampling occurred at barb wire corrals baited with a scent lure during 2000–2015 (Table 8 and Fig. 6). Sampling occurred from May through October but varied within years. Sites were selected based on previous grizzly bear telemetry, sightings, and access. Remote cameras supplemented hair snagging at numerous sites and were useful in identifying family groupings and approximate ages of sampled bears. Hair snag sampling effort during 2012 was altered and reduced to avoid conflicts with the US Geological Survey study to estimate grizzly bear population size.

In 2002 study personnel also assisted with an MDFWP black bear population hair snag estimate that sampled 285 sites in the Yaak River portion of the study area. During 2003, 184 sites on a 5 km^2 grid were sampled on approximately 4,300 km^2 in the Cabinet Mountains portion of the recovery zone. In 2009, 98 sites were sampled south of the Clark Fork River. Other years had much lower numbers of sampled sites.

Nine hundred and eighty-one sites were sampled with this technique from 2000–2015 (Table 8 and Fig. 6). Thirty-seven sites provided grizzly bear hair from at least 34 individuals.

Table 8. Grizzly bear hair snagging corrals and success in the Cabinet-Yaak study area, 2000–2015.

Year	Number of sites	Sites with grizzly bear pictures	Sites with grizzly bear hair	Individual grizzly bear genotypes	Locations with grizzly bear pictures or hair	Comments
2000	1	0	0	0		
2001	3	0	0	0		
2002	319	4	9	9	MF Bull R., W Fisher Cr., EF Rock Cr., NF Big Cr., NF Sullivan, Pete Cr., 4th July Cr., Spread Cr., Solo Joe Cr.	
2003	184	1	1	1	WF Rock Cr., W Fisher Cr.	
2004	14	1	2	3	EF Bull R., EF Rock Cr.	
2005	17	2	1	1	EF Bull R., Libby Cr.	
2006	19	1	3	3	Cub Cr., Silverbutte Cr., Bear Cr., and EF Rock Cr.	
2007	36	4	4	9	Devils Club Cr., EF Rock Cr., Bear Cr., W F Rock Cr., W Fisher Cr., Pete Cr., NF Meadow Cr.	Female with young EF Rock Cr., Female with young WF Rock Cr.
2008	21	1	1	1	EF Bull R.	
2009	122	4	2	4	Bear Cr., Libby Cr., NF Callahan Cr., W Fisher Cr.	Female with young Bear Cr.
2010	24	4	3	5	EF Rock Cr., W Fisher Cr., Cub Cr., Drift Cr.	Female with young EF Rock Cr.
2011	72	8	8	13	EF Rock Cr., Bear Cr., W Fisher Cr., NF 17-mile Cr., Spruce Cr., Hensley Cr., Chippewa Cr., Solo Joe Cr.	Siblings Spruce Cr., Female with young Solo Joe Cr.
2012	821	1	46	29	Beaver Cr. (USFWS); myriad others from USGS population estimate efforts (Kendall et al. 2016)	USFWS effort genotyped 1 GB from 31 corrals
2013	5	2	2	2	W. Fisher Cr.EF Rock Cr.	Female with young W Fisher Cr.
2014	65	5	3	4	Boyd Cr., Miller Cr., Libby Cr., Midge Cr., Faro Cr., Spread Cr.	Female with young Faro Cr.
2015	48	9	5	7	Pete Cr., Hellroaring Cr., Boulder Cr (Cabinets), NF EF Bull Cr., Libby Cr., Rock Cr., Bear Cr.	Female with young Hellroaring Cr.; Female with cubs Bear Cr. and Libby Cr.
Total	1817	47	82	53 [1]		

[1]Some individuals captured multiple times among years.

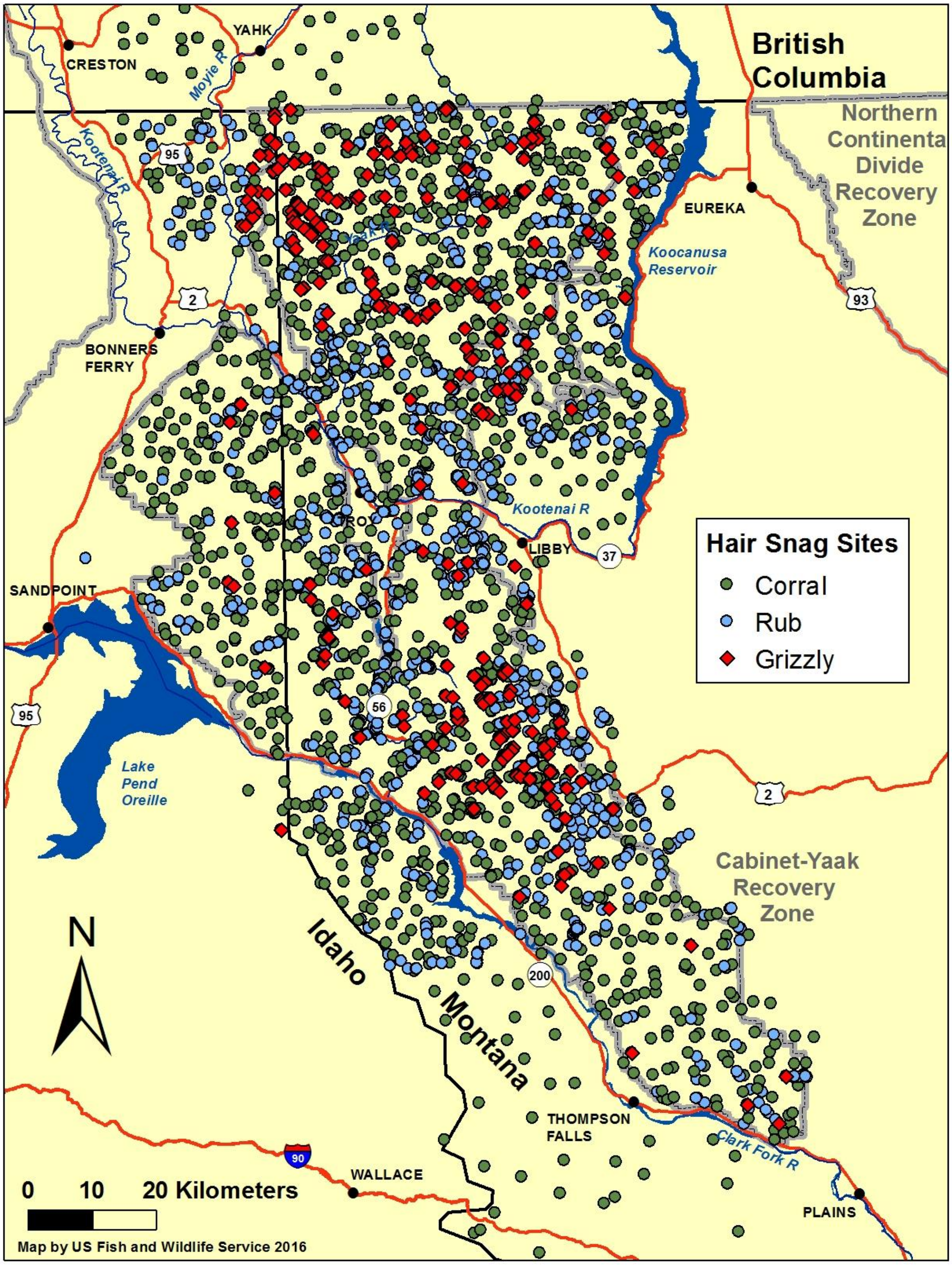


Figure 6. Location of hair snag sample sites in the Cabinet Mountains, 2000–15.

During 2012 the USGS established and sampled hair from 1,373 rub trees across the CYGBRZ (Kendall et al. 2016). The study made preliminary data available regarding success of this effort by providing us the 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 2015. We also established other observed rub trees. In 2015, we collected 2285 samples from visits to 765 individual rub trees (Table 9). Samples were evaluated during cataloging and 616 were judged not to be from black bears and sent to Wildlife Genetics International Laboratory in Nelson, British Columbia for DNA extraction and genotyping. Since 2013, we have genetically identified 44 individual grizzly bears (26 males, 18 females) from a total of 5191 samples collected via rub effort.

Table 9. Grizzly bear hair rubs and success in the Cabinet-Yaak study area, 2012–2015.

Year	Number of rubs checked	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	449	1038 (6)	479 (12)	33	17	9	8
2014	592	1895 (7)	707 (19)	50	24	14	10
2015	765	2258 (6)	616 (22)	76	29	20	9
Total	1480[3]	13547 (4)	6441 (8)	163[3]	54[4]	33[4]	21[4]

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

[2] 2012 effort and results entirely from USGS population estimation study (Kendall et al. 2016). 2013-15 efforts are entirely from USFWS Cabinet-Yaak GB Recovery Program.

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

[4]Some individuals captured multiple times among years.

Grizzly Bear Genetic Sample Summary

Captures, genotypes from hair or tissue, and observations of grizzly bears by study personnel in the Cabinet-Yaak study area were summarized during 1986–2015 (Appendix 2). Individuals not radio-collared or genotyped were conservatively separated by size, age, location, coloration, genetic information, or reproductive status. Conservative classification of sightings may result in unique individuals being documented as one individual. Individual status or relationships may change with new information.

One hundred seventy-six individuals were identified within the Cabinet-Yaak study area with 157 bears captured or genotyped and 20 unmarked individuals observed during 1986–2015 (Appendix 2). Sixty-eight of these animals are known or suspected to have died. Human causes were linked to 48 of these mortalities. Nineteen were believed to have died of natural causes. Thirteen of these 18 mortalities involved cubs. Four mortalities were from unknown causes. Twelve bears were known to have emigrated from the population. Three were augmentation bears returning to their area of capture, one was an augmentation bear that moved south and was killed, three went north of BC Highway 3 where one was killed, three bears went east of the recovery area where two are known dead, and two went west to the Selkirk Mountains. All bears known to have left the population are either augmentation bears or male individuals.

We determined parent-offspring relationships of Yaak grizzly bears using sample genotypes from 1986–2015. A majority of our detected sample of grizzly bears in the Yaak descends from female grizzly bear 106 (Figure 7). Bear 106 produced 5 known litters. To date, her matrilines tie to 41 known 1st, 2nd, and 3rd generation male or female offspring. Since 1986, we have genetically detected 36 female grizzly bears in the US Yaak and BC Yahk, 25 (69%) of which are direct maternal descendants of bear 106. Since 2014, all female bears detected in the Yaak are her maternal descendants. In 2015 alone, we detected 1 daughter, 6 granddaughters, and 3 great-granddaughters of 106.

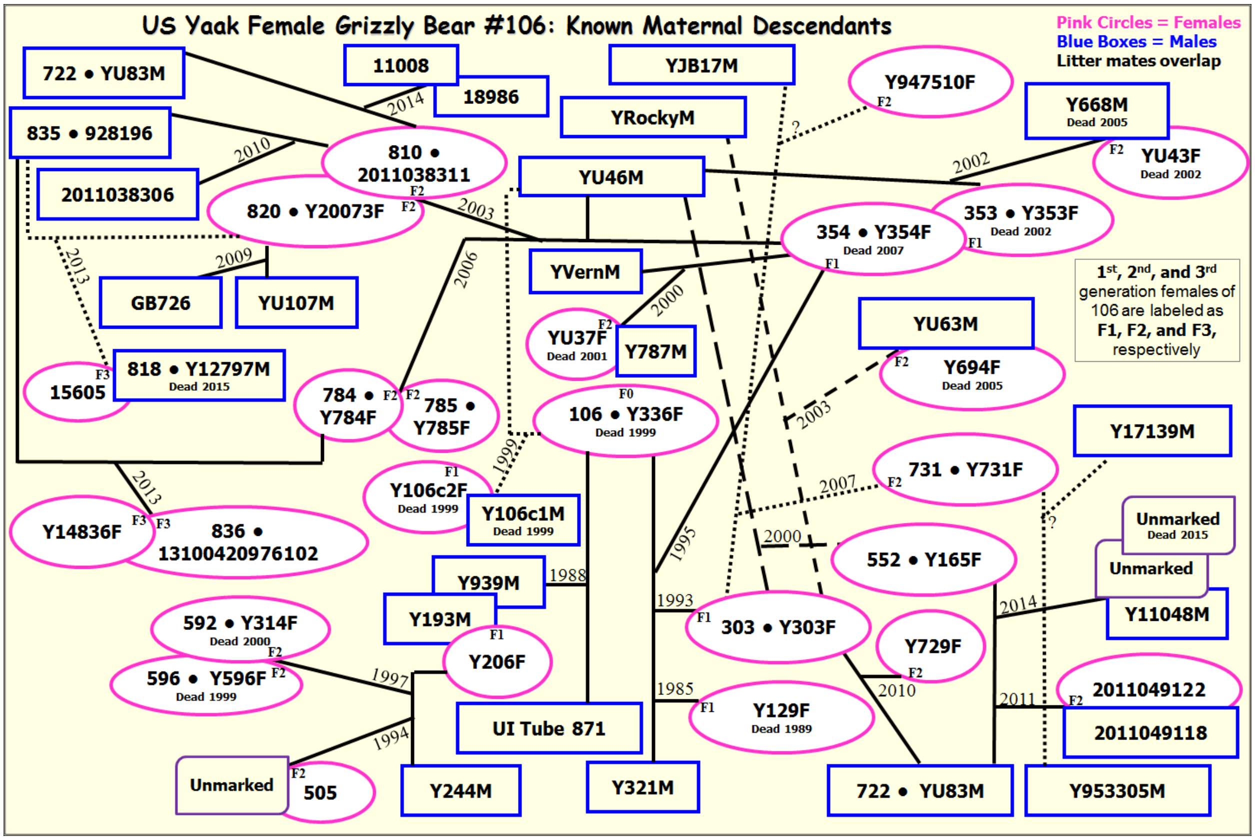


Figure 7. Most likely pedigree displaying matrilineal ancestry of female grizzly bear 106 in the Yaak, 1986–2015. Squares indicate males and circles represent females. Lines indicate a parent-offspring relationship. F0 is the initial generation, F1 is the first generation of female offspring of 106, F2 is the second generation, and F3 is the third generation. Numbers along lines indicate when the descendant litter was produced.

The Cabinet Mountains population was estimated to be 15 bears or fewer in 1988 (Kasworm and Manley 1988). However the lack of native bears identified since 1989 suggests that the population may have been well below the level of 15 individuals. Genetic samples from the Cabinet Mountains (1983–2015) were analyzed and determined to originate from 56 different grizzly bears. Three of these were from captures during 1983–1988, 17 were from augmentation bears during 1990–2015, and 35 from captures, mortalities, or hair snagging during 1997–2015. Only 9 genotyped bears not known to be augmentation bears or their offspring have been identified in the Cabinet Mountains since 1990. Of these 9, 4 are known to be dead. The augmentation effort appears to be the primary reason that grizzly bears remain and were increasing in the Cabinet Mountains.

In 1993, claws from a grizzly bear were discovered in Baree Creek of the Cabinet Mountains. 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 3 bears captured in the Cabinet Mountains from 1983-1988 were a triad with bear 680 being the offspring of bears 678 and 14.

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 (Kasworm et al. 2007). She was 2 years old at the time of her release and would have been 13 years-old when the first hair sample was obtained during 2004. Pedigree analysis indicates that bear 286 has produced at least 10 first generation offspring, 14 second generation offspring, and 1 third generation offspring. Four of those first generation offspring are adult females that are known to have reproduced (Fig. 8). Bear 286 was killed in a self-defense incident with a hunter in November of 2009. Of the 9 bears genotyped since 1990 that are not related to the augmentation effort, two are adult males that bred with 286 to contribute to the first generation. Four are a family group (adult female with 3 cubs) identified south of the Clark Fork River in 2002. One bear was a subadult male captured near Thompson Falls in 2011 in an incident involving livestock depredation. Another was a male migrant from the Selkirk mountains identified in 2012, who is now known to have moved back to the Selkirks. The remaining bear was an adult male killed in the Little Thompson River during 2014. This bear was known to have originated in the Northern Continental Divide Population to the northeast and moved into the Cabinet-Yaak during 2014.

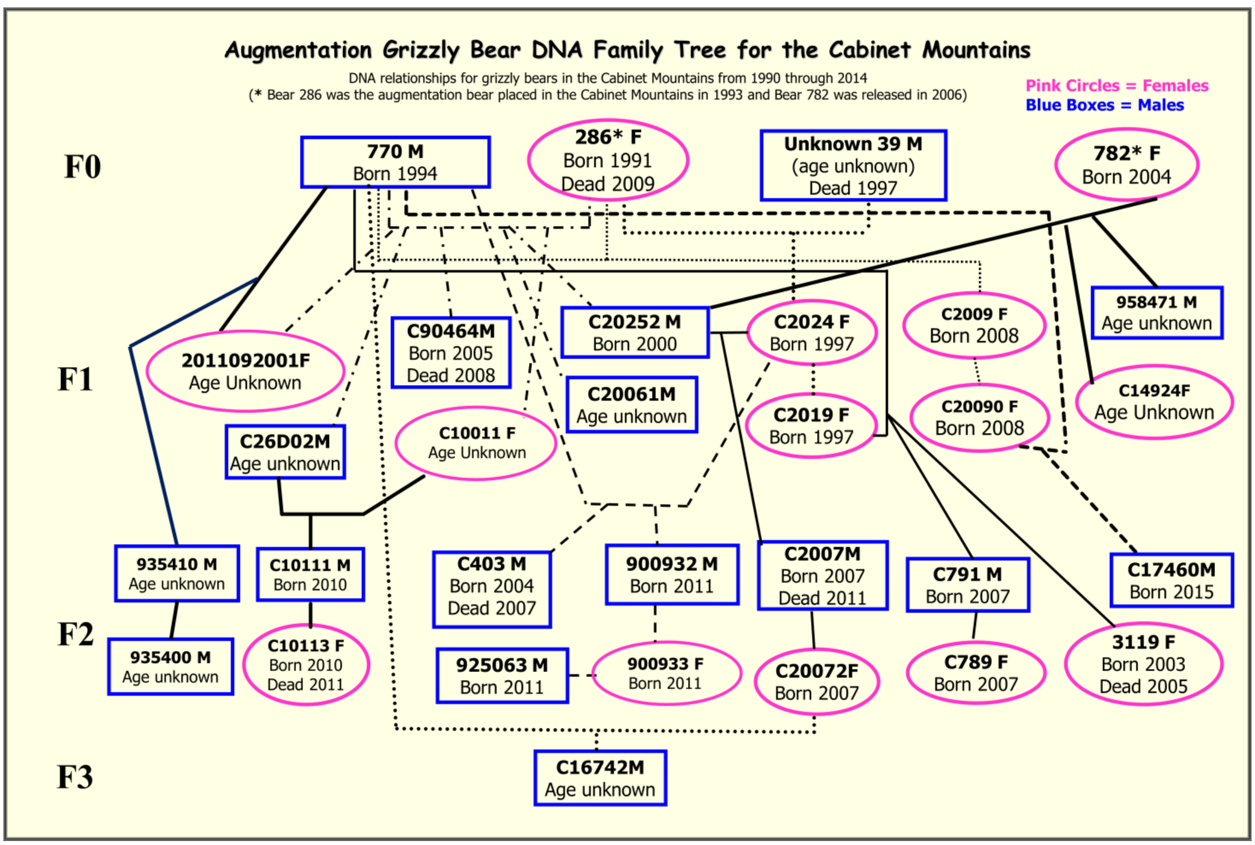


Figure 8. Most likely pedigree resulting from translocated female grizzly bears 286 and 782 in the Cabinet Mountains, 1993–2014. Squares indicate males and circles represent females. Lines indicate a parent-offspring relationship. F0 is the initial generation, F1 is the first generation of offspring for translocated female 286 or 782, F2 is the second generation and F3 is the third generation.

Known Grizzly Bear Mortality

Forty-nine instances of known and probable grizzly bear mortality from all causes were detected inside or near the CYGBRZ (excluding Canada) during 1982–2015 (Tables 1 and 10, Fig. 9). There were five known grizzly bear mortalities inside or near the CYGBRZ (including Canada) during 2015. There were 17 instances of known grizzly bear mortality in Canada within 16 km of the CYGBRZ in the Yahk and South Purcell population units from 1982-2015 (Tables 1 and 10, Fig. 9). One of these mortalities occurred during 2015. This summary included radio-collared bears regardless of where they died. Seasons were defined as follows: April 1 to May 31 (spring), June 1 to August 31 (summer), and September 1 to November 30 (autumn).

Table 10. Cause, timing, and location of known and probable grizzly bear mortality in or within 16 km of the Cabinet-Yaak recovery zone (including Canada), 1982–2015 (including all radio collared bears 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	3					2	1		1	1	1	9
Subadult female						1	1	1	2	3		8
Adult male	2			1	1		2			3		9
Subadult male	2				4		2			3		11
Yearling					1	1					1	3
Cub					1	9	2			1		13
Unknown					1							1
Total	7			1	8	13	8	1	3	11	2	54
Season[1]												
Spring					1	1	1			3		5
Summer	1				1	12	1	1				17
Autumn	6			1	6		5		3	7		28
Unknown							1			1	2	4
Ownership												
US Private	3			1	2		5		3	4		18
US Public	4				6	13	3	1		7	2	36
Canada												
Adult female				2								2
Subadult female	1							1				2
Adult male		1		2	1					1		5
Subadult male				1						1		2
Yearling						1						1
Cub						4						4
Unknown			1									1
Total	1	1	1	5	1	5		1		2		17
Season[1]												
Spring		1		1		1		1				4
Summer			1	1		4						6
Autumn	1			3	1					2		7
Unknown												
Ownership												
BC Private				4								4
BC Public	1	1	1	1	1	5		1		2		13

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

Fifty-three mortalities involved individuals of known sex or age in the U.S.: 9 adult females, 9 adult males, 8 subadult females, 11 subadult males, 3 yearlings, and 13 cubs. Mortality causes (and frequency) were natural (13), unknown but human-caused (11), poaching (8), mistaken identity (8), defense of life (7), train collision (3), unknown (2), management removal (1), and trap predation (1) (Table 11). Five mortalities occurred during spring, 17 during summer, 28 during autumn, and 4 at unknown time of year. One natural mortality occurred during spring and 12 occurred during summer. Three unknown but human-caused mortalities occurred during spring, 7 during autumn, and 1 was unknown. One poaching mortality occurred during spring and summer each, 5 during autumn, and one was unknown. One mistaken identity mortality occurred during spring and summer each, and 6 in autumn. One defense of life occurred in summer and 6 in autumn. All train collisions occurred during autumn. The single management removal occurred during autumn and the single trap predation death occurred during summer.

Seventeen mortalities involved individuals of known sex or age in Canada: 2 adult females, 5 adult males, 2 subadult females, 2 subadult males, 1 yearling, and 4 cubs. Mortality causes (and frequency) were: natural (5), management removal (5), unknown but human-caused (2), mistaken identity (1), legal hunting in Canada (1), defense of life (1), trap predation (1), and black bear hunting with hounds in Canada (1) (Table 11). Four mortalities occurred during spring, 6 during summer, and 7 during autumn. One natural mortality occurred during spring and 4 in summer. One management removal occurred during spring, one during summer, and three during autumn. Two unknown but human-caused mortalities occurred during autumn. One mistaken identity and defense of life mortality occurred during autumn. Legal hunting mortality in Canada and the trap predation death occurred during spring. The black bear hound hunting mortality occurred in British Columbia during summer.

Sixty-seven percent (14 of 21) of known human-caused mortalities occurring on the US National Forests were <500m of an open road and 33% were >500m from an open road (7 of 21). Thirty-three percent of known human caused mortalities occurring on the National Forests were located within core habitat (7 of 21).

Sixteen instances of known mortality occurred in the U.S. and Canada during the 17-year period from 1982–1998 with 12 (71%) of these mortalities being human-caused. During this time of a high rate of population increase (Table 1), the annual rate of known human caused mortality was 0.76 mortalities per year. Twenty-six instances of known mortality occurred during the 8 year period from 1999–2006 with 17 (65%) of these mortalities human-caused. Annual rate of known human-caused mortality was 2.13 per year from 1999–2006. This was a time of population decrease because of high mortality (Table 1). Twenty-nine instances of known mortality occurred during the 9 year period from 2007–2015 with 22 (76%) of these mortalities human-caused. Annual rate of known human-caused mortality was 2.44 per year from 2007–2015. This was a time of improving rate of increase in the population (Table 1). Though the rate of known human caused mortality increased 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 during 1982-1998. Total known female mortality rate decreased from 1.88 during 1999–2006 to 0.78 during 2007–2015 and known human caused female mortality rate decreased from 1.50 to 0.56. This decline of female mortality is largely responsible for the improving population trend from 2007–2015.

The increase in total known mortality beginning in 1999 may be linked to poor food production during 1998–2004 (Fig. 9). Huckleberry production during these years was about half the 20-year 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 often causes females to not produce cubs in the following year. Poor food production may also cause females to travel further for food, which may expose young to greater risk of mortality from conflicts with humans, predators, or accidental deaths. Four cub mortalities were from one female bear that 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.

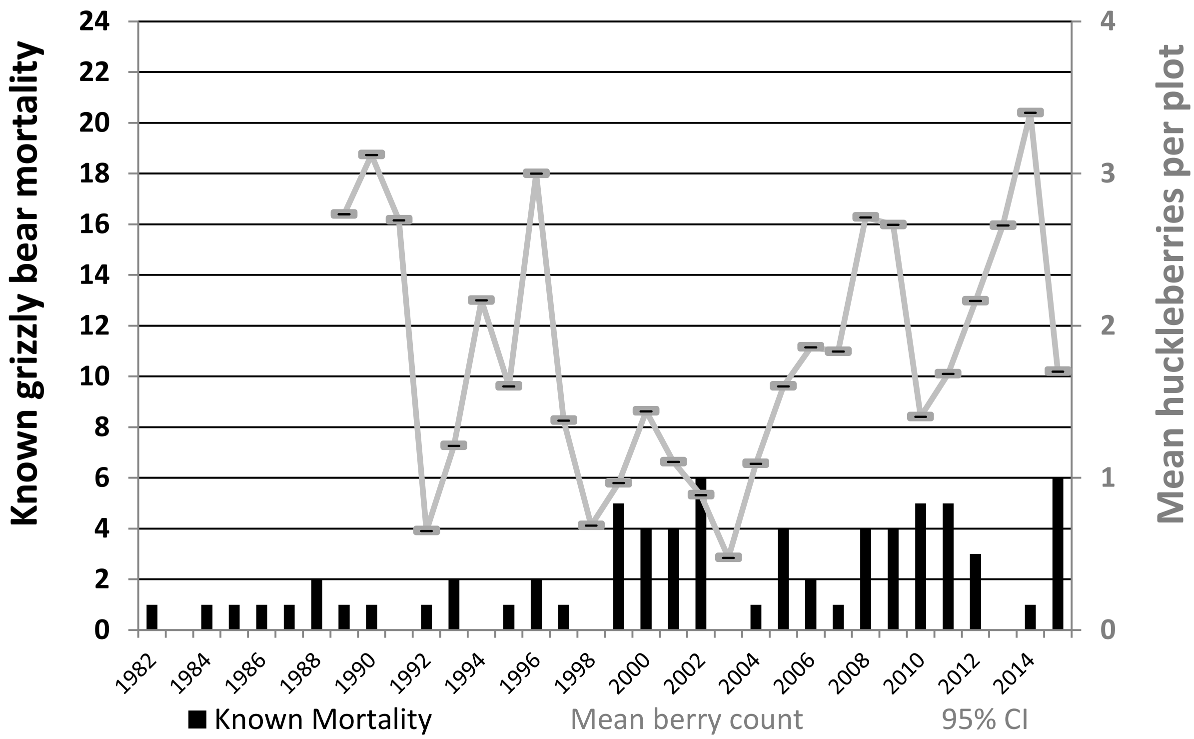


Figure 9. Known grizzly bear annual mortality from all causes in or within 16 km of the Cabinet-Yaak recovery zone (including Canada) and all radio collared bears by cause, 1982–2015 and huckleberry production counts, 1989–2015.

Use of known human-caused mortality counts probably results in under-estimates of total human-caused mortality. Numerous mortalities identified by this study 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. Seventeen radio-collared bears died from human causes during 1982–2015. Nine of these were reported by the public (53%) and 8 were unreported (47%). 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 (Table 11). Samples sizes in the CYGBRZ are much smaller than Yellowstone and we grouped data based on the cumulative population trend (ʎ, Fig 10). The unreported estimate added 21 mortalities to the 71 known mortalities from 1982–2015. The unreported estimate includes bears killed in Canada which are not counted in the recovery criteria (USFWS 1993).

Table 11. Annual grizzly bear mortality in or within 16 km of the Cabinet-Yaak recovery zone (including Canada) and estimates of unreported mortality, 1982–2015.

Years	Population trend	Management or research	Radio monitored	Unknown cause	Public reported	Unreported estimate	Total
1982-1998	Improving	2	7	1	6	5	21
1999-2006	Declining	4	16	0	6	5	31
2007-2015	Improving	2	14	1	12	11	40
Total		8	37	2	24	21	92

Grizzly Bear Mortality, Reproduction, and Population Trend

This report segment updates information on survival rates, cause-specific mortality, and population trend following the methods used in a peer reviewed journal paper (Wakkinen and Kasworm 2004). These survival and reproductive estimates supersede all previous calculations.

Native 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 1983–2015 (Table 12). Adult female survival was 0.952 (95% CI 0.889–1.0, n=15) with 1 instance of natural mortality and 1 poaching among 15 radio-collared bears monitored for 40.7 bear-years. The natural mortality occurred during summer and the poaching occurred during autumn. Adult male survival was 0.885 (95% CI 0.784–0.986, n=25) with 1 legal hunting mortality in Canada, 1 defense of life, and 2 unknown but human-caused mortality among 25 radio-collared bears monitored for 34.0 bear-years. The hunting mortality occurred during spring 35 km northwest of the recovery zone in British Columbia. Defense of life and both the unknown but human-caused mortality occurred during autumn. Subadult female survival was 0.818 (95% CI 0.657–0.979, n=18) among 18 bears monitored for 21.9 bear-years. The trap predation mortality occurred in summer when a bear captured in a foot snare was killed by another grizzly bear. A defense of life and 2 unknown but human-caused mortalities occurred during autumn. Sixteen subadult males were monitored for 11.3 years and produced a survival rate of 0.746 (95% CI 0.513–0.979, n=16). There was 1 spring unknown but human-caused mortality, one mistaken identity during autumn, and one unknown but human caused mortality during autumn. Yearling survival was 0.889 (95% CI 0.744–1.0, n=33) among 33 bears monitored for 16.3 bear-years. One bear died during spring and one during summer from natural causes. Fourteen of 38 cubs died, resulting in a survival rate of 0.632 (95% CI 0.479–0.785, n=38). Two cubs died by poaching during autumn, and 12 cubs were believed to have died of natural causes during summer.

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, 1983–2015.

	Demographic parameters and mortality rates					
Parameter	Adult female	Adult male	Subadult female	Subadult male	Yearling	Cub
Individuals / bear-years	15 / 40.7	25 / 34.0	18 / 21.9	16 /11.3	33 / 16.3	38 / 38[a]
Survival[b] (95% CI)	0.952 (0.889–1.0)	0.885 (0.784-0.986)	0.818 (0.657–0.979)	0.746 (0.513-0.979)	0.889 (0.744–1.0)	0.632 (0.479–0.785)
Mortality rate by cause						
Legal Hunt Canada	0	0.032	0	0	0	0
Natural	0.025	0	0	0	0.111	0.316
Defense of life	0	0.029	0.043	0.055	0	0
Mistaken ID	0	0	0	0.075	0	0
Poaching	0.022	0	0	0	0	0.053
Trap predation	0	0	0.050	0	0	0
Unknown human	0	0.053	0.089	0.125	0	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 native, 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 British Columbia or U.S. and broken into three time periods. The three periods (1983–1998, 1999-2006, and 2007–2015) 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 0.944. 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. A large increase in mortality occurring on private lands within the U.S. also contributed heavily to this increase in overall mortality and may also be related to poor berry production that may have caused bears to search more widely for foods that may occur on private lands. Several mortalities occurring during 1999–2006 were associated with sanitation issues on private lands. Several deaths of management bears occurred on private lands, but were not included in this calculation. Capture biases occur for management bears because traps were set only once a conflict occurred and removed after the animal was captured. Point estimates for human caused mortality occurring on public lands in the U.S. and British Columbia decreased from 1983–1998 to 1999–2006 and again from 1999–2006 to 2007–2015. This apparent decrease in mortality rates on public lands from 1983–1998 to 1999–2006 is particularly noteworthy given the increase in overall mortality rates. 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, 1983–2015.

Parameter	1983–1998	1999–2006	2007–2015
Individuals / bear-years	23 / 48.9	21 / 20.3	37 / 38.1
Survival[b] (95% CI)	0.899 (0.819–0.979)	0.792 (0.634–0.950)	0.944 (0.869–1.0)
Mortality rate by location and cause			
Public / natural	0	0.059	0
U.S. public / human	0.061	0.036	0.029
U.S. private / human	0	0.075	0.027
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 were calculated for 18 augmentation grizzly bears from 1990–2015. Bears that left the area, but did not die were censored. Thirteen female and five male bears ranged in age from 2–10, but were pooled for this calculation because of small sample size. Survival for augmentation bears was 0.767 (95% CI 0.601–0.934, n=18) with 1 instance of natural mortality, 1 poaching, 1 mistaken identity, and 1 train collision among 18 radio-collared bears monitored for 19.5 bear-years. The natural mortality occurred during summer, poaching, mistaken identity, and train mortality occurred during autumn. The female that died of a natural mortality produced a cub before her death, but it is believed the cub died at the same time.

Management Grizzly Bear Survival and Cause-Specific Mortality

Kaplan-Meier survival rates were calculated for 7 management grizzly bears from 2003–15. All bears were males aged 2–5, but were pooled for this calculation because of small sample size. Survival rate was 0.480 (95% CI 0.141–0.819, n=7) with 1 instance of mistaken identity, 1 defense of life, and 1 unknown but human-caused mortality among 7 radio-collared bears monitored for 4.0 bear-years. All mortality occurred during autumn.

Native Grizzly Bear Reproduction

Mean age of first parturition among native grizzly bears was 6.5 years (95% CI; 6.1–6.9, n=11, Table 16). Three of four bears used in the calculation were radio-collared from ages 2–8. The fourth individual was captured with a cub at age 6 years old. We assumed this was her first reproductive event given her age. Seven other first ages of reproduction were established through genetic parentage analysis and known age of offspring. Twenty-one litters comprised of 45 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 2.14 (95% C.I. 1.89–2.39, n=21, Table 14). Twenty reproductive intervals were determined through both monitoring radio-collared bears and known genetic parentage analysis paired with remote camera observation (Table 15). Mean inter-birth interval was calculated as 2.80 years (95% C.I. 2.36–3.24, n=20)l. Booter software provides several options to calculate a 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 0.378 female cubs/year/adult female (95% C.I. 0.296–0.491, n=13 adult females, Table 16). In all calculations the sex ratio of cubs born was assumed to be 1:1.

Table 14. Native grizzly bear reproductive data from the Cabinet-Yaak 1983–2015.

Bear	Year	Cubs	Age at first reproduction	Reproductive Interval[1]	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	2		4	♀ #353 dead in 2002, ♀ #354 dead in 2007
106	1999	2			♀ #106 and 2 cubs dead in 1999
206	1994	2	6	3	♀ #505
206	1997	2			♀ #596 dead in 1999, ♀ #592 dead in 2000
538	1997	1	6	3	1 yearling separated from ♀ #538 in 1998
538	2000	2		1	2 cubs dead in 2000
538	2001	2		1	2 cubs dead in 2001
538	2002	2			2 cubs of unknown sex and fate
303	2000	2	7	3	1 cub dead in 2000, ♀ #552
303	2003			4	At least 2 cubs
303	2007			3	
303	2010	3			1 cub dead in 2010
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	3	7		♀ #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	3			♀ #789, ♂ #791, Unk sex dead in 2007
675	2009	2	7	1	2 cubs dead in 2009
675	2010	1			1 cub dead in 2010
552	2011	2		3	♀ 2011049122, ♂ 2011049118
552	2014	3			3 cubs of unknown sex
784	2013		7		At least 2 cubs
810	2010		7	4	At least one cub
810	2014	2			2 cubs observed at camera site, August 2014
820	2009		6	4	At least one cub
820	2013				At least 2 cubs
831	2004		7	3	At least 1 cub
831	2007				At least 2 cubs
831	2012				At least 3 cubs

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

Population Trend

Approximately 95% of the survival data and 85% of the reproductive data used in population trend calculations came from bears monitored in the Yaak River portion of this population, hence this result is most indicative of that portion of the recovery area. 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. We have no data to suggest that mortality or reproductive rates are different between the Yaak River and the Cabinet Mountains. The Cabinet Mountains portion of the population was estimated to be <15 in 1988 (Kasworm and Manley 1988) and subsequent lack of identification of native bears through genetic techniques would suggest the population was possibly 5–10. Population augmentation has transplanted 18 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 fold, but this increase is largely a product of the augmentation effort with reproduction from that segment.

The estimated finite rate of increase (λ) for 1983–2015 using Booter software with the unpaired litter size and birth interval data option was 1.011 (95% C.I. 0.924–1.084, Table 15). Finite rate of change in the population was an annual 1.1% for the period (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 small sample sizes yield wide confidence intervals around any calculated estimate of trend (i.e., λ). The probability that the population was stable or increasing was 61%. The decline in Lambda from the 2014 calculation (1.014) to the 2015 calculation (1.011) occurred largely because of new genetics data that caused an increase in first age of reproduction and birth interval.

Sample size concerns limited calculation of point estimates of cumulative annual rate of change until 1998 (Fig. 9). Finite rates of increase calculated for the period 1983–1998 (λ = 1.067) suggested an increasing population (Wakkinen and Kasworm 2004). Survival rates for adult and subadult females were 0.948 and 0.901 respectively, at that time. Adult and subadult female survival rates declined to 0.926 and 0.740 respectively in 2006 at the lowest point in the cumulative lambda calculations (Fig. 10). Human-caused mortality has accounted for much of this decline in survival rates and population trend. During 2015, adult female survival and subadult female survival had increased to 0.951 and 0.818 respectively and 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, 1983–2015.

Parameter	Sample size	Estimate (95% CI)	SE	Variance (%)[a]
Adult female survival[b] (S_a)	15 / 40.6[c]	0.951 (0.873–1.0)	0.034	24.7
Subadult female survival[b] (S_s)	18 / 21.7[c]	0.818 (0.637–0.958)	0.085	62.7
Yearling survival[b] (S_y)	33 / 16.2[c]	0.884 (0.723–1.0)	0.076	2.1
Cub survival[b] (S_c)[d]	38/38	0.632 (0.474–0.790)	0.079	4.5
Age first parturition (*a*)	11	6.5 (6.1–6.8)	0.195	0.6
Maximum age (*w*)	Fixed	27		
Unpaired Reproductive rate (*m*)[e]	13/20/21[f]	0.378 (0.296–0.491)	0.051	5.3
Unpaired Lambda (λ)	5000 bootstrap runs	1.011 (0.924–1.084)	0.041	

[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 15.

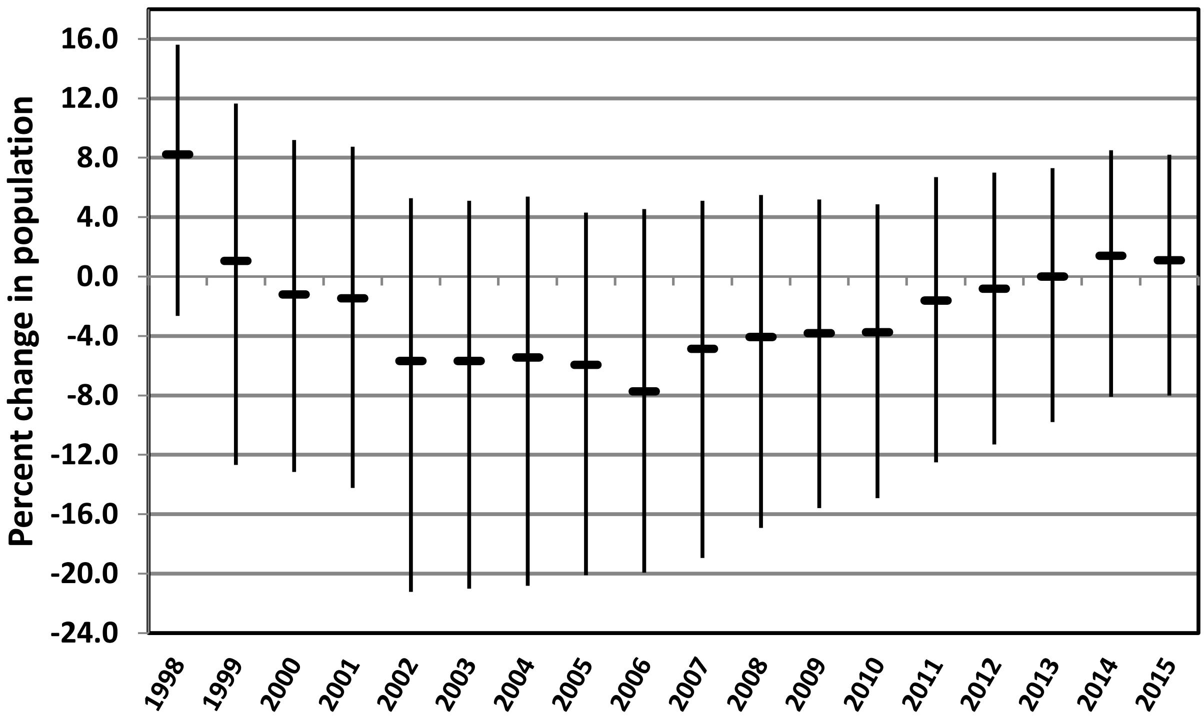


Figure 10. Point estimate and 95% confidence intervals for cumulative annual calculation of population rate of change for native grizzly bears in the Cabinet-Yaak recovery area, 1983–2015. Each entry represents the annual rate of change from 1983 to that date.

Capture and Marking

Cabinet Mountains

Research trapping was conducted in the Cabinet Mountains portion of the CYGBRZ from 1983–87. Three adult grizzly bears were captured during this effort (1 female and 2 males). No trapping effort occurred from 1988–1994. In 1995 an effort was initiated to recapture relocated bears in order to determine success of the population augmentation program and capture any native bears in the Cabinet Mountains. During 1983–2015, 7,452 trap-nights were expended to capture 11 known individual grizzly bears and 308 individual black bears (Table 16 and 17, Fig. 11). Rates of capture by individual were 1 grizzly bear/677 trap-nights and 1 black bear/24 trap-nights. A trap-night was defined as one site with one or more snares set for one night. None of the augmentation bears were captured during subsequent trapping efforts. Much of the trapping effort before 2002 involved use of horses on backcountry trails and closed roads. In 2003, two culvert traps were airlifted to the East Fork of Rock Creek by helicopter. Traps were operated during the last week of August and first week of September. Three black bears were captured. No grizzly bears were captured, though one was observed near the traps.

Yaak River, Purcell Mountains South of BC Highway 3

Trapping was conducted in the Yaak portion of the CYGBRZ during 1986–87 as part of a black bear graduate research study (Thier 1990). Trapping was continued from 1989–2015 by the U.S. Fish and Wildlife Service. Ninety-three captures of 51 individual grizzly bears and 519 captures of 435 individual black bears were made during 10,310 trap-nights during 1986–2015 (Tables 16 and 17, Fig. 11). Rates of capture by individual were 1 grizzly bear/202 trap-nights and 1 black bear/24 trap-nights.

Trapping effort was concentrated in home ranges of known bears during 1995–2015 to recapture adult females with known life histories. Much of the effort involved using horses in areas inaccessible to vehicles, such as backcountry trails and closed roads.

Salish Mountains

Trapping occurred in the Salish Mountains, south of Eureka, Montana, in 2003. An adult female grizzly bear (5 years old), and 5 black bears were captured during 63 trap-nights of effort (Tables 16, 17).

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 2004-08 (Table 16 and Fig. 11). 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.

Population Linkage Kootenai River Valley, Montana

Twelve black bears were captured and fitted with GPS radio collars during 2004-07 to determine bear crossing patterns of the Kootenai River valley near the junction of Highway 2 and 508. These captures were distributed north (6 females and 3 males) and south of the Kootenai River (1 female and 2 males).

Population Linkage Clark Fork River Valley, Montana

Seventeen black bears were captured and fitted with GPS radio collars in the Clark Fork River Valley during 2008–11 to examine bear crossing opportunities near the junction of Highways 200 and 56. Eleven of these bears (3 females and 8 males) were north of the Clark Fork River and 6 bears (6 males) south of the river.

Population Linkage Interstate 90 Corridor, Montana and Idaho

In 2011 and 2012, we collared black bears with GPS radio collars along I-90 between St. Regis, MT and the MT-ID border (near Lookout Pass). Twenty bears were captured 23 times during 446 trap-nights of effort, resulting in 19 trap-nights/capture (Table 16). A total of 16 bears were collared (15 in Montana, 1 in Idaho). Eight of the bears (2 females and 6 males) were collared north of the interstate highway and 8 (3 females and 5 males) were collared south of the highway.

Population Linkage Highway 95 Corridor, Idaho

We began an effort in 2011 to collar black bears with GPS radio collars along Highway 95 between Bonners Ferry and Sandpoint, Idaho. The effort centered on the McArthur Lake State Wildlife Management Area. Nineteen black bears were captured during 413 trap-nights of effort, or 22 trap-nights/capture (Table 16). Fourteen bears were collared. Nine of those bears (4 females and 5 males) were collared west of the highway, and 5 (5 males) were east of the highway.

Table 16. Capture effort and success for grizzly bears and black bears within project study areas, 1983–2015.

Area / Year(s)	Trap-nights	Grizzly Bear Captures	Black Bear Captures	Trap-nights / Grizzly Bear	Trap-nights / Black Bear
Cabinet Mountains,1983–15					
Total Captures	7452	14	426	532	17
Individuals[1]	7452	11	309	677	24
Salish Mountains, 2003[1]	63	1	5	63	13
Yaak River South Hwy 3, 1986–15					
Total Captures	10310	93	519	111	20
Individuals[1]	10310	51	435	202	24
Purcells N. Hwy 3, BC 2004–09					
Total Captures	390	10	37	39	11
Individuals[1]	390	9	32	43	12
Interstate 90, 2011–12					
Total Captures	446	0	23	0	19
Individuals[1]	446	0	20	0	22
Hwy 95, ID, 2011					
Total Captures	408	0	19	0	21
Individuals[1]	408	0	19	0	21

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

Table 17. Grizzly bear capture information from the Cabinet-Yaak, Purcell, and Selkirk Mountain populations, 1983–2015. Multiple captures of a single bear during a given 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

Bear	Capture Date	Sex	Age (Est.)	Mass kg (Est.)	Location	Capture Type
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
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, open freezer, killed goats
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, garbage feeding
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, garbage feeding
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

Bear	Capture Date	Sex	Age (Est.)	Mass kg (Est.)	Location	Capture Type
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, garbage feeding
668	10/11/05	M	3	120	Yaak R., MT	Management, 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, fruit trees
789	9/18/07	F	Cub	36	Pilgrim Cr., MT	Management, fruit trees
791	9/18/07	M	Cub	39	Pilgrim Cr., MT	Management, fruit trees
785	10/15/07	F	1	75	Pete Cr., MT	Research
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, 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, 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	19	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	235	Cool Cr., MT	Research
839	6/19/15	M	4	172	Bear Cr., MT	Research
810	7/16/15	F	12	264	Hellroaring Cr., MT	Research
818	7/18/15	M	2	181	Meadow Cr., MT	Research
820	8/20/15	F	12	327	Hellroaring Cr., MT	Research
726	10/5/15	M	6	500	Libby Cr., MT	Management, beehives

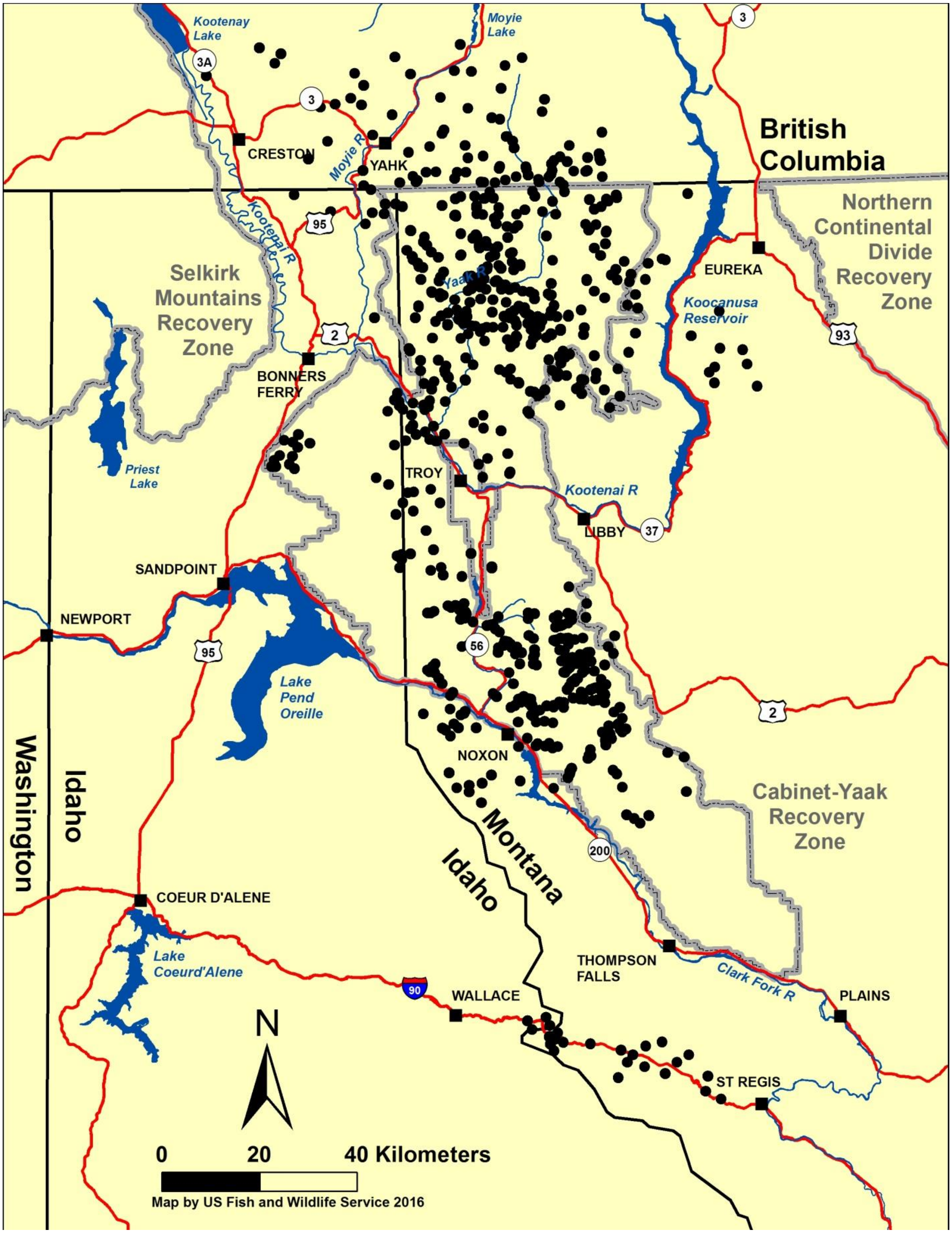


Figure 11. Trap site locations in the Cabinet-Yaak study areas 1983–2015.

Cabinet Mountains Augmentation Captures Flathead River, Montana and British Columbia

From 1990-94 four female grizzly bears were captured in the Flathead River Valley of British Columbia and released in the Cabinet Mountains to augment the existing population. Twenty-two different grizzly bears were captured during 840 trap-nights, to obtain the 4 subadult females transplanted. Capture rates were 1 grizzly bear/38 trap-nights, and 1 suitable subadult female/210 trap-nights. A transplanted bear and her cub died of unknown causes a year after release. The remaining three bears were monitored until their collars fell off. 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 within the target area for more than one year. Though one of the transplanted bears produced a cub, the animal had likely bred prior to translocation and did not satisfy our criteria for reproduction with native males.

In 2005 an adult female grizzly bear (A1) was captured in the North Fork of the Flathead River drainage by Montana Dept. of Fish, Wildlife and Parks personnel and relocated to the West Cabinet Mountains near Spar Lake. In 2006 a subadult female (782) was captured in the South Fork of the Flathead River drainage by state personnel and released in the same area near Spar Lake with a GPS radio collar. No bears were transplanted in 2007 as no suitable females were captured. Two female grizzly bears were released in the East Fork of the Bull River during 2008 during late July and early August, respectively. The first (4-year-old) came from the upper Stillwater drainage of the Whitefish Range and the second (3-year-old) came from Swan River. Both bears were equipped with GPS radio collars. In October 2008 both of these bears were killed. In September 2009 an adult female from Big Creek in the North Fork of the Flathead River drainage was released in the Spar Lake area. In July 2010, two subadult bears, a male (5-year-old) and a female (4-year-old), were transplanted to the Cabinet Mountains. A male from Dead Horse Creek was released near Spar Lake and a female from Spruce Creek was released at Silverbutte Creek. Two 2–year-old bears were released in 2011. A female (725) from Puzzle Creek in the Middle Fork of the Flathead River drainage was released near Spar Lake and a male (723) from Stryker Ridge near Antice Creek was also released near Spar Lake. A 2-year-old male grizzly bear (918) was caught in the East Fork of Swift Creek and was moved to the Cabinet Mountains during 2012 and released in the East Fork of the Bull River. In late July 2013, a 3-year-old male grizzly bear (919) was released west of Spar Lake. This bear was captured in Coal Creek within the North Fork Flathead drainage. In June of 2014, two sibling 2-year-old females (920 and 921) were caught in the North Fork of the Flathead and relocated just west of Spar Lake. A two-year-old male grizzly bear (924) was caught in Stryker Basin (Antice Creek) in the Whitefish Mountains in August of 2015. Shortly after release near Spar Lake, bear 924 moved south into the Bitterroot Mountains. In late September 2015, bear 924 was reported dead, killed by a black bear hunter in Beaver Creek near Prichard, Idaho.

Radio Telemetry Monitoring

Black Bear – Linkage Research

We previously collected radio collar data for black bears on three study areas around Highways 3 in BC (18 bears), Highway 2 in northwest Montana(16 bears), and Highway 95 in northern Idaho (23 bears, Lewis 2007) (Fig. 12). We are planning a comprehensive RSF analysis that will examine habitat variables associated with telemetry data from to identify probable linkage areas across highways for black bears similar to that already done for grizzly bears (Proctor et al. 2015).

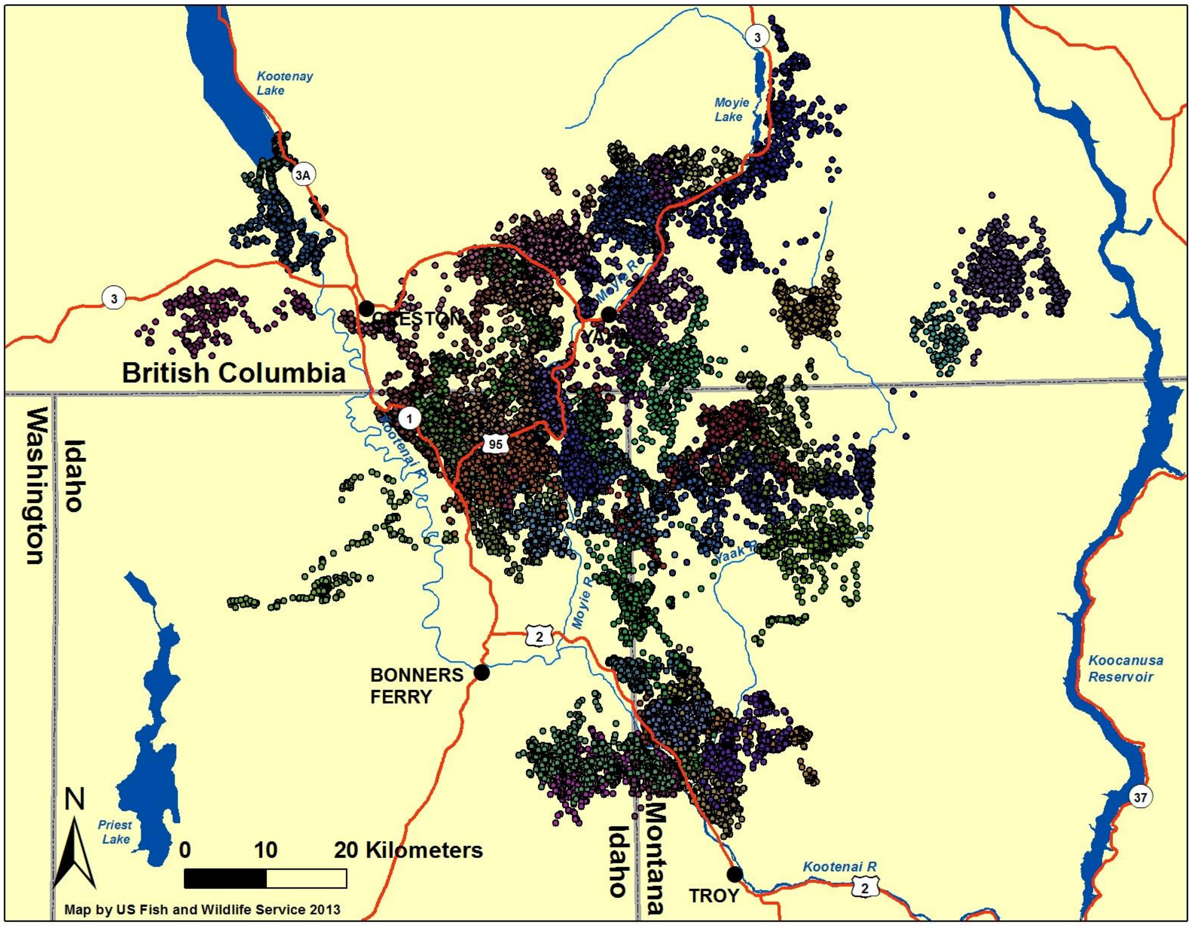


Figure 12. Telemetry locations from 57 collared black bears along Highways US 2, BC 3, and US 95 in southeast British Columbia, north Idaho, and northwest Montana during 2004–2011.

We completed black bear monitoring on 3 additional study areas during 2012. The Clark Fork / Highway 200 study area is near the confluence of the Bull River and Clark Fork Rivers near Noxon, Montana. The Lookout Pass / Interstate 90 study area is between St. Regis, Montana and Wallace, Idaho. The McArthur Lake / Highway 95 study area is 15 miles south of Bonners Ferry, Idaho.

In the Clark Fork River / Highway 200 study area we retrieved collars during October from 4 black bears that wore collars from 2011–12. These monitoring data have been added to previously collected data from another 10 black bears collared during 2008–11. All collar data has been entered in a database and has been reviewed. Initial analysis and summary is complete and files were prepared for RSF modeling (Fig.13). Telemetry data indicated that 2 of these animals crossed Highway 200 and two other bears crossed Highway 56.

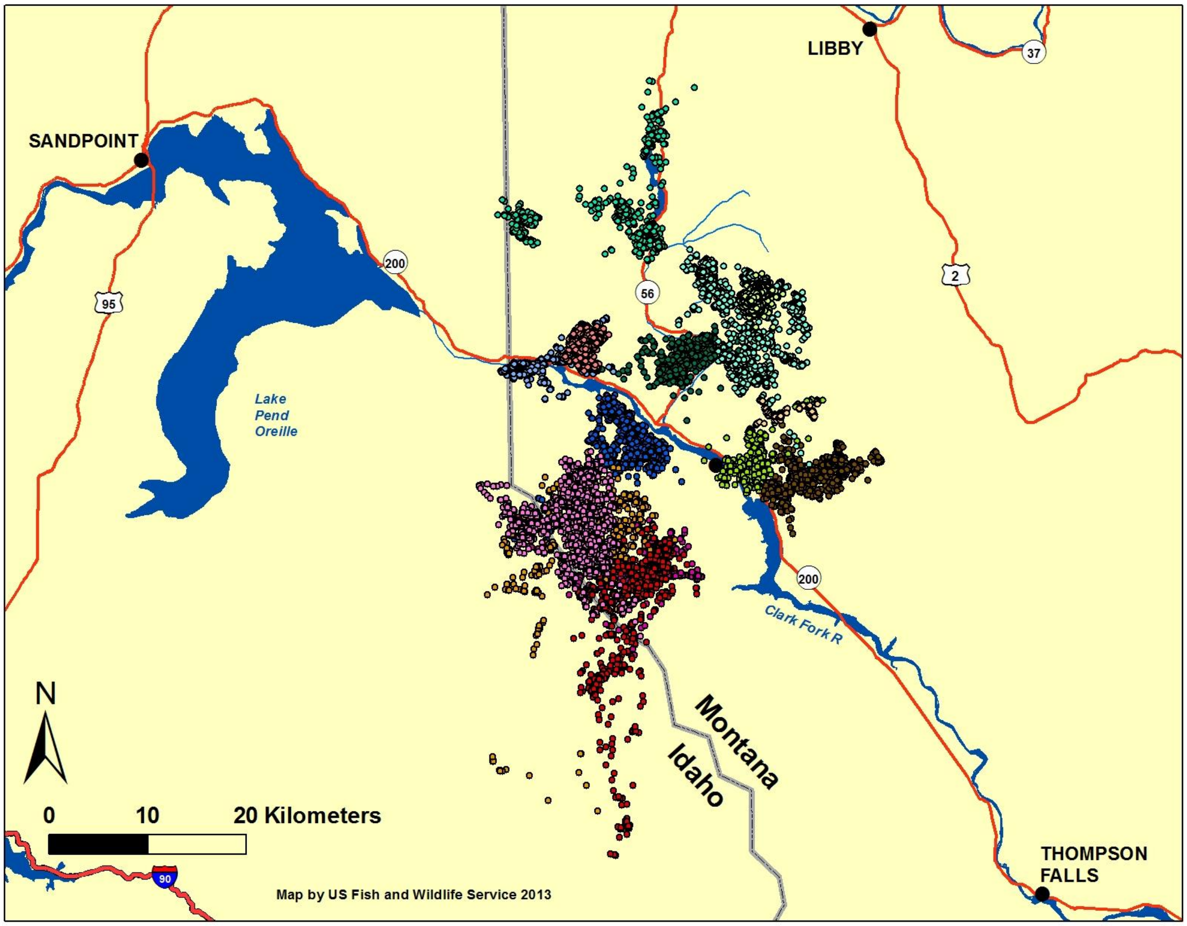


Figure 13. Telemetry locations from 14 black bears collared near Highways 200 and 56 near the Idaho-Montana border during 2008–12.

Fourteen radio collars were placed on black bears in the I-90 study site near Lookout Pass during 2011. Several collared black bears were lost to hunter harvest during the fall of 2011 and the spring of 2012 and two additional collars were placed on bears in 2012 as replacements. One collar and data were lost when a hunter accidentally shot the radio collar while attempting to kill a bear. Fifteen collars were retrieved in October of 2012 and that data has been prepared for RSF analysis (Fig. 14). Monitoring dated indicated that four bears crossed I-90 and one of these moved north and crossed Highway 200.

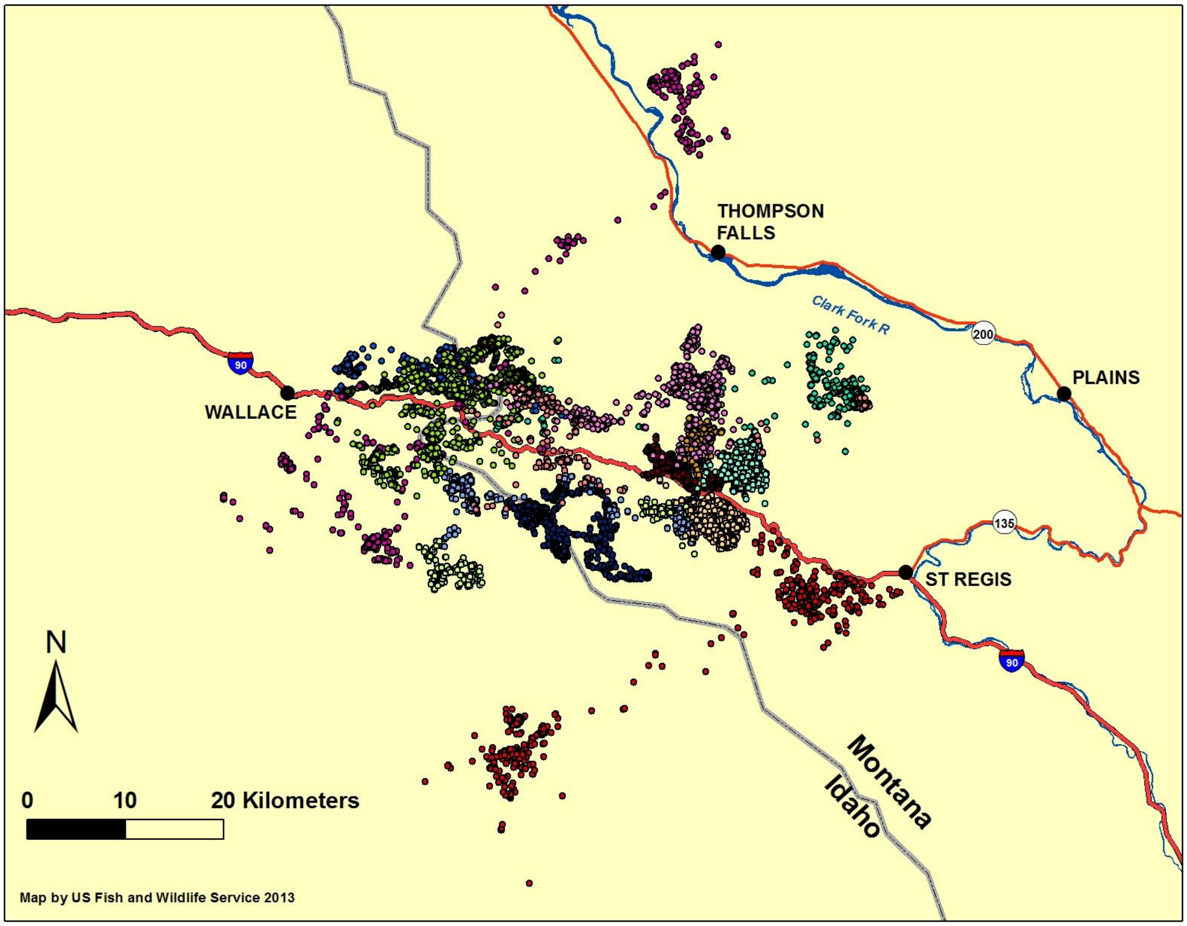


Figure 14. Telemetry locations from 15 black bears collared along Interstate 90 near the Idaho-Montana border during 2011–12.

Fourteen collars were placed on black bears along Highway 95 near McArthur Lake in 2011. No animals were harvested by hunters in 2011, but one bear was killed by hunters in 2012. Another bear was killed by a neck snare set for coyotes in 2012 and a third bear was found dead and is under investigation by IDFG. Data from collars has been initially analyzed and prepared for RSF analysis (Fig. 15). Monitoring data indicated that two of these animals crossed Highway 95.

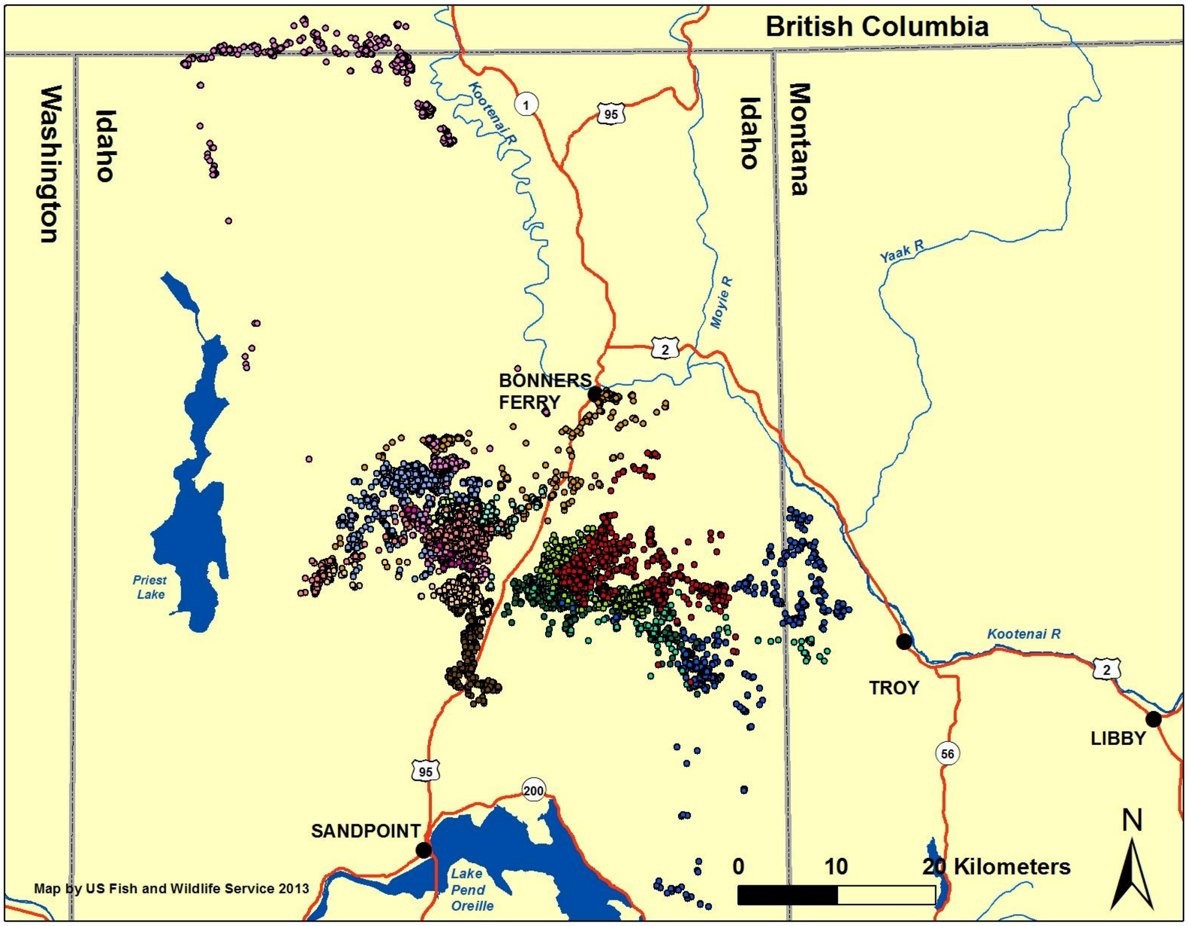


Figure 15. Telemetry locations from 14 collared black bears near highway 95 in north Idaho during 2011–12.

Our analysis will be combined with data from Highways BC 3, US 95 north, and US 2. The comprehensive RSF analysis will examine habitat variables associated with telemetry data from 99 black bears collared from all highways and attempt to identify probable linkage areas across highways for black bears. We will use a suite of seamless GIS layers, and will identify key variables that depict black bear linkage habitat. Ultimately, we will compare these results with grizzly bear linkage habitat. All data has been organized and analysis is underway.

Our goal in comparing grizzly and black bear linkage areas across major highways was to determine the ability of black bears to potentially act as surrogates for grizzly bears in areas where grizzly bear data is lacking (i.e., Highway I-90). Another goal is to identify black bear linkage areas to initiate development of a multi-species approach in linkage management. A final paper will be submitted to a peer reviewed journal when analysis is complete.

Grizzly Bear Monitoring and Home Ranges

Sixteen grizzly bears were monitored with radio collars during portions of 2015. Research monitoring included three females (two adults and 1 subadult) and five males (3 adults and 2 subadults) in the Yaak River and three females (1 native adult and 2 subadults) and two males (subadults) in the Cabinet Mountains. Four bears from the Cabinet Mountains (2 subadult males and 2 subadult females) were part of the augmentation program.

Aerial, specific locations and GPS collar locations were used to calculate home ranges. The convex polygon life ranges were computed for bears monitored during 1983-2015 (Table 18 and Appendix 4 Figs. 33-120). Bears with multiannual home range estimates and sample sizes in excess of 50 locations were used to calculate basic statistics. Native adult male life range averaged 1,938 km^2 (95% CI ± 435, n = 20) and native adult female life range averaged 677 km^2 (95% CI ± 369, n = 11) using the minimum convex polygon estimator.

The minimum convex polygon estimator for bear 106 was 658 km^2 during her 1986–99 life time. Her home range was smallest during 1986, 1988, 1991, 1993, and 1995 when she had cubs. Four known female offspring of bear 106 established home ranges around their maternal range. 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.

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 habitat at the same time to avoid conflict.

Table 18. Home range sizes of native (independent or family groups) and transplanted grizzly bears in the Cabinet-Yaak recovery zone, Purcell Mountains and Salish Mountains 1983–2015.

Bear	Sex	Age (Est)	Years	Collar Type	Number of fixes	100% Convex polygon (km^2)	Area of use
678	F	28-34	1983-89	VHF	173	658	Cabinet Mts, MT
680	M	11-12	1984-85	VHF	75	1,947	Cabinet Mts, MT
14	M	27	1985	VHF	23	589	Cabinet Mts, MT
101	M	8	1986	VHF	38	787	Yaak River, MT
106	F	8-20	1986-99	VHF	379	852	Yaak River, MT
128	M	4-14	1987-97	VHF	204	2,895	Yaak River, MT
129	F	1-3	1987-89	VHF	42	60	Yaak River, MT
134	M	8-9	1987-88	VHF	20	594	Yaak River, MT
192	M	2	1990	VHF	10	574	Yaak River, MT
193	M	2	1990	VHF	34	642	Yaak River, MT
206	F	2-7	1990-95	VHF	208	1,332	Yaak River, MT
218	F	5-6	1990-91	VHF	95	541	Cabinet Mts, MT
244	M	6-18	1992-04	VHF	158	1,406	Yaak River, MT
258	F	6-7	1992-93	VHF	54	400	Cabinet Mts, MT
286	F	2-3	1993-94	VHF	82	266	Cabinet Mts, MT
311	F	3-4	1994-95	VHF	16	209	Cabinet Mts, MT
302	M	1-3	1994-96	VHF	60	514	Yaak River, MT
303	F	1-22	1994-01, 2011-15	GPS & VHF	12,058	570	Yaak River, MT
342	M	4-12	1996-04	VHF	134	1,653	Yaak River, MT
355	M	(6)	1996	VHF	5	N/A	Yaak River, MT & BC
358	M	8-10	1996-98	VHF	55	1,442	Yaak River, MT & BC
363	M	4-7	1996-99	VHF	120	538	Yaak River, MT
386	M	5-6	1997-98	VHF	29	1,895	Yaak River, MT
354	F	2-4	1997-99	VHF	70	537	Yaak River, MT
538	F	6-11	1997-02	VHF	232	835	Yaak River, MT & BC
592	F	2-3	1999-00	VHF	59	471	Yaak River, MT & BC
596	F	2	1999	VHF	10	283	Yaak River, MT & BC
552	F	1-15	2001, 2012-15	VHF-GPS	1,431	1,210	Yaak River, MT

Bear	Sex	Age (Est)	Years	Collar Type	Number of fixes	100% Convex polygon (km²)	Area of use
577	F	1	2002	VHF	11	2	Cabinet Mts, MT
578	M	1	2002	VHF	3	N/A	Cabinet Mts, MT
579	M	1	2002	VHF	10	5	Cabinet Mts, MT
353	F	7	2002	VHF	37	119	Yaak River, MT
651	M	7-11	2002-03,06	GPS & VHF	1,827	1,004	Yaak River, MT & BC
787	M	3-4	2003-04	VHF	84	1,862	Yaak River, MT
648	F	5-7	2003-05	VHF	85	948	Salish Mts, MT
576	M	3-4	2005-06	GPS & VHF	2,290	1,320	Yaak River, MT & BC
675	F	2-8	2004-10	GPS & VHF	1,827	714	Yaak River, MT & BC
10	F	11	2004	GPS	1,977	176	Moyie River, BC
11	M	7	2004	GPS	894	1,453	Moyie River, BC
12	F	11	2004	GPS	1,612	333	Moyie River, BC
17	M	8	2005	GPS	1,903	3,074	Yaak River, MT & BC
677	M	6	2005	GPS	519	3,361	Yaak River, MT & BC
688	M	3-4	2005-06	GPS	3,421	1,544	Moyie & Goat River, BC
694	F	2	2005	VHF	11	89	Yaak River, MT
292	F	4	2005	GPS	7,062	253	Moyie & Goat River, BC & ID
770	M	11-12	2005-06	VHF	20	326	Cabinet Mts, MT
2	M	(7-9)	2005-06	GPS	1,337	2,860	Moyie / Yahk, BC
A1	F	(8-10)	2005-07	VHF	73	725	Cabinet Mts, MT
782	F	2-5	2006-08	GPS	1,126	1,932	Cabinet Mts, MT
780	M	6-8	2006-08	VHF	56	1,374	Cabinet Mts, MT
103	M	3-4	2006-07	GPS	4,872	6,545	Kootenai, & Pend Oreille River, BC, ID, & WA
5381	M	4-5	2006-07	GPS	11,491	1,949	Moyie & Goat River, BC & ID
130	F	26-27	2007-08	GPS	3,986	281	Goat River, BC
131	F	(5)	2007-08	GPS	3,270	276	Goat River, BC
784	F	1-3	2007-09	GPS	2,606	524	Yaak River, MT
785	F	1-2	2007-08	GPS	362	207	Yaak River, MT
772	F	10	2007	VHF	14	446	Cabinet Mts, MT
635	F	4	2008	GPS	285	451	Cabinet Mts, MT
790	F	3	2008	GPS	227	423	Cabinet Mts, MT
715	F	(10-11)	2009-10	GPS	437	6,666	Cabinet Mts, MT
731	F	2-4	2009-11	GPS	1,652	852	Yaak River, MT
799	M	3-4	2010-11	GPS	1,422	805	Cabinet Mts, MT
713	M	5-6	2010-11	GPS & VHF	562	5,999	Cabinet Mts, MT
714	F	4-6	2010-12	GPS	1,684	2,389	Cabinet Mts & Flathead, MT
737	M	4-7	2010-13	GPS & VHF	680	2,351	Yaak River, MT & BC
1374	M	2	2010	GPS	14	381	Yaak River, MT & BC
722	M	12-15	2011-14	GPS	3,194	3,314	Yaak River, MT & BC
723	M	2-3	2011-12	GPS	430	1,063	Cabinet Mts, MT
724	M	2-3	2011-12	VHF	29	873	Cabinet Mts, MT
725	F	2-4	2011-13	GPS	3,194	3,314	Cabinet Mts & Flathead, MT
726	M	2-3,6	2011-12,15	GPS	3,086	2,156	Kootenai & Yaak River, MT
729	F	1-5	2011-13, 15	GPS	14,313	535	Yaak River, MT
732	M	5	2011	GPS	875	458	Yaak River, MT
918	M	2-4	2012-14	GPS	1,192	587	Cabinet Mts, MT
826	M	(5)	2013	GPS	164	1,820	Yaak& Kootenai River, MT & BC
919	M	4-5	2013-14	GPS	345	436	Cabinet Mts, MT
808	M	4-5	2014-15	GPS	1,273	1,722	Yaak River, MT
831	F	14	2014	GPS	434	218	Cabinet Mts, MT
835	M	19-20	2014-15	GPS	726	4,145	Yaak River, MT
836	F	1-2	2014-15	GPS	1,060	587	Yaak River, MT
837	M	6-7	2014-15	GPS	771	1,227	Yaak River, MT
920	F	2-3	2014-15	GPS	2,710	890	Cabinet Mts, MT

Bear	Sex	Age (Est)	Years	Collar Type	Number of fixes	100% Convex polygon (km²)	Area of use
921	F	2-3	2014-15	GPS	2,033	259	Cabinet Mts, MT
810	F	12	2015	GPS	1,407	230	Yaak River, MT
818	M	2	2015	GPS	461	225	Yaak River, MT
839	M	3	2015	GPS	206	169	Cabinet Mts, MT
820	F	12	2015	GPS	1,117	293	Yaak River, MT
924	M	2	2015	GPS	741	2,068	Cabinet Mts, MT
1001	M	6	2015	GPS	1,352	1,357	Selkirk Mts, BC

Grizzly Bear Denning Chronology

We used VHF and GPS location data from radio-collared grizzly bears (1983–2015) to summarize den entry and exit dates by month and week. Den entry dates (*n* = 97) ranged from the third week of October to the last week of December. Ninety-three (96%) entries occurred between the 4th week of October and the 3rd week of December (Fig. 16). 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 enter dens later than females (Fig. 16). Female-offspring family groups tend to enter dens later than independent adult females (Fig. 17). By December 1, 38% of Cabinet and Yaak grizzly bears have not yet entered winter dens.

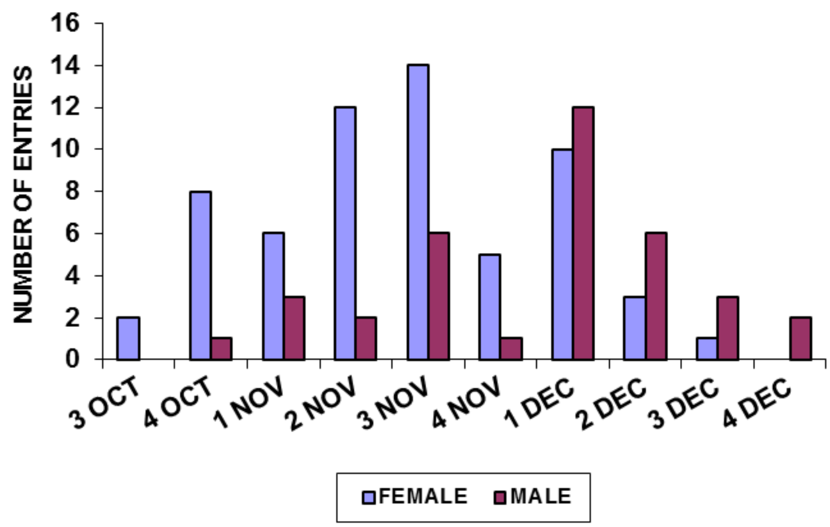


Figure 16. Month and week of den entry for male and female radio-collared grizzly bears in the Cabinet-Yaak grizzly bear recovery zone, 1983–2015.

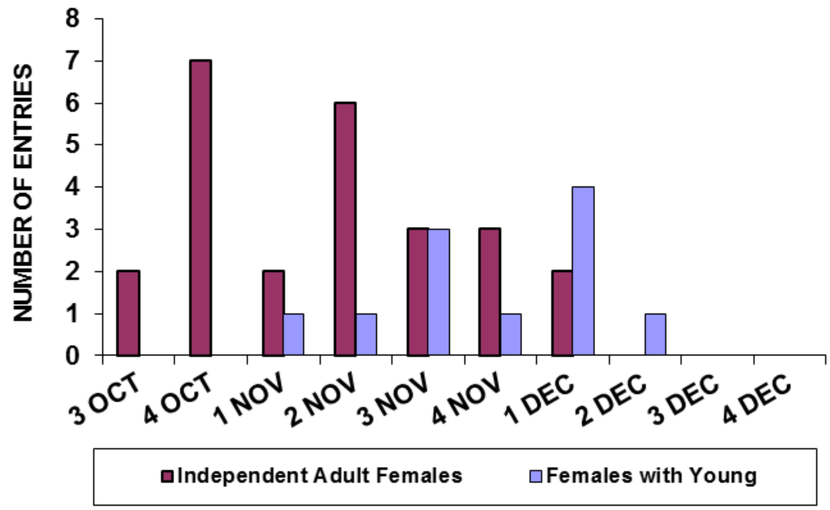


Figure 17. Month and week of den entry for adult female, radio-collared grizzly bears in the Cabinet-Yaak grizzly bear recovery zone, 1983–2015.

Den exit dates (*n* = 84) ranged from the third week of March to the third week of May (Fig. 18). Eighty-one (96%) exit dates occurred from the 4th 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 tend to exit dens one week earlier than females (Fig. 18). Seventy-nine percent of den exits occurred during the month of April. By May 1, 13% of Cabinet and Yaak grizzly bears are still in dens, nearly two-thirds of which are females with cubs-of-the-year (COY). Females with cubs appear to exit dens later than other adult females (median exit during 1st week of May; Fig. 18). All adult females with COY remained at dens until at least the 15th of April (Fig. 19).

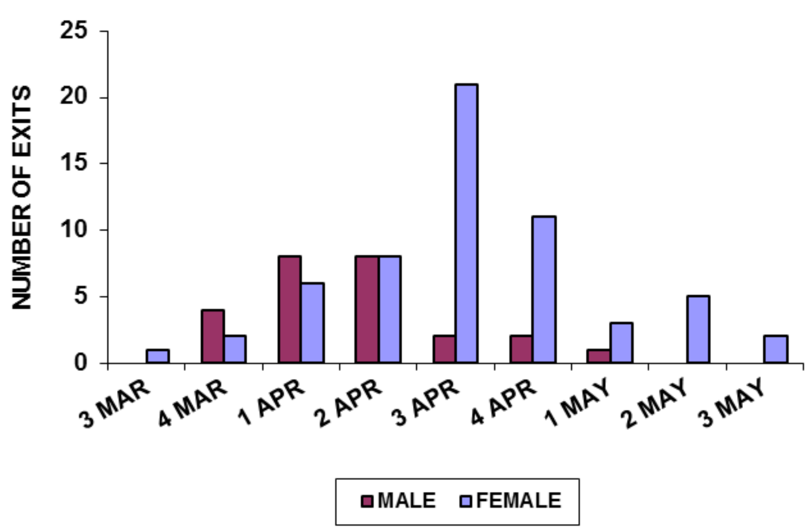


Figure 18. Month and week of den exit for male and female radio-collared grizzly bears in the Cabinet-Yaak grizzly bear recovery zone, 1983–2015.

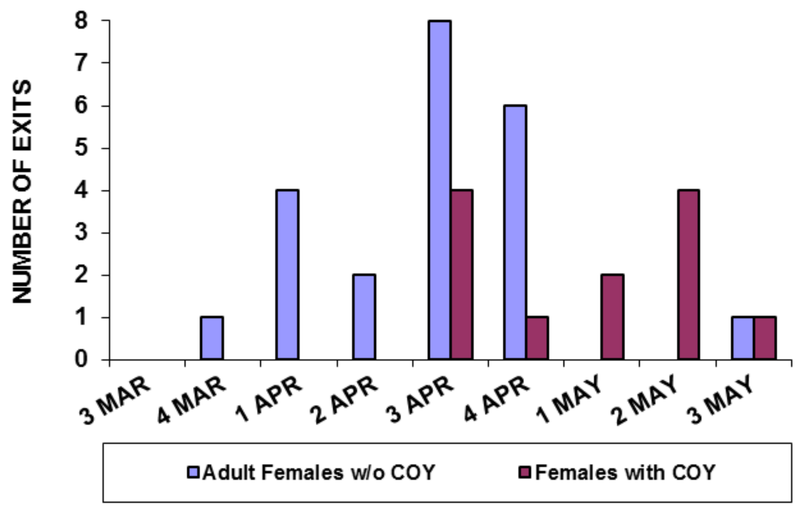


Figure 19. Month and week of den exit for adult female, radio-collared grizzly bears (with and without cubs-of-the year [COY]) in the Cabinet-Yaak grizzly bear recovery zone, 1983–2015.

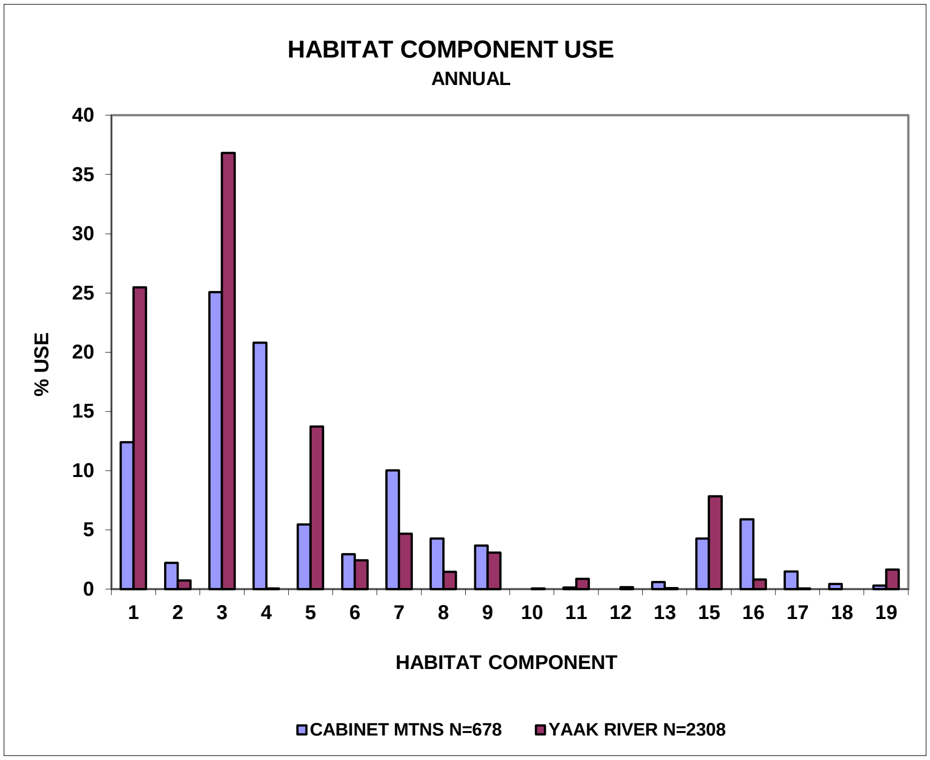
Grizzly Bear Use of Habitat Components

Grizzly bear use of habitat components was summarized on a seasonal basis during 1983–2009. Only VHF radio locations (1983–2009) were used in this analysis. Radio locations derived from GPS radio collars will be analyzed separately through resource selection function techniques in the future. Spring was defined as den exit through 15 June, summer was 16 June through 15 September, and autumn was 16 September through den entry. VHF radiolocation sample sizes for the Cabinet Mountains were: 152 in spring, 379 in summer, and 130 in autumn. Radiolocation sample sizes for the Yaak River were: 480 in spring, 1061 in summer, and 713 in autumn. Den site sample sizes were 17 in the Cabinet Mountains and 54 in the Yaak River.

Radio collared grizzly bears in the Cabinet Mountains and Yaak River made greatest annual use of closed timber, timbered shrub fields, mixed shrub snow chutes, mixed shrub / cutting units, alder shrub fields, huckleberry shrub fields, and graminoid and beargrass sidehill parks (Fig. 20). Primary differences in annual use of habitat components include greater use of mixed shrub snow chutes, alder shrub fields, huckleberry shrub fields, and beargrass sidehill parks in the Cabinet Mountains and greater use of closed timber, timbered shrub fields, mixed shrub/cutting units, and graminoid sidehill parks in the Yaak River. A brief description of all 19 habitat components is provided in Appendix 5.

Spring use of habitat components by grizzly bears in the Cabinet Mountains and Yaak River drainage was dominated by closed timber, timbered shrub fields, mixed shrub snow chutes, mixed shrub cutting units, alder shrub fields, and graminoid sidehill parks (Fig. 21). Notable differences between study areas include heavier use of snow chutes, alder, and graminoid parks in the Cabinet Mountains and heavier use of closed timber, timbered shrub fields, and cutting units in the Yaak River. Food habits indicate that bears are utilizing grasses, sedges, succulent forbs, and corms of glacier lily and biscuitroot during spring (Kasworm and Thier 1993). Snow chutes, cutting units, alder, and graminoid parks provide these items.

Summer use of habitat components by grizzly bears in the Cabinet Mountains and Yaak River drainage was dominated by closed timber, timbered shrub fields, mixed shrub snow chutes, mixed shrub cutting units, mixed shrub burns, alder shrub fields, huckleberry shrub fields, graminoid sidehill parks, and beargrass sidehill parks (Fig. 22). Differences between study areas include heavier use of snow chutes, huckleberry shrub fields, and beargrass parks in the Cabinet Mountains and heavier use of closed timber, timbered shrub fields, cutting units, and graminoid parks in the Yaak River. Food habits indicate heavy use of succulent forbs, insects, and berries (mostly huckleberries) (Kasworm and Thier 1993).



Habitat Components

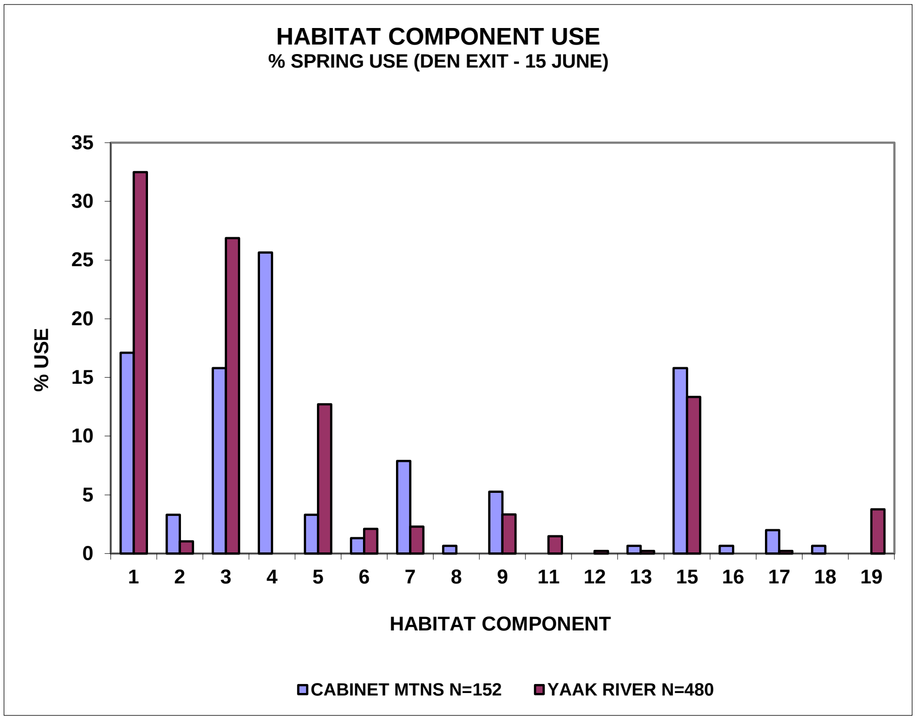
1. Closed Timber
2. Open Timber
3. Timbered Shrub field
4. Mixed Shrub/Snow chute
5. Mixed Shrub/Cutting Unit
6. Mixed Shrub/Burn
7. Alder Shrub
8. Huckleberry Shrub
9. Riparian Stream bottom
10. Marsh
11. Wet Meadow
12. Dry Meadow
13. Drainage Forb field
14. Snow chute
15. Graminoid Sidehill Park
16. Beargrass Sidehill Park
17. Slab rock
18. Talus/Rock/Scree
19. Timbered Grass

Figure 20. Annual habitat component use in the Cabinet Mountains and Yaak River, 1983–2009.

Autumn use of habitat components by grizzly bears in the Cabinet Mountains and the Yaak River drainage was dominated by closed timber, timbered shrub fields, mixed shrub snow chutes, mixed shrub cutting units, mixed shrub burns, alder shrub fields, huckleberry shrub fields, graminoid sidehill parks, and beargrass sidehill parks (Fig. 23). Differences between study areas include heavier use of snow chutes, huckleberry shrub fields, and beargrass parks in the Cabinet Mountains and heavier use of closed timber, timbered shrub fields, cutting units, and graminoid parks in the Yaak River. Autumn bear diets reverted back to grasses and sedges during late rains and subsequent green-up. Berries can still be important when they are still available at higher elevations or mountain ash berries which persist on plants beyond first snowfall. Bears utilize carrion and gut piles from hunter harvested or wounded deer and elk.

Differences in use between the Cabinet Mountains and the Yaak River study areas appear related to amounts or availability of these components in each study area. Much of the use of closed timber and timbered shrub fields occurred adjacent to other components that provided food and may have been used for cover or bedding areas.

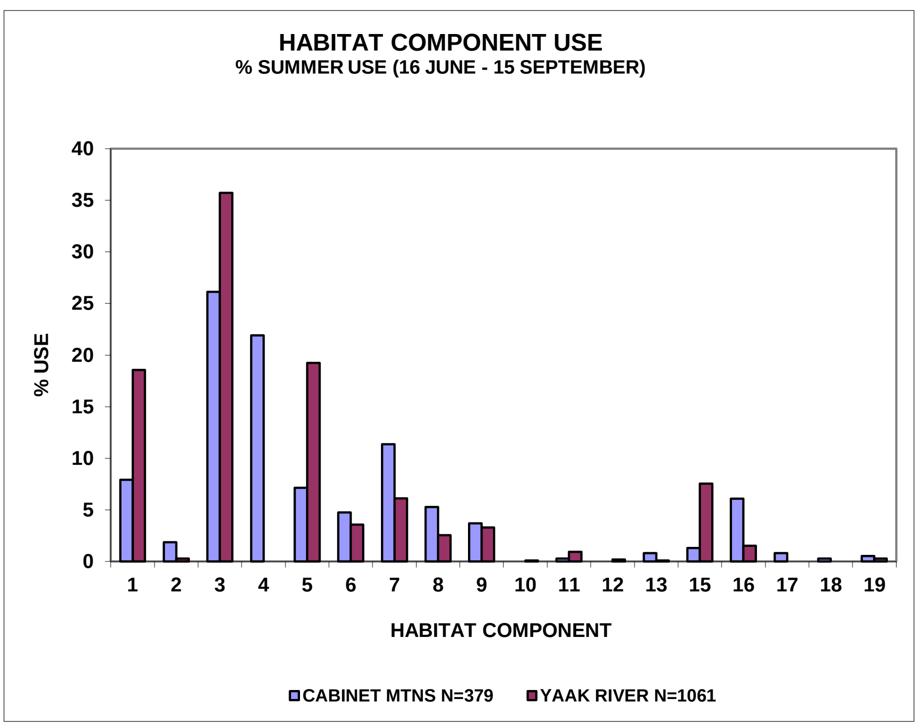
Den use of habitat components by grizzly bears in the Cabinet Mountains and Yaak River drainage was dominated by closed timber, timbered shrub fields, graminoid sidehill parks, and beargrass sidehill parks (Fig. 24). Differences between the two study areas include heavier use of beargrass parks in the Cabinet Mountains and heavier use of closed timber, timbered shrub fields, and graminoid parks in the Yaak River.



Habitat Components

1. Closed Timber
2. Open Timber
3. Timbered Shrub field
4. Mixed Shrub/Snow chute
5. Mixed Shrub/Cutting Unit
6. Mixed Shrub/Burn
7. Alder Shrub
8. Huckleberry Shrub
9. Riparian Stream bottom
10. Marsh
11. Wet Meadow
12. Dry Meadow
13. Drainage Forb field
14. Snow chute
15. Graminoid Sidehill Park
16. Beargrass Sidehill Park
17. Slab rock
18. Talus/Rock/Scree
19. Timbered Grass

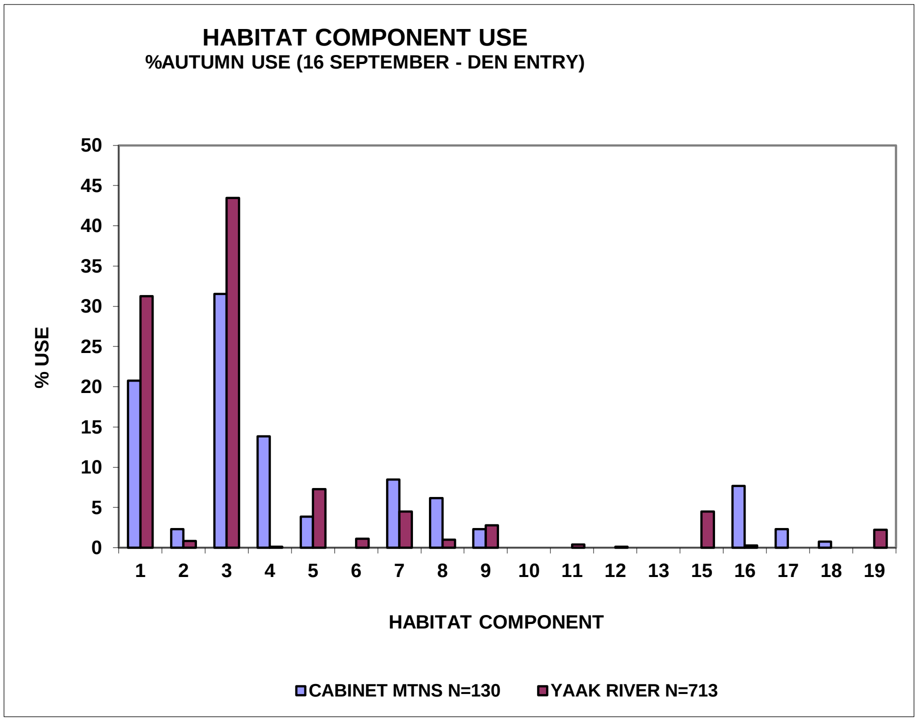
Figure 21. Spring habitat component use in the Cabinet Mountains and Yaak River, 1983-2009.



Habitat Components

1. Closed Timber
2. Open Timber
3. Timbered Shrub field
4. Mixed Shrub/Snow chute
5. Mixed Shrub/Cutting Unit
6. Mixed Shrub/Burn
7. Alder Shrub
8. Huckleberry Shrub
9. Riparian Stream bottom
10. Marsh
11. Wet Meadow
12. Dry Meadow
13. Drainage Forb field
14. Snow chute
15. Graminoid Sidehill Park
16. Beargrass Sidehill Park
17. Slab rock
18. Talus/Rock/Scree
19. Timbered Grass

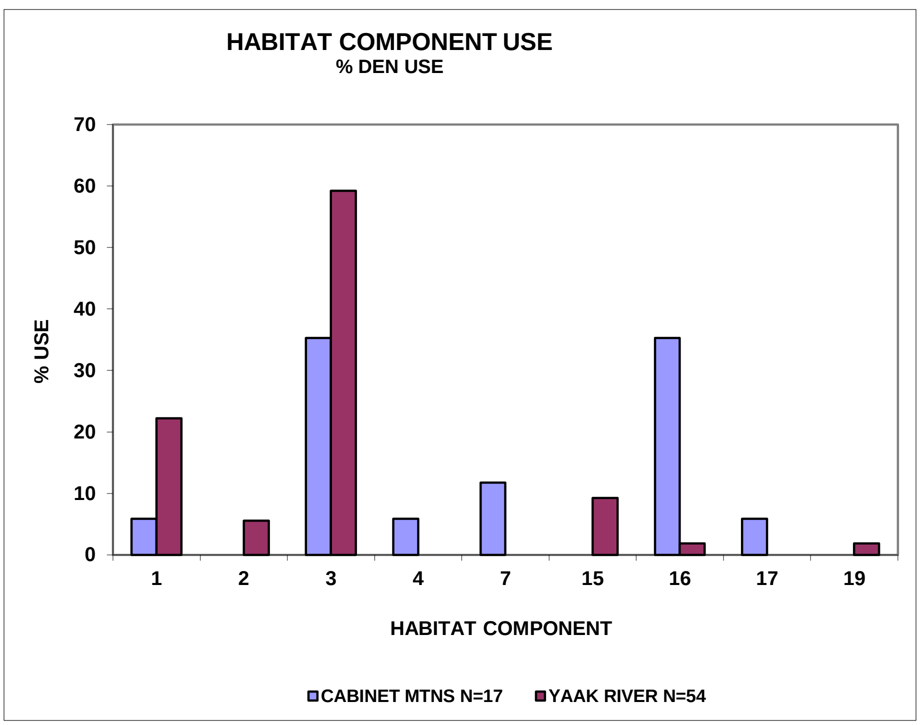
Figure 22. Summer habitat component use in the Cabinet Mountains and Yaak River, 1983-2009.



Habitat Components

1. Closed Timber
2. Open Timber
3. Timbered Shrub field
4. Mixed Shrub/Snow chute
5. Mixed Shrub/Cutting Unit
6. Mixed Shrub/Burn
7. Alder Shrub
8. Huckleberry Shrub
9. Riparian Stream bottom
10. Marsh
11. Wet Meadow
12. Dry Meadow
13. Drainage Forb field
14. Snow chute
15. Graminoid Sidehill Park
16. Beargrass Sidehill Park
17. Slab rock
18. Talus/Rock/Scree
19. Timbered Grass

Figure 23. Autumn habitat component use in the Cabinet Mountains and Yaak River, 1983-2009.



Habitat Components

1. Closed Timber
2. Open Timber
3. Timbered Shrub field
4. Mixed Shrub/Snow chute
5. Mixed Shrub/Cutting Unit
6. Mixed Shrub/Burn
7. Alder Shrub
8. Huckleberry Shrub
9. Riparian Stream bottom
10. Marsh
11. Wet Meadow
12. Dry Meadow
13. Drainage Forb field
14. Snow chute
15. Graminoid Sidehill Park
16. Beargrass Sidehill Park
17. Slab rock
18. Talus/Rock/Scree
19. Timbered Grass

Figure 24. Den habitat component use in the Cabinet Mountains and Yaak River, 1983-2009.

Grizzly Bear Use by Elevation

Differences in elevation between the Cabinet Mountains and the Yaak River study areas are reflected in the bear location data from both areas (Figs. 25 and 26). Annual mean elevation used by grizzly bears in the Cabinet Mountains was 1,575 meters compared to 1,497 meters for the Yaak River. Monthly mean elevation followed similar patterns with Cabinet Mountain grizzly bears utilizing higher elevations during most months except November. Sample size in the Cabinet Mountains during November was small, but bears were generally forced into lower elevations by snowfall prior to den entry and may have been responding to increased amount of carrion in the form of gut piles and wounded animals from ungulate hunters. Mean den elevation in the Cabinet Mountains was 1,875 meters and 1,698 meters in the Yaak River.

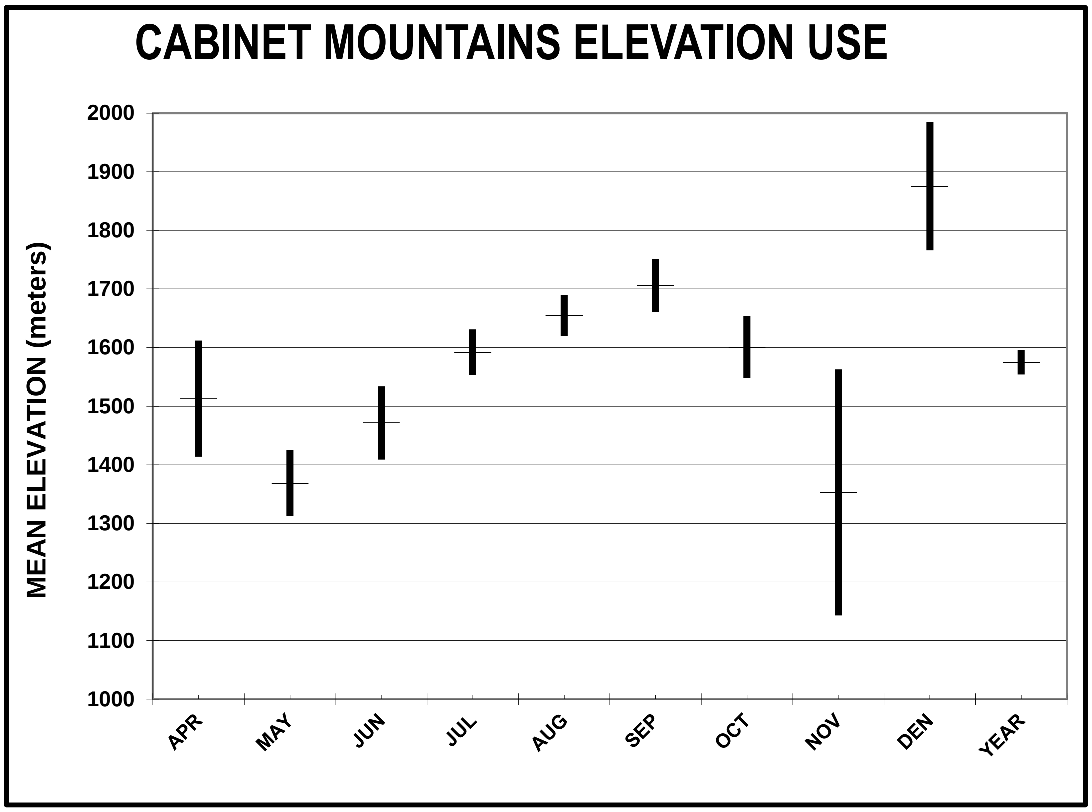


Figure 25. Mean elevation and 95% confidence intervals of radiolocations in the Cabinet Mountains, 1983–2009.

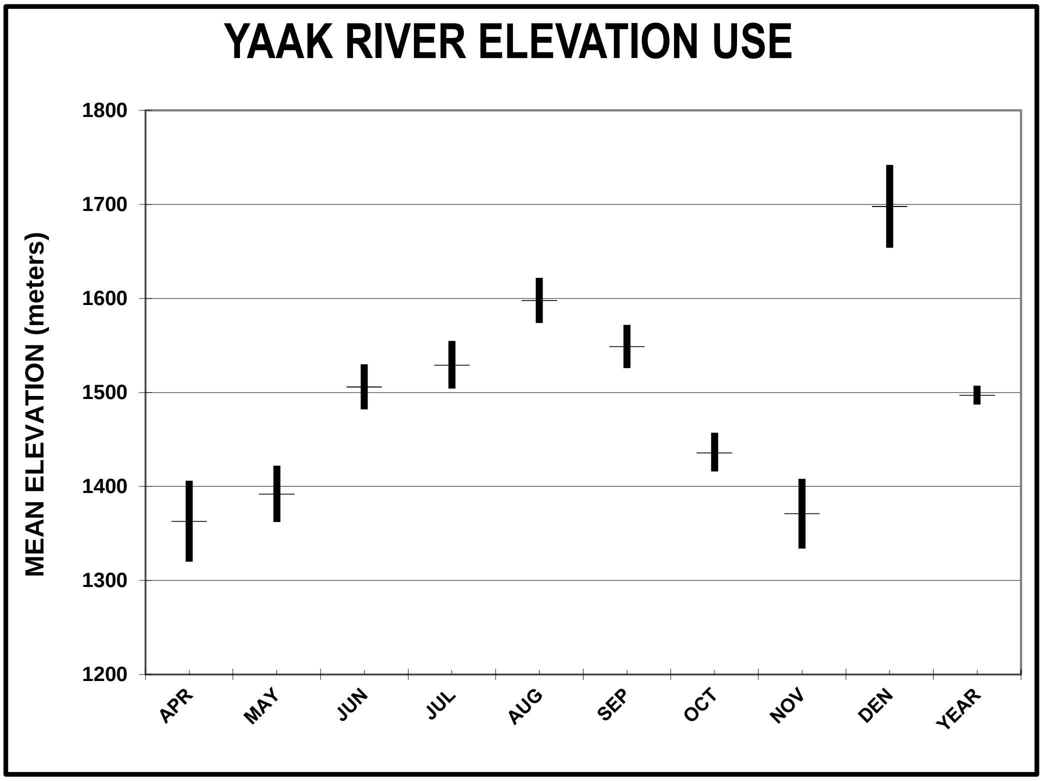


Figure 26. Mean elevation and 95% confidence intervals of radiolocations in the Yaak River, 1986–2009.

Grizzly Bear Use by Aspect

Use of aspect by grizzly bears varied between the Cabinet Mountains and Yaak River study areas, particularly during early spring (Figs. 27 and 28). South aspects received greatest use in the Cabinet Mountains during April and May. However, grizzly bears in the Yaak area showed more balanced use of all aspects during that time. Generally grizzly bears in the Cabinet Mountains made greater use of southerly slopes during all months than the Yaak River. South aspects were most heavily used by grizzly bears in the Cabinet Mountains for den sites, but used least in the Yaak River. Elevation, slope, and the resultant vegetation in addition to snow melt likely interacted to produce the observed patterns of use.

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.

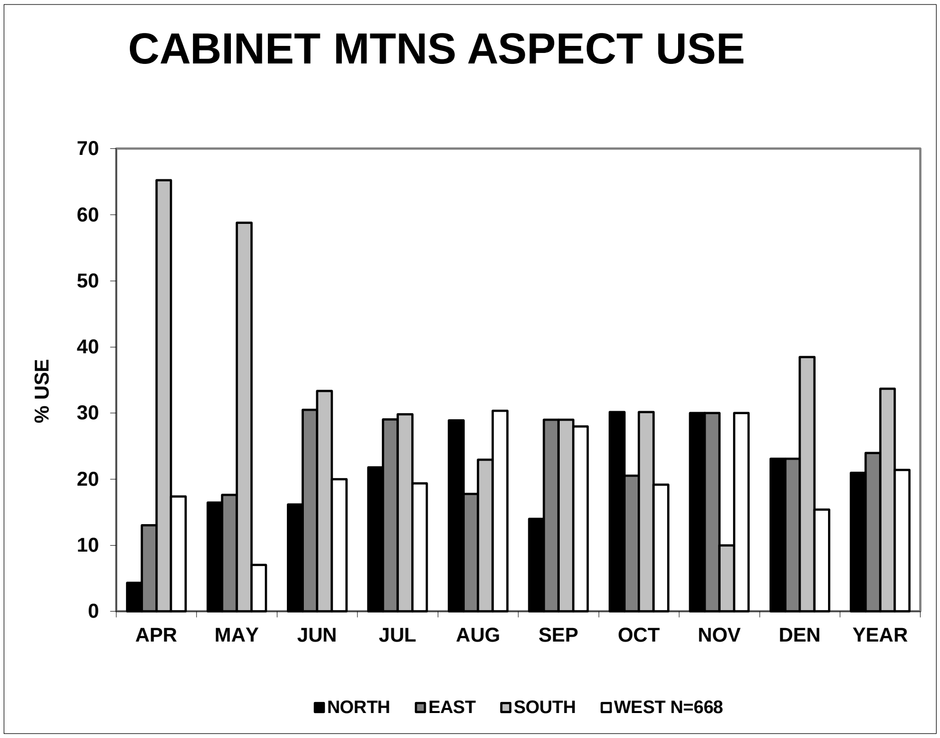


Figure 27. Aspect of radiolocations in the Cabinet Mountains, 1983-2009.

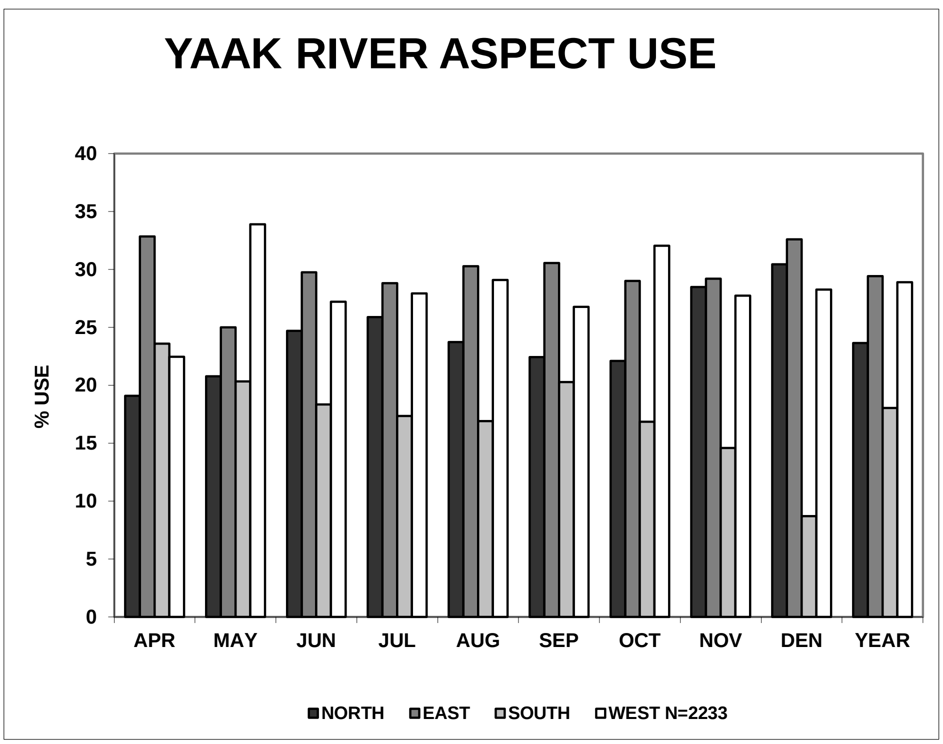


Figure 28. Aspect of radiolocations in the Yaak River, 1986-2009.

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. The majority of samples come 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 Cabinet-Yaak and Selkirk ecosystems. Across the Selkirk and Cabinet-Yaak 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 percent 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 contain nearly 22% animal matter (n = 84 hair samples). Adult female use of animal matter varies 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, conflict and 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 indication, 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). We currently have 23 bears with paired guard hair and underfur samples from a single capture event. 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 increased their meat consumption by 67% from summer to 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 on 5/18/2012) consuming 14% in spring time, 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 Mountains between 1981 and 1992. Graminoids (grasses and sedges) were consumed frequently (43% of scats) by grizzly bears in May. Additionally, meat, presumably from winter-killed deer and moose, accounted for 40% of all dry matter consumed in April and May (Fig. 29). 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 foods from shrubs (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 shrub (*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 shrub food items (i.e., the most calorie-dense foods available in Cabinet-Yaak Ecosystem) constitute 64% of total dry matter consumed annually by grizzly bears.

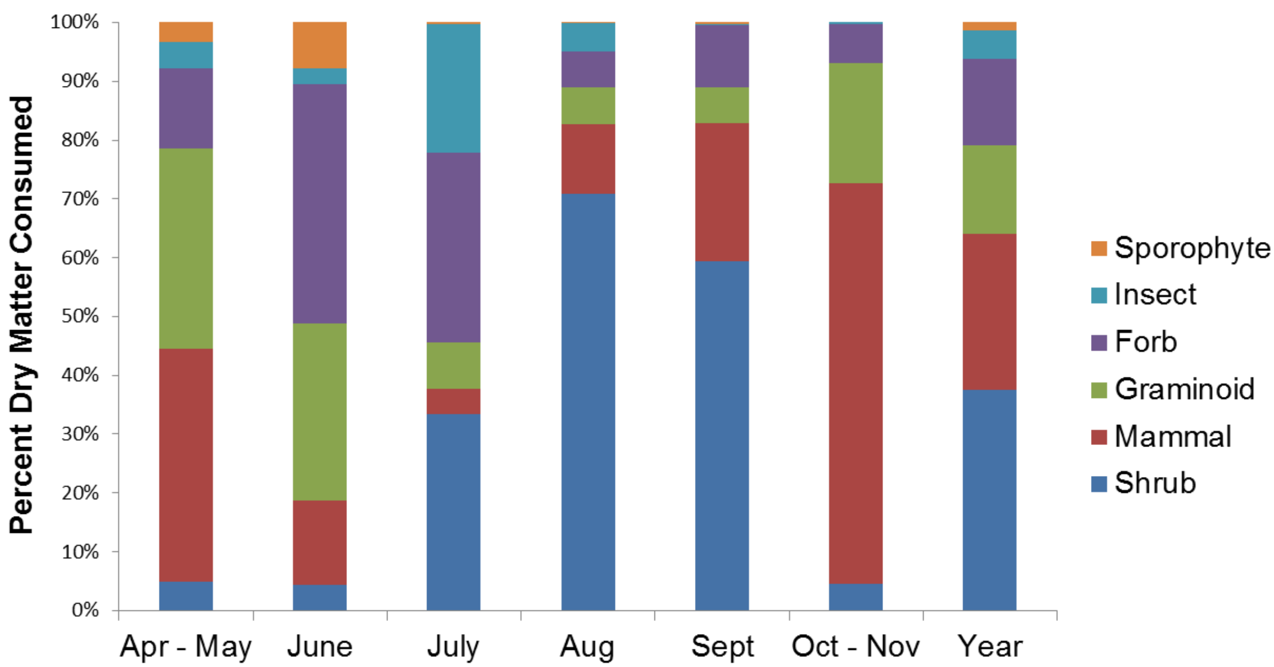


Figure 29. Monthly percent of total dry matter of foods consumed by grizzly bears in the Cabinet Mountains and Yaak River, 1981-1992.

Black bear scats (n = 618) were collected between 1984 and 1992. Relative use of foods was quite similar to that of grizzly bears between April and August (Fig. 30) However, black bear food habits in September and October were quite different from grizzly bears. Black bears tend to use berries of shrubs (*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 a 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%).

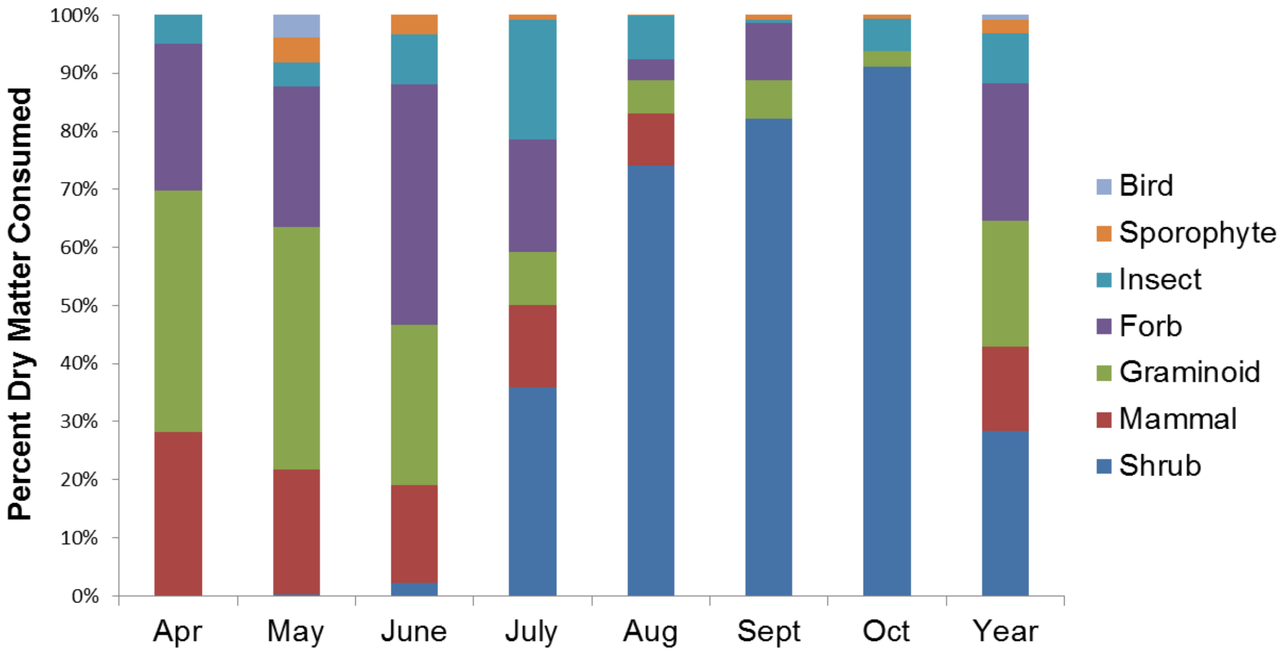


Figure 30. Monthly percent of total dry matter of foods consumed by black bears in the Cabinet Mountains and Yaak River, 1984-1992.

Berry Production

Huckleberry

We evaluated eleven huckleberry transects during 1989, 19 during 1990–99, 18 in 2000, 20 in 2001, 21 in 2002–03, 23 in 2004, 16 in 2005,18 in 2006, 16 in 2007, 18 in 2008-09,17 in 2010, 15 in 2011, 16 in 2012, and 15 in 2013–15. During the entire study period (1989–2015), the mean number of berries per plot was 1.7 (95% CI ± 0.14). Mean annual berry counts between 1989 and 2015 ranged from 0.5–3.4 (Fig. 31). Low berry counts occurred in 1992-93, 1998–99, 2001–04, 2010, and 2015. Above average counts occurred in 1989–91, 1994, 1996, 2006–09, and 2012–14. Highest mean annual counts occurred in 2014. Mean annual counts for the past decade (2006–2015) have averaged 2.2 berries per plot, 71% higher than mean annual counts during the previous decade (1996–2005; 1.3 berries per plot).

Serviceberry

We evaluated five sites for serviceberry production during 1990–96. We added one site in 1997 and another in 2005. We discontinued one site in 2007 and another in 2013. A sixth site was added in 2015. The overall mean berry count per plant was 110 (95% CI ± 25) during the study. Mean berry counts per plant ranged from 12 to 355 during the 25+ year index (Fig. 31). Low counts occurred during 1992, 1994, 1999, 2002, 2004–06, 2010, and 2012–15. Above average counts occurred during 1990–91, 1993, 1995–97, 2003, 2009, and 2011. Considering the entirety of the data, the past six years have been particularly less productive (2010–15; 56 berries per plant), and six-year average counts have been decreasing for over two decades now (185 berries per plant from 1992–97, 88 from 1998–2003, 70 from 2004–09).

Mountain Ash

Three sites were evaluated for mountain ash production in 2001–15 (Fig. 31). Total mean berry count was 165 berries per plant (95% CI ± 62), with the highest elevation site producing the most berries in the most years (2003, 2005–07, 2010). Sites with eastern and northern aspects exhibited considerably lower variation in berry counts from one year to the next than those with southern aspects. Poor production years occurred in 2003, 2006, 2010–11,, 2013, and 2015. Above average production occurred in 2001, 2005, 2008–09, and 2012.

Buffalo berry

Five buffalo berry transects (5 plants at each transect) were evaluated during 1990–99 and 2002–03. No sites were sampled during 2004–06 seasons. One new transect (10 plants) was established in 2007; this was the only transect sampled in 2007. Another transect (10 plants) was added in 2008. These two transects were observed in 2008–15. Mean berry count per plant from all transects was 185 (95% CI ± 50) during the study period. Mean berry counts ranged between 15 to 627 berries per plot from 1990 to 2015 (Fig. 32), with low counts in 1998–99, 2002–03, 2007, 2013, and 2015. High counts occurred in 1990, 1993, 2009–12, and 2014.

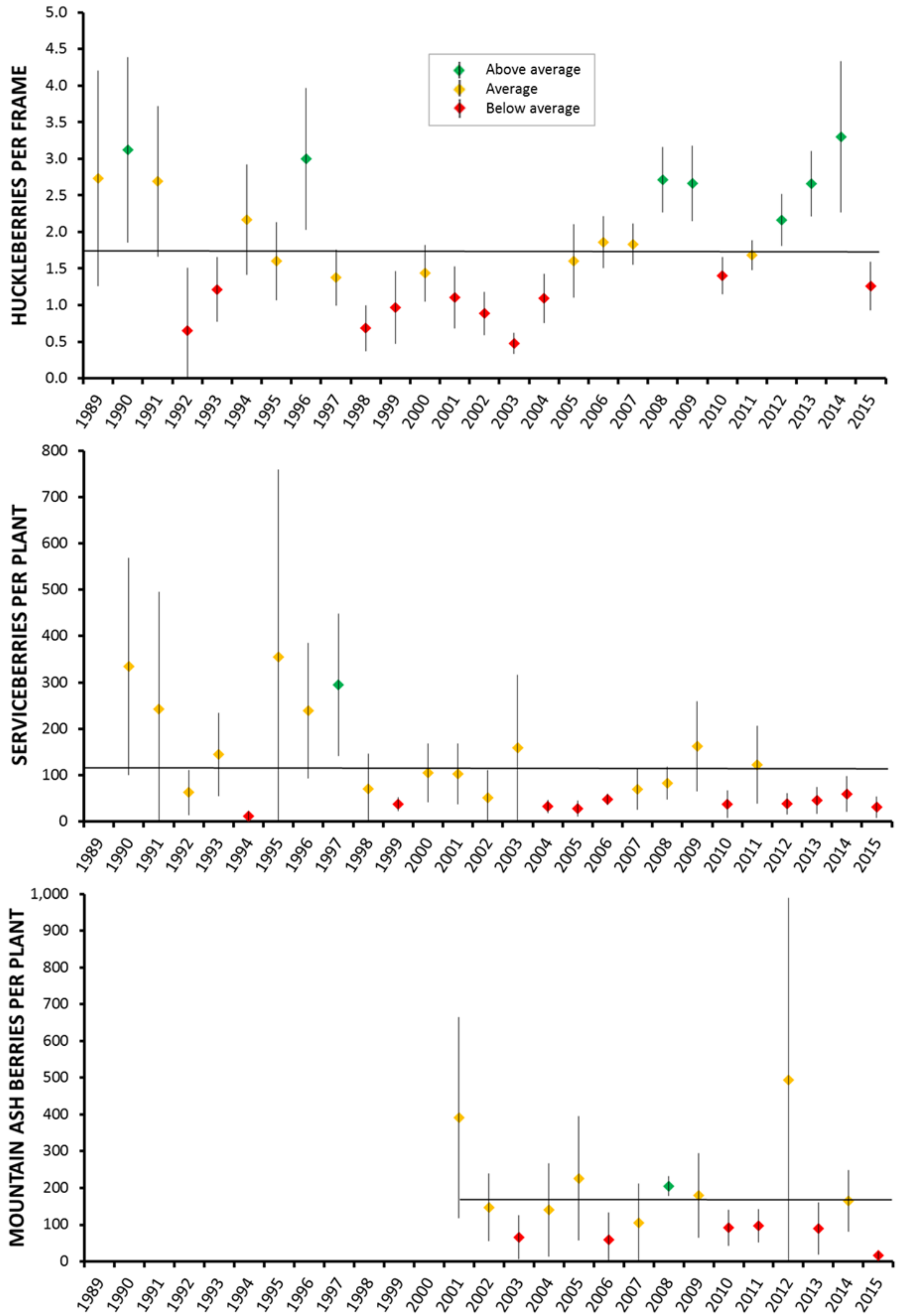


Figure 31. Mean berries per plot (or plant) and 95% confidence intervals for huckleberry, serviceberry, and mountain ash transects in the Cabinet-Yaak, 1989–2015. The horizontal line indicates study-wide mean production, 1989–2015.

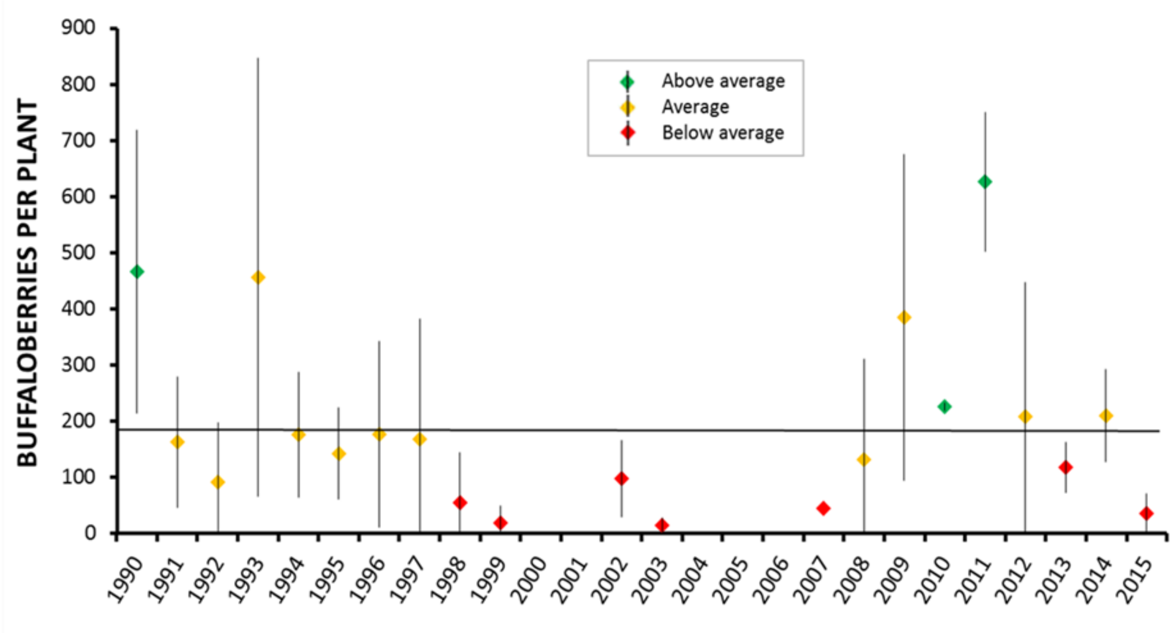


Figure 32. Mean berries per plant (±95% confidence interval) for buffalo berry transects in the Cabinet-Yaak, 1990–2015. Horizontal line indicates study-wide mean production, 1990–2015.

Because of its relatively far-ranging distribution in the Cabinet-Yaak and life history of inhabiting larger areas (e.g. shrub fields) than other berry-producing plants, huckleberries appear to provide a greater amount of food for bears in the Cabinet-Yaak. 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 appear 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 Cabinet-Yaak. Below-average production among all species surveyed occurred in 1992, 1998–2000, 2002, 2004, and 2015. The 2015 berry season marks the first time we have observed below average counts for all four berry species in one year.

Fluctuations in berry production in the Cabinet-Yaak may be influenced by climatic variables. Holden et al. (2012) found huckleberry production in the Cabinet-Yaak 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 Cabinet-Yaak grizzly bears.

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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 or within 10 miles[3] during Year 1.	Mortality removal year	No mortality
3	Bear dies in Target recovery area or within 10 miles after Year 1.	Mortality removal year	Mortality, Year 2 or later
4	Bear returns to Source area[2] and is alive in Year 1.	No mortality	No mortality
5	Bear returns to Source area and is alive after Year 1.	No mortality	No mortality
6	Bear returns to Source area and dies there after Year 1.	Mortality removal year only	No mortality
7	Bear dies outside both Target and Source areas within Year 1.	Mortality removal year	No mortality
8	Bear dies outside both Target and Source areas after Year 1.	Mortality removal year	No mortality
9	Collar failure/lost bear in Target area within Year 1.	Mortality removal year	No mortality
10	Collar failure/lost bear in Target area 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. Known grizzly bear mortality in or near the Cabinet-Yaak recovery zone and the Yahk grizzly bear population unit in British Columbia, 1949-2015.

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

YEAR	LOCATION	TOTAL	SEX / AGE	MORTALITY CAUSE
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
1982	GROUSE, ID	1	ADULT MALE	HUMAN, ILLEGAL KILL
1984	HARVEY CR, ID	1	UNKNOWN	HUMAN, MISTAKEN IDENTITY (Black Bear)
1985	LYONS CR, MT	1	ADULT MALE	HUMAN, DEFENSE OF LIFE BY HUNTER
1986	BURNT CR, MT	1	CUB	UNKNOWN (NATURAL)
1987	FLATTAIL CR, MT	1	FEMALE CUB	HUMAN, MISTAKEN IDENTITY (Elk)
1988	LEWISBY CR, BC	1	ADULT MALE	HUMAN, LEGAL HUNTER KILL (BC)
1988	N F 17-MILE CR, MT	1	ADULT FEMALE	HUMAN, DEFENSE OF LIFE BY HUNTER
1989	BURNT CR, MT	1	SUBADULT FEMALE	HUMAN, RESEARCH TRAP (Predation)
1990	POVERTY CR, MT	1	SUBADULT MALE	HUMAN, ILLEGAL
1992	TRAIL CR, MT	1	ADULT FEMALE	UNKNOWN
1993	LIBBY CR, MT	2	ADULT FEMALE AND CUB	UNKNOWN (NATURAL)
1994	JIM CR, BC	1	SUBADULT MALE	HUMAN, MANAGEMENT
1994	SOUTHWEST CRANBROOK, BC	3	2 FEMALES AND 1 MALE	HUMAN, MANAGEMENT
1995	RYAN CR, BC	1	ADULT MALE	HUMAN, MANAGEMENT REMOVAL
1996	DODGE CR, MT	1	SUBADULT MALE	HUMAN, UNDETERMINED
1996	GOLD CR, BC	1	ADULT MALE	HUMAN, UNDETERMINED
1997	LIBBY CR, MT	1	ADULT MALE	HUMAN, ILLEGAL
1997	PLUMBOB CR, BC	1	MALE	HUMAN, MANAGEMENT
1997	WARDNER, BC	1	ADULT FEMALE	HUMAN, MANAGEMENT
1997	MAYOOK, CR,BC	1	SUBADULT MALE	HUMAN, ILLEGAL KILL
1999	17 MILE CR, MT	3	ADULT FEMALE, 2 CUBS	NATURAL MORTALITY (Predation)
1999	W FK YAHK R, BC	1	SUBADULT FEMALE	HUMAN, DEFENSE OF LIFE BY HUNTER
1999	E FK YAAK R, MT	1	ADULT MALE	HUMAN, MANAGEMENT REMOVAL
2000	HAWKINS CR, BC	2	2 CUBS	UNKNOWN (NATURAL)
2000	FOWLER CR, MT	1	1 CUB	UNKNOWN (NATURAL)
2000	PETE CR, MT	1	SUBADULT FEMALE	HUMAN, UNDETERMINED
2001	COLD CR, BC	2	2 CUBS	UNKNOWN (NATURAL)
2001	SPREAD CR, MT	1	SUBADULT FEMALE	HUMAN, MISTAKEN IDENTITY (Black Bear)
2001	ELK CR, MT	1	ADULT FEMALE	HUMAN, TRAIN COLLISION
2002	MARTEN CR, MT	1	SUBADULT FEMALE	NATURAL
2002	PORCUPINE CR, MT	1	SUBADULT FEMALE	HUMAN, UNDETERMINED (Illegal)
2002	YAAK R, MT	4	ADULT FEMALE, 3 CUBS	HUMAN, ILLEGAL
2002	BLOOM CR, BC	1	UNKNOWN	HUMAN, BLACK BEAR HOUND HUNTERS
2002	KOOTENAY R, BC	1	FEMALE	HUMAN, DEFENSE OF LIFE
2004	WEST FORT STEELE, BC	1	MALE	HUMAN, DEFENSE OF LIFE AT DUMP
2004	JIM CR, BC	1	ADULT MALE	HUMAN, MISTAKEN IDENTITY
2004	NEWGATE,BC	1	ADULT FEMALE	HUMAN, MANAGEMENT REMOVAL

YEAR	LOCATION	TOTAL	SEX / AGE	MORTALITY CAUSE
2005	RUSSELL CR, BC	1	ADULT MALE	HUMAN, LEGAL HUNTER KILL (BC)
2005	GOVERNMENT CR, MT	1	SUBADULT FEMALE	HUMAN, TRAIN COLLISION
2005	PIPE CR, MT	1	SUBADULT FEMALE	HUMAN, ILLEGAL
2005	YAAK R, MT	1	SUBADULT MALE	HUMAN, ILLEGAL
2005?	CURLEY CR, MT	1	ADULT	HUMAN, UNDETERMINED
2006	COLD CR, BC	1	ADULT FEMALE	HUMAN, RESEARCH TRAP (Predation)
2006	RAINY CR, BC	1	ADULT FEMALE	HUMAN, MANAGEMENT REMOVAL
2007	SPREAD CR, MT	1	ADULT FEMALE	HUMAN, DEFENSE OF LIFE
2008	FISHTRAP CR, MT	1	UNKNOWN SUBADULT	HUMAN, UNDER INVESTIGATION
2008	CLARK FORK RIVER, MT	1	SUBADULT FEMALE	HUMAN, TRAIN COLLISION
2008	CLARK FORK RIVER, MT	1	SUBADULT FEMALE	HUMAN, POACHING
2008	NF YAHK RIVER, BC	1	ADULT MALE	HUMAN.MISTAKEN IDENTITY, WOLF TRAP
2009	COPPER CR, ID	2	2 CUBS	UNKNOWN (NATURAL)
2009	BENTLEY CR, ID	1	SUBADULT MALE	HUMAN, MISTAKEN IDENTITY (Black Bear)
2009	EF BULL R, MT	1	ADULT FEMALE	HUMAN, DEFENSE OF LIFE
2010	AMERICAN CREEK, MT	1	CUB	NATURAL
2010	HAWKINS CREEK, BC	1	SUBADULT MALE	HUMAN, UNDER INVESTIGATION
2010	COLD CR, BC	1	SUBADULT MALE	HUMAN, WOLF TRAP, SELKIRK RELOCATION
2010	PINE CR, MT	1	ADULT MALE	HUMAN, POACHING
2011	EF ROCK CR, MT	1	SUBADULT	UNKNOWN
2011	FARO CR, MT	1	ADULT MALE	HUMAN, MISTAKEN IDENTITY (Black Bear)
2011	CHERRY CR, MT	1	SUBADULT MALE	HUMAN, MISTAKEN IDENTITY (Black Bear)
2011	PIPE CR, MT	1	SUBADULT MALE	HUMAN, DEFENSE OF LIFE
2011	LITTLE CR, MT	1	ADULT MALE	HUMAN, UNDER INVESTIGATION
2012	MISSION CR, ID	2	ADULT FEMALE, 1 CUB	HUMAN, UNDER INVESTIGATION
2012	DUCK CR., BC	1	ADULT MALE	HUMAN, MANAGEMENT REMOVAL
2014	L. THOMPSON R., MT	1	ADULT MALE	HUMAN, DEFENSE OF LIFE
2015	YAAK R., MT	1	SUBADULT MALE	HUMAN, ILLEGAL
2015	SINK CR., BC	1	YEARLING	NATURAL
2015	MOYIE R. ID	1	SUBADULT MALE	HUMAN, DEFENSE OF LIFE
2015	BEAVER CR., ID	1	SUBADULT MALE	HUMAN, MISTAKEN IDENTITY (Black Bear)

Appendix 3. Grizzly bears captured, observed, photographed, or genotyped by study personnel in the Cabinet Mountains and Yaak River, 1986–2015.

Cabinets

Bear ID	Genetic Lab ID	Sex	Years detected	Comments
678	C678F	F	1983-89, 93	Born 1955. Monitored 1983-89. Unknown cause mortality 1993.
680	C680M	M	1984-86	Born. 1973. Monitored 1984-85. Observed 1986.
14	C306M	M	1985	Born 1959. Monitored 1985. Self-defense mortality 1985.
218		F	1990-92	Born 1985. Augmentation, Monitor 1990-91. Observed 1992.
258	Ca258F	F	1992-93	Born 1986. Augmentation, Monitor 1992-93. Produced cub 1993. Natural mortality 1993.
286	Ca172F	F	1993-95, 02, 05, 09	Born 1991. Augmentation, Monitor 1993-95. DNA 2005. Self-defense mortality 2009.
Unmarked	Unmarked	?	1993	Born 1993. Probable natural mortality 1993.
311	NY311F	F	1994-95	Born 1991. Augmentation, Monitor 1994-95.
UNK 39	CUk39M	M	1997	Human Undetermined mortality 1997.
770	CU29M	M	2000, 02, 05-15	Born 1994. Photo 2002?, 08, 13. Monitored 2005-06. DNA 2000, 05-15
UNK 38	C23F	F	2001	Adult female train mortality 2001.
831	C20241F	F	2001-02, 07, 11-15	Born 1997? Sibling 772. DNA 2001-02, 04, 07, 11-15. Photo 2011, 13-14; Monitored 2014
577	C577F	F	2002	Born 2001. Natural mortality 2002. Sibling 578 and 579.
578	C578M	M	2002	Born 2001. Sibling 577 and 579.
579	C579M	M	2002-03	Born 2001. Sibling 577 and 578. Observed 2003.
772	C20191F	F	2002-03, 07-08,14	Born 1997. DNA 2002-03, 2007. Monitored 2007 with 2 cubs. observed 2008, captured 2014
3119	C3119gF	?	2003-05	Born 2003. Train mortality 2005.
780	C20252M	M	2002,06-08,10-15	Born 2000. Monitored 2006-08. DNA 2002, 2010-15
403	C403M	M	2004, 07	Born 2004. At least 1 cub photographed with adult female. Mortality 2007 in NCDE.
A1	CaA1F	F	2005-08	Born 1997? Augmentation Monitor 2005-07. Observe with 780 2008?
200618415	C20061M	M	2006	DNA 2006.
782	Ca782F	F	2006-08,14	Born 2004. Augmentation Monitor 2006-08. DNA 2008.
789	C789F	F	2007, 08	Born 2007. Marked 2007. DNA 2007. Observed 2008.
791	C791M	M	2007, 08	Born 2007. Marked 2007. DNA 2007. Observed 2008.
799	C2007M	M	2007, 10-11	Born 2007. DNA 2007, 2011 Monitor 2010-11 as 799. Mortality 2011.
200721053	C20072F	F	2007, 11-12, 14	Born 2007. DNA 2007, 2011-12
635	Ca635F	F	2008	Born 2004. Augmentation Monitor 2008. Train mortality 2008
790	Ca790F	F	2008	Born 2005. Augmentation Monitor 2008. Poaching mortality 2008
C90464M	C90464M	M	2008	Born 2005. Human under investigation mortality 2008.
C067801	C67801	M	2009	Rose Lake, ID, Mortality Mistaken ID 2009
G 2009001005	C20090F	F	2009-10, 12, 15	Born 2008. Yearling cub of 286. DNA 2009-10, 12, 15. Photo 2009-10, 15
715	Ca715F	F	2009-10	Born 1998? Augmentation Monitor 2009. Returned to Flathead 2010.
2009001002	C2009F	F	2009, 11	Born 2008. Yearling cub of 286, DNA and Photo 2009, 2011
26D02a	C26D02M	M	2009, 11, 13,14	Montanore scat dog DNA 2009. Cub photo with 286 in 2005? DNA 2011, 2013
2010011131	C10111M	M	2010	Born 2010, DNA/photo 2010
2010011205	C10011F	F	2010	Adult 2010, DNA/photo 2010
714	Ca714F	F	2010	Monitored 2010, Augmentation. Returned to Flathead 2010.
2010011328	C10113F	F	2010-11	Born 2010, DNA/photo 2010, Unknown mortality 2011
713	Ca713M	M	2010-12, 15	Augmentation Monitored 2010-11. DNA 2011-12, 15. Flathead capture 2012
2011092001	2011092001	F	2011-12	DNA 2011-12. Photo 2011
724	GB 724	M	2011-12	Management Monitored 2011-12
725	GB725	F	2011-13	Augmentation Monitored 2011-13, returned to Flathead then back to Cabinets
723	GB 723	M	2011-12,14	Augmentation Monitored 2011-12
928442	928442	M	2012	DNA 2012. Selkirk immigrant. Moved back to Selkirks by 2015
935400	935400	M	2012	DNA 2012
935410	935410	M	2012, 15	DNA 2012, 2015

Cabinets

Bear ID	Genetic Lab ID	Sex	Years detected	Comments
958471	958471	M	2012, 15	DNA 2012, 2015
918	GB 918	M	2012-14	Augmentation Monitored 2012-14
839	900932	M	2012-15	Born 2011 to 831. DNA 2012-13, 2015. Photo 2014. Monitored 2014-15
925063	925063	F	2012-14	Born 2011 to 831. DNA 2012-14. Photo 2014. Monitored 2014
919	GB 919	M	2013-14	Augmentation Monitored 2013-14
900933	900933	F	2012-15	Born 2011 to 831. DNA 2012, 2014-15. Photo 2013-15. Monitored 2014
79575279	C90467M	M	2014	Defense Mortality 2014
C14924F	C14924F	F	2014	DNA 2014
920	GB 920	F	2014-15	Augmentation Monitored 2014-15
921	GB 921	F	2014-15	Augmentation Monitored 2014-15
C16742M	C16742M	M	2015	DNA 2015
C17460M	C17460M	M	2015	Born 2015, DNA/photo 2015

Yaak River

Bear ID	Genetic Lab ID	Sex	Years detected	Comments
Unmarked	Unmarked	?	1986	Born 1986. Natural mortality 1986.
106	Y336F	F	1986-99	Born 1978.Monitor 1986-99. Natural mortality 1999.
101	Unmarked	M	1986-87	Born 1978.Monitor 1986-87.
129	Y129F	F	1986-89	Born 1986.Monitor 1986-89. Trap predation mortality 1989.
Unk3	Y308F	F	1987	Born 1987 cub of 25. Mistaken-ID mortality 1987
134	UI Tube 871	M	1987-88	Born 1978.Monitor 1987-88. BC hunting mortality 1988.
128	Y128M	M	1987-92, 97, 01	Born 1983.Monitor 1987-92 and 1997. Natural Mortality 2001
25	Y25F	F	1988	Self Defense Adult female mortality 1988
193	Y193M	M	1988-90	1988 cub of 106. Monitor 1988-90.
192	Y939M	M	1988-90	1988 cub of 106. Monitor 1988-90. Poaching mortality 1990.
206	Y206F	F	1988-95, 97	1988 cub of 106. Monitor 1988-95. Observed 1997 with 2 cubs
UNK22	Y321M	M	1991	DNA 1991
R178	Y178M	M	1991-92, 01	1991 cub of 106.Monitor 1991-92. DNA BC 2001
Unmarked	Unmarked	?	1991-92	1991 cub of 106.Monitor 1991-92.
244	Y244M	M	1992-94, 03-04	Born 1986.Monitor 1992-94 & 2003-04.
34	Unmarked	F	1993	Transplanted to Bloom Cr by BC 1993, captured in US 1993.
355	Y355M	M	1993, 96	Born 1990. Monitor 1996. Human, Undetermined mortality 1996.
358	Y330M	M	1993, 96-99	Born 1988. Monitor 1996-98. Management removal mortality 1999.
302	Unmarked	M	1993-96	Born 1993. cub of 106. Monitor 1993-96. Human Undetermined mortality 1996.
303	Y303F	F	1993-01, 03,07, 10-15	1993 cub of 106. Monitor 1994-2001, 2010-15. Observe 2003 2 cubs, 3 cubs 2010. DNA 2012, 15. Photo 2011-13.
Unmarked	Unmarked	F	1994, 98	Unmarked female consort of 244 and 363.
Unmarked	Unmarked	?	1994-95, 98	1994 cub of 206, sibling of bear 505. Monitor 1994-95, Observed 1998?
505	Unmarked	F	1994-95, 98	1994 cub of 206.Monitor 1994-95. Observed 1998?
353	Y353F	F	1995-99, 02	1995 cub of 106.Monitor 1995-97, 2002. Observed 1998-99. Poaching mortality 2002.
354	Y354F	F	1995-99, 07	1995 cub of 106. Monitor 1995-99. Self-defense mortality 2007.
342	YU46M	M	1996-99, 02-04, 11	Born 1992. Monitor 1996-99, 2003-04. DNA 2002, 2011. Human, under investigation mortality 2011.
363	Y363M	M	1996-99, 05	Born 1992.Monitor 1996-99. DNA 2005, Human Undetermined mortality 2005?
68853	Y68853F	F	1997	1997 mortality, Wardner, BC Management removal.
72832	Y72832M	M	1997	1998 mortality, Mayook, BC Unknown .
384	Y384M	M	1997,	Born 1990.Monitor 1997.
596	Y596F	F	1997, 99	1997 cub of 206. Monitor 1999. Self defense mortality 1999.
538	Y538F	F	1997-02	Born 1991.Monitor 1997-02.
386	YVernM	M	1997-98, 00-01, 05	Born 1992.Monitor 1997-98. DNA 2005.

Yaak River

Bear ID	Genetic Lab ID	Sex	Years detected	Comments
592	Y314F	F	1998, 99-00	1997 cub of 206. Monitor 1999. DNA 1999. Human Undetermined mortality 2000.
UNK55	YU55F	F	1999	1997 cub of 538. Monitor 1997-98. Found skull 1999 at 386 lost collar in BC.
106cub1	Y106c1M	M	1999,	1999 cub of 106. Natural Mortality 1999.
106cub2	Y106c2F	F	1999,	Born 1999. cub of bear 106. Natural Mortality 1999.
UNK26	N323M	M	1999, 2012	DNA 1999, 2012
Unmarked	Unmarked	?	2000,	2000 cub of 538. Natural Mortality 2000.
Unmarked	Unmarked	?	2000,	2000 cub of 538. Natural Mortality 2000.
Unmarked	Unmarked	?	2000,	2000 cub of 303. Natural Mortality 2000.
552	Y165F	F	2000-02, 11-15	2000 cub of 303. Monitor 2000-01, 12-15. DNA 2001-02, 11-15. Photo 2012, 14
Unmarked	Unmarked	?	2001	2001 cub of 538. Natural Mortality 2001.
Unmarked	Unmarked	?	2001	2001 cub of 538. Natural Mortality 2001.
UNK37	YU37F	F	2001	2000 cub of 354. Unmarked yearling mistaken identity mortality 2001
M-0235	Y235F	F	2002	DNA 2002. Human Undetermined mortality 2002.
7434	Y7434F	F	2002	DNA 2002
688	PTerryM	M	2002, 05-06	2002 cub of 538. Crossed Highway 3 to North. Monitor 2005-06.
10165b	Y10165F	F	2005, 06	2002 cub of 538, DNA 2004-05, BC. Trap predation mortality 2006.
Unmarked	Unmarked	?	2002	2002 cub of 353. Assumed Human mortality 2002.
UNK43	YU43F	F	2002	2002 cub of 353. Poaching mortality 2002.
651	YRockyM	M	2002, 2005-06, 08	Born 1995.Monitor 2002 and 2005-06. Human, Mistaken Identity Wolf Trap 2008 BC
787	Y787M	M	2002-04	2000 cub of 354. DNA 2002 Monitor 2003-04.
576	Y576M	M	2004-06	Born 2002.Monitor 2004-06. DNA 2005.
675	Y675F	F	2004-11	Born 2002.Monitor 2004-10. Lost 2 cubs in 2009. Lost 1 cub 2010. DNA 2011-12
Unmarked	Unmarked	F	2004	Management capture and removal 2004, BC.
10252c	Y10252cF	F	2005	DNA 2005, BC
10252b	Y10252M	M	2005	DNA 2005, BC
10303g	Y10303M	M	2005	DNA 2005, BC
M1	YU63M	M	2005	2003 cub of 303.Monitor 2005 Relocated NW Peak. Lost contact.
677	YCoryM	M	2005	Born 1999.Monitor 2005.
694	Y694F	F	2005	2003 cub of 303.Monitor 2005. Human Undetermined mortality 2005.
17	YJB17M	M	2005	Born 1997. DNA 2002 Monitor 2005.
668	Y668M	M	2005	Born 2002, cub of 353,.Monitor 2005. Mistaken ID 2005
31	S31M	M	2005	Immigrant from Selkirks. Hunter harvest 2005. BC.
292	YMarilF	F	2005-06	Born 2001.Monitor 2005. Human Mortality 2006.
103	YHydeM	M	2006	Born 2003.Monitor 2006. Went to Selkirks 2006
5381	P9190M	M	2006,09-10, 12	Born 2002.Monitor 2006,2009-10. Management removal 2012.
820	Y20073F	F	2007-08, 11-12, 15	Born 2003 to 354. DNA 2007, 12, 15. Photo 2011, 15. Monitored 2015
Unmarked	Unmarked	?	2007	Born 2007. Cub of 303
731	Y731F	F	2007, 09-12, 15	Born 2007 to 303, observed 2007. Monitored 2009-11. DNA 2011-12, 15
785	Y785F	F	2007-08	2006 cub of 354. Radio Monitored 2007-08
784	Y784F	F	2007-09, 14-15	2006 cub of 354. Radio Monitored 2007-09, 14-15. Photo 2014-15.
Unmarked	Unmarked	?	2009	Born 2009. Cub of 675. Natural mortality 2009.
Unmarked	Unmarked	?	2009	Born 2009. Cub of 675. Natural mortality 2009.
722	YU83M	M	2009, 11-15	DNA 2009, 12-15. Monitored 2011-12, 14. Photo 2011, 14-15
737	YGB737M	M	2010-15	Monitored 2010-13. DNA 2012, 14-15. Photo 2012, 14
Unmarked	Unmarked	?	2010	Born 2010. Cub of 675. Natural mortality 2010.
1374	P1374M	M	2010	Monitored 2010. Human under investigation mortality 2010
Unk107	YU107M	M	2010	Human under investigation mortality 2010.
726	GB 726	M	2011-12,14-15	Born 2009 to 820. DNA 2012, 14-15. Photo 2011. Monitor 2011-12, 15.
Unmarked	Unmarked	?	2010	Born 2010. Cub of 303. Natural mortality 2010.
729	GB 729	F	2010-15	Born 2010. Cub of 303. DNA 2013-14. Monitor 2011-13, 15
Unmarked	Unmarked	?	2010-13	Born 2010. Cub of 303. Photo 2011-13

Yaak River

Bear ID	Genetic Lab ID	Sex	Years detected	Comments
Unk123	GB 732	M	2011	Born 2006. Management capture 2011. Self-defense mortality 2011
2011038306	2011038306	M	2011-13	DNA 2011-13. Photo 2011
810	2011038311	F	2011-12,14-15	Born 2003 to 354. DNA 2011-12, 13-15. Photo 2011, 14-15. Monitored 2015
2011049118	2011049118	M	2011-12	Born 2011 to 552. DNA 2011-12. Photo 2012
2011049122	2011049122	F	2011-13	Born 2011 to 552. DNA 2011-13. Photo 2012
UNK 116	200354a	M	2011	DNA 2011 Mistaken ID mortality
10569c1	10569F	F	2005, 12	DNA 2005 (BC). Hall Mtn Mortality 2012
Y90479M	Y90479M	M	2012	Hall Mtn Mortality 2012 cub born 2012
953305	953305	M	2012	DNA 2012
955503	955503	M	2012	DNA 2012
826	922947	M	2012-13	Monitored 2013. DNA 2012-13
835	928196	M	2012-15 14	Born 1995. DNA 2012-15. Photo 2014. Monitored 2014-15
947510	947510	F	2012-13	DNA 2012-13
958729	958729	M	2012-15	DNA 2012-15
13082220975203	13082220975203	M	2013	DNA 2013
836	13100420976102	F	2013-15	Born 2013 to 784. DNA 2013-15. Photo 2014-15. Monitored 2014-15
807	YGB807M	M	2014-15	Monitored 2014-15. DNA 2014-15. Photo 2014. Went to Selkirks 2015
808	YGB808M	M	2014-15	Monitored 2014-15. DNA 2015. Photo 2014
837	YGB837M	M	2014-15	Monitored 2014-15. DNA 2014-15. Photo 2014-15
Unmarked	Unmarked	?	2014-15	Born 2014 to 552. Monitored 2014-15. Natural mortality 2015.
Unmarked	Unmarked	?	2014-15	Born 2014 to 552. Monitored 2014-15.
Y14836F	Y14836F	F	2014-15	Born 2013 to 784. DNA 2014-15. Photo 2014-15. Monitored 2014-15
818	Y12797M	M	2014-15	Born 2013 to 820. DNA 2014. Monitored 2015. Human-caused mortality 2015
Y11048M	Y11048M	M	2014-15	Born 2014 to 552. DNA 2014-15. Photo 2014. Monitored 2014-15
Y11008M	Y11008M	M	2014-15	Born 2014 to 810. DNA 2015. Photo 2014-15. Monitored 2014
Y18986M	Y18986M	M	2014-15	Born 2014 to 810. DNA 2015. Photo 2014-15. Monitored 2014
Y15605F	Y15605F	F	2015	Born 2013 to 820. DNA 2015. Photo 2015?
Y16496M	Y16496M	M	2015	DNA 2015
Y16749M	Y16749M	M	2015	Born to Selkirk Female 226, apparent immigrant. DNA 2015
Y17139M	Y17139M	M	2015	Born to 731. DNA 2015
Y91208M	Y91208M	M	2015	Human-caused, illegal mortality 2015

Appendix 4. Grizzly Bear Home Ranges

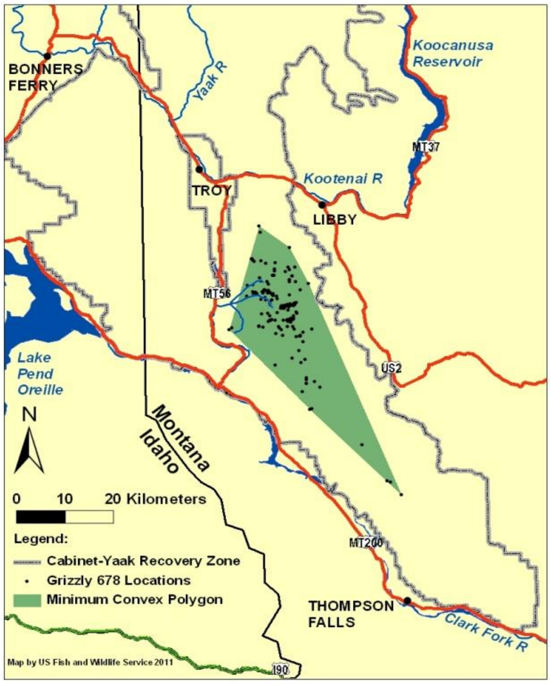


Figure 33. Radio locations and minimum convex (shaded) life range of female grizzly bear 678 in the Cabinet Mountains, 1983-89.

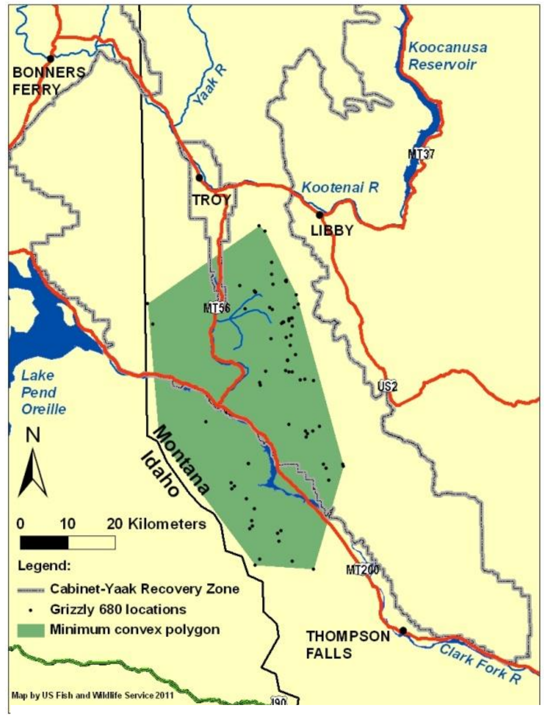


Figure 34. Radio locations and minimum convex (shaded) life range of male grizzly bear 680 in the Cabinet Mountains, 1984-85.

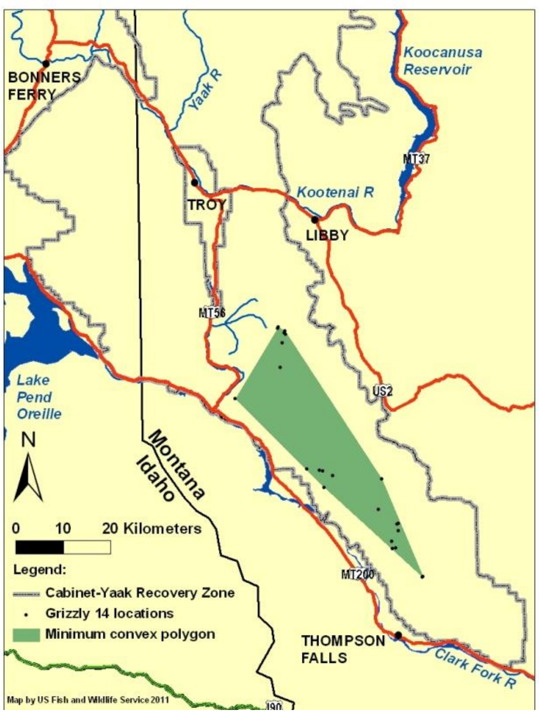


Figure 35. Radio locations and minimum convex (shaded) life range of male grizzly bear 14 in the Cabinet Mountains, 1985.

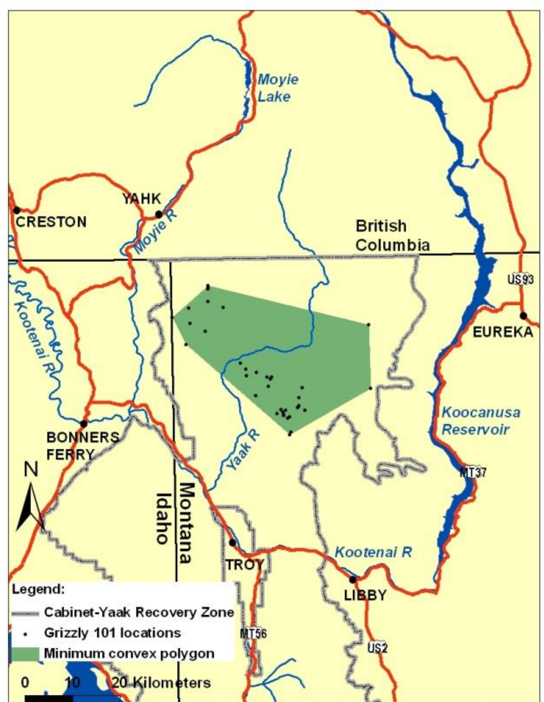


Figure 36. Radio locations and minimum convex (shaded) life range of male grizzly bear 101 in the Yaak River, 1986-87.

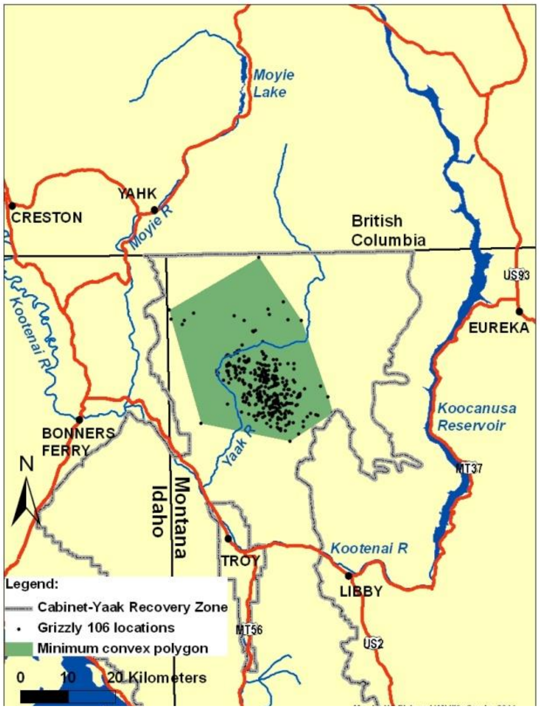


Figure 37. Radio locations and minimum convex (shaded) life range of female grizzly bear 106 in the Yaak River, 1986-99.

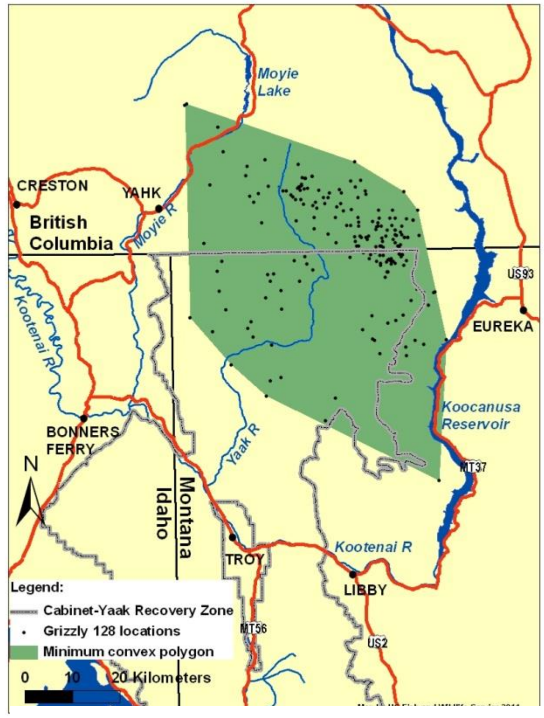


Figure 38. Radio locations and minimum convex (shaded) life range of male grizzly bear 128 in the Yaak River, 1987-97.

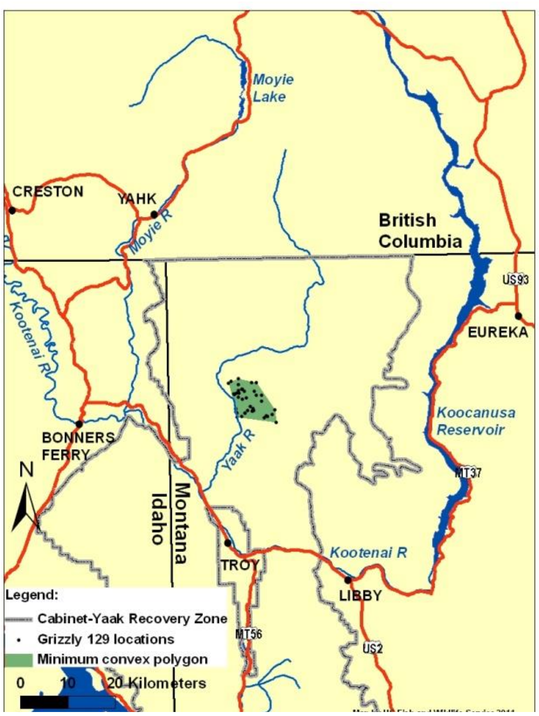


Figure 39. Radio locations and minimum convex (shaded) life range of female grizzly bear 129 in the Yaak River, 1987-89.

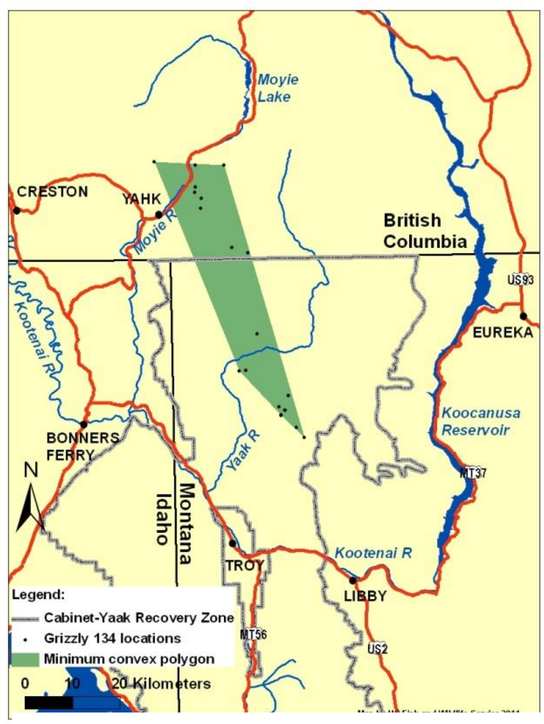


Figure 40. Radio locations and minimum convex (shaded) life range of male grizzly bear 134 in the Yaak River, 1987-88.

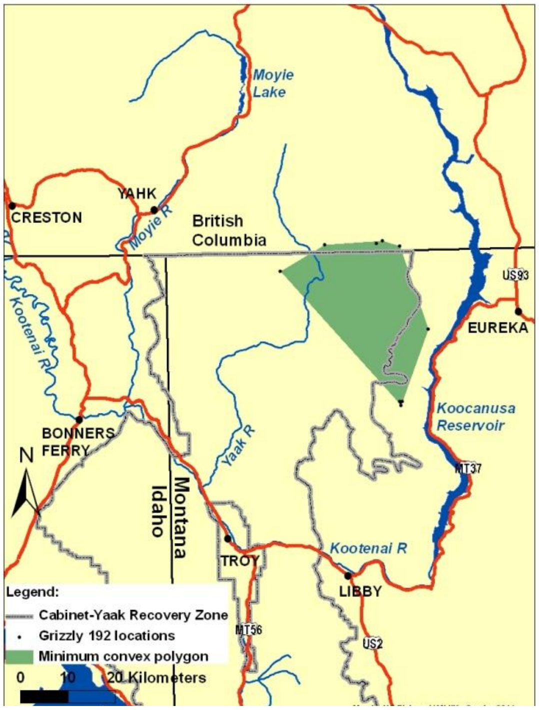


Figure 41. Radio locations and minimum convex (shaded) life range of male grizzly bear 192 in the Yaak River, 1990.

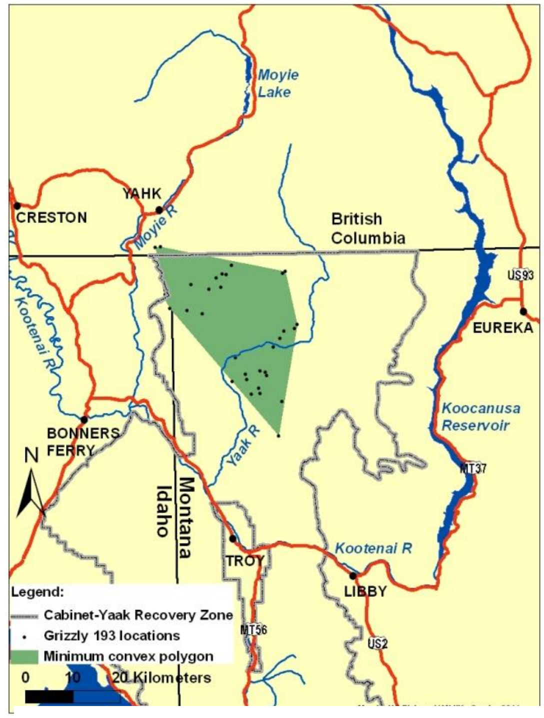


Figure 42. Radio locations and minimum convex (shaded) life range of male grizzly bear 193 in the Yaak River, 1990.

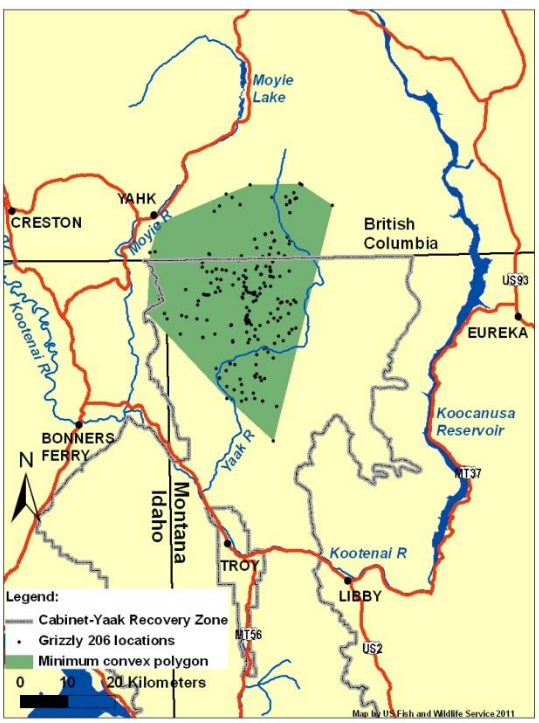


Figure 43. Radio locations and minimum convex (shaded) life range of female grizzly bear 206 in the Yaak River, 1991-94.

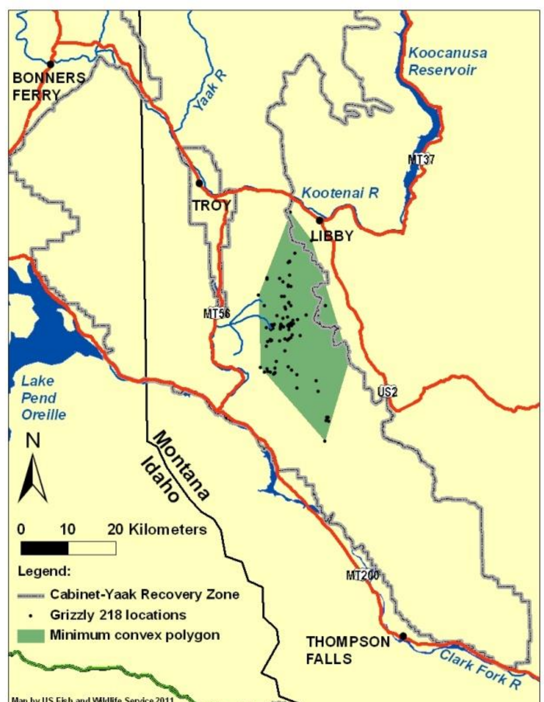


Figure 44. Radio locations and minimum convex (shaded) life range of female augmentation grizzly bear 218 in the Cabinet Mountains, 1990-91.

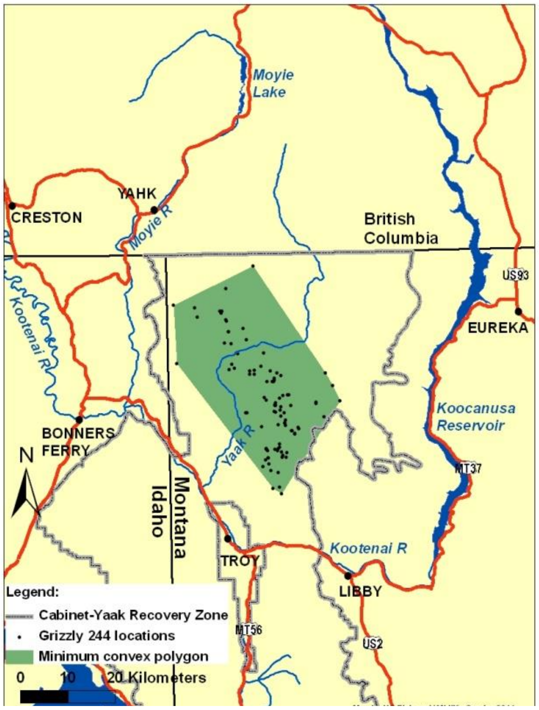


Figure 45. Radio locations and minimum convex (shaded) life range of male grizzly bear 244 in the Yaak River, 1992-03.

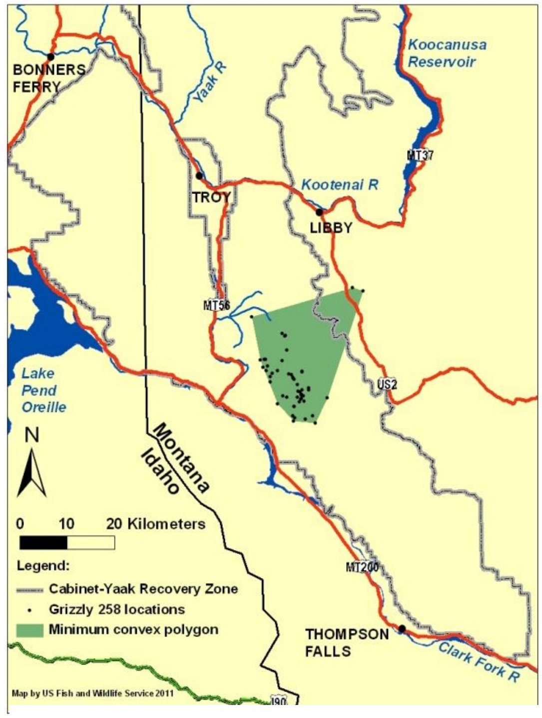


Figure 46. Radio locations and minimum convex (shaded) life range of female augmentation grizzly bear 258 in the Cabinet Mountains, 1992-93.

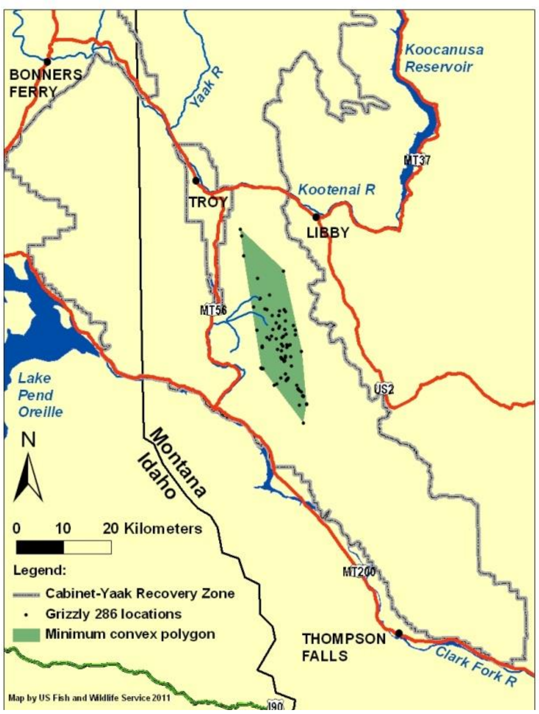


Figure 47. Radio locations and minimum convex (shaded) life range of female augmentation grizzly bear 286 in the Cabinet Mountains, 1993-95.

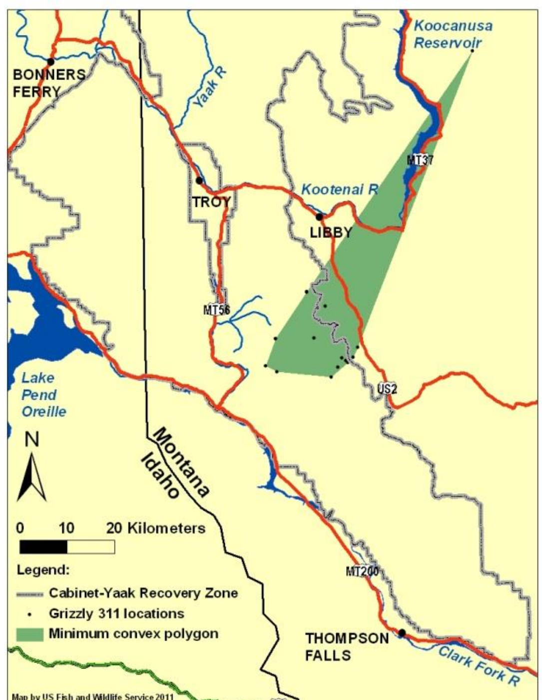


Figure 48. Radio locations and minimum convex (shaded) life range of female augmentation grizzly bear 311 in the Cabinet Mountains, 1994-95.

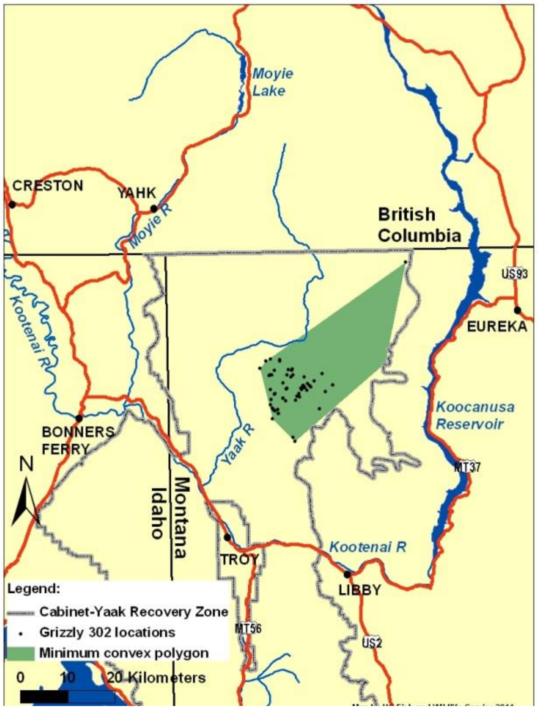


Figure 49. Radio locations and minimum convex (shaded) life range of male grizzly bear 302 in the Yaak River, 1994-96.

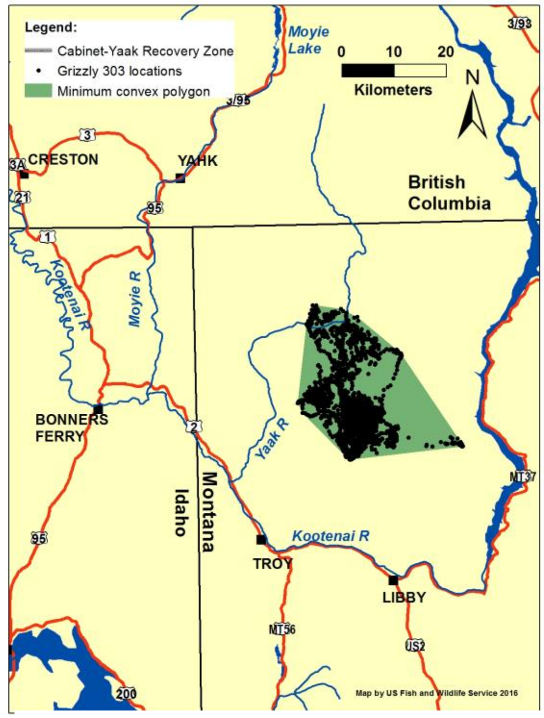


Figure 50. Radio locations and minimum convex (shaded) life range of female grizzly bear 303 in the Yaak River, 1994-01 and 2011-15.

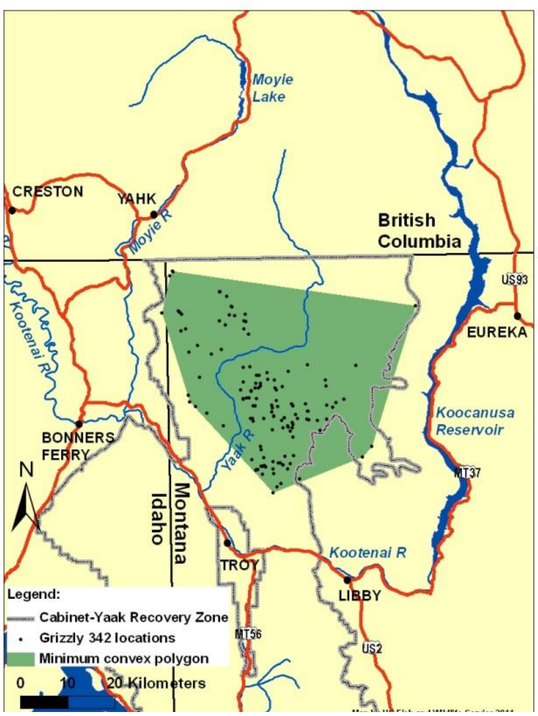


Figure 51. Radio locations and minimum convex (shaded) life range of male grizzly bear 342 in the Yaak River, 1995-01.

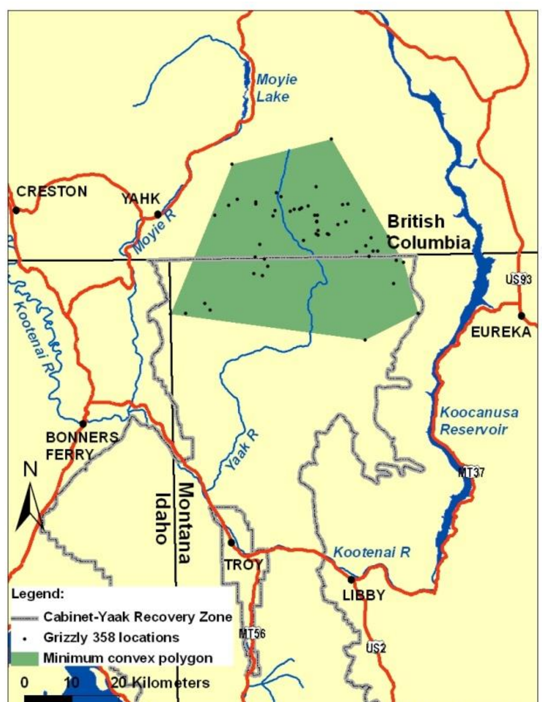


Figure 52. Radio locations and minimum convex (shaded) life range of male grizzly bear 358 in the Yaak River, 1996-98.

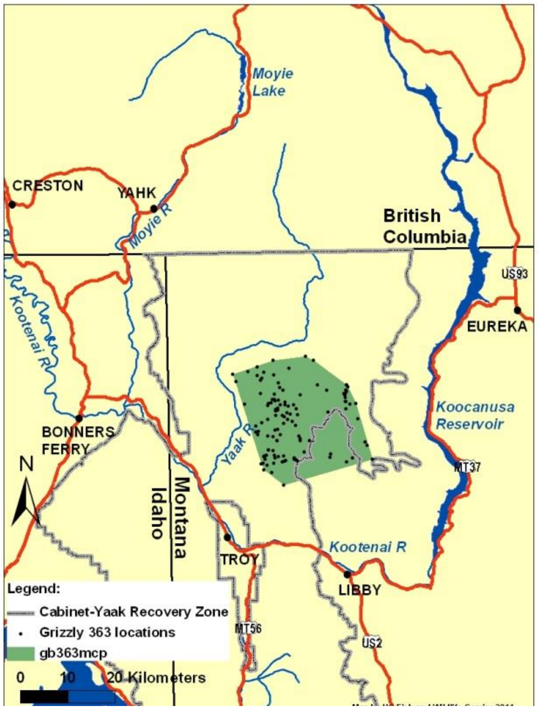


Figure 53. Radio locations and minimum convex (shaded) life range of male grizzly bear 363 in the Yaak River, 1996-99.

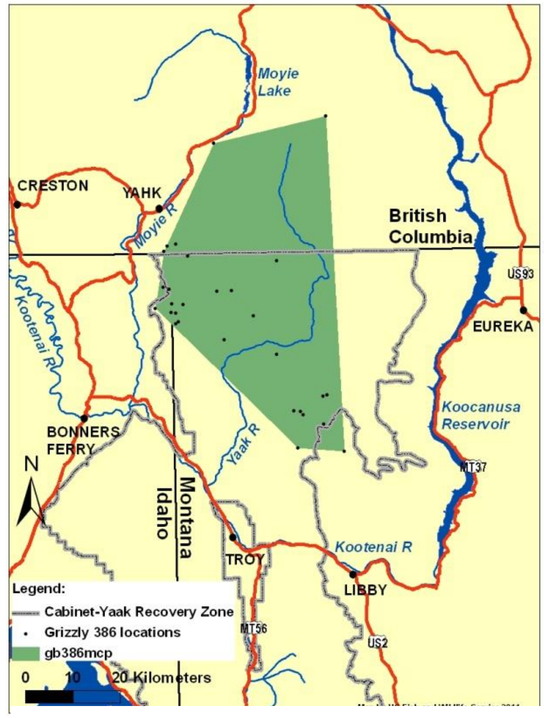


Figure 54. Radio locations and minimum convex (shaded) life range of male grizzly bear 386 in the Yaak River, 1997-99.

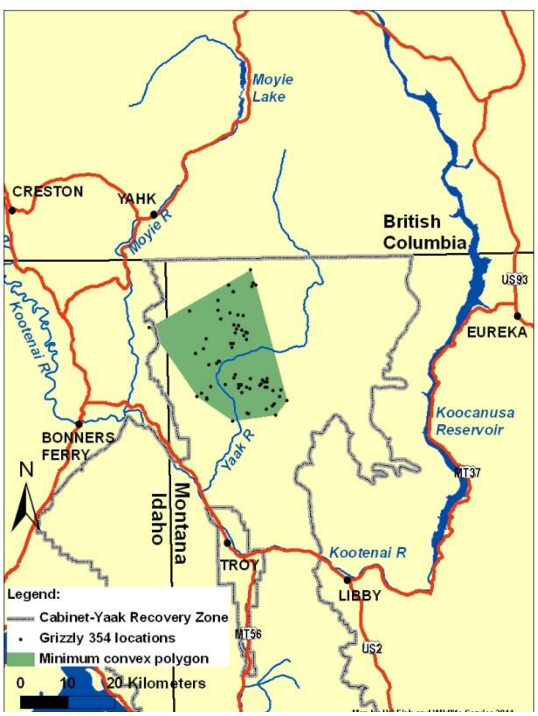


Figure 55. Radio locations and minimum convex (shaded) life range of female grizzly bear 354 in the Yaak River, 1997-99.

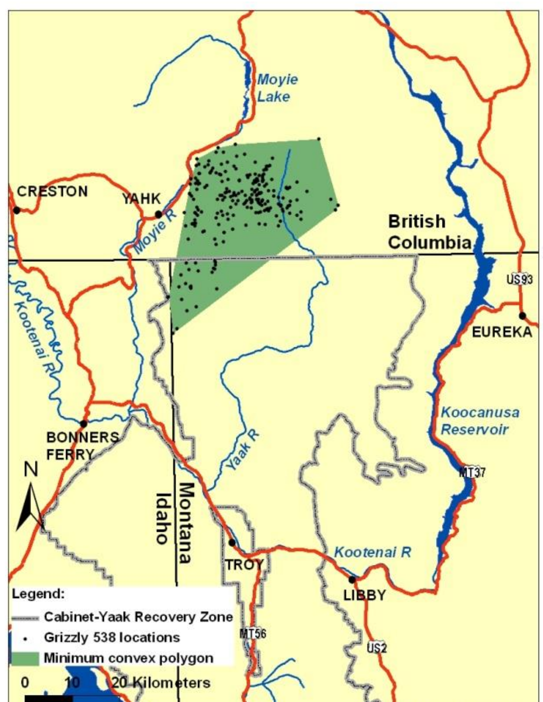


Figure 56. Radio locations and minimum convex (shaded) life range of female grizzly bear 538 in the Yaak River, 1997-02.

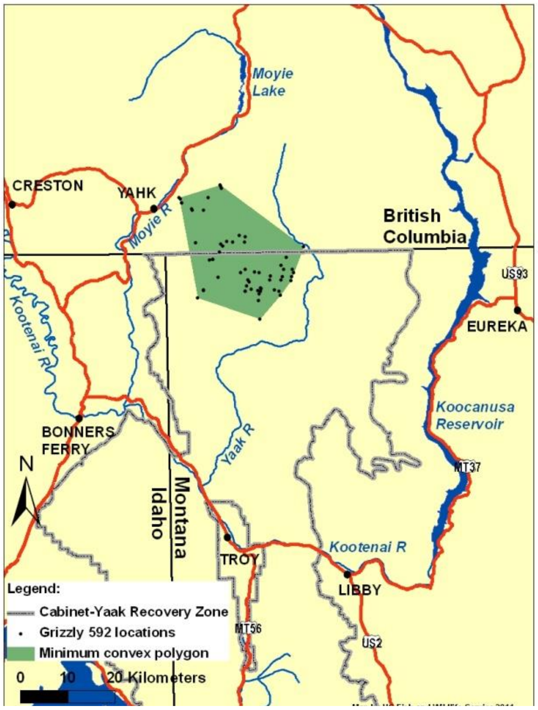


Figure 57. Radio locations and minimum convex (shaded) life range of female grizzly bear 592 in the Yaak River, 1999-00.

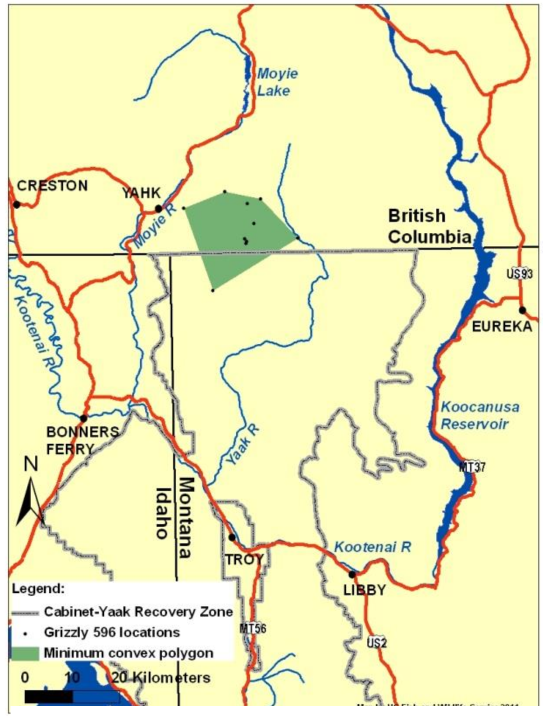


Figure 58. Radio locations and minimum convex (shaded) life range of female grizzly bear 596 in the Yaak River, 1999.

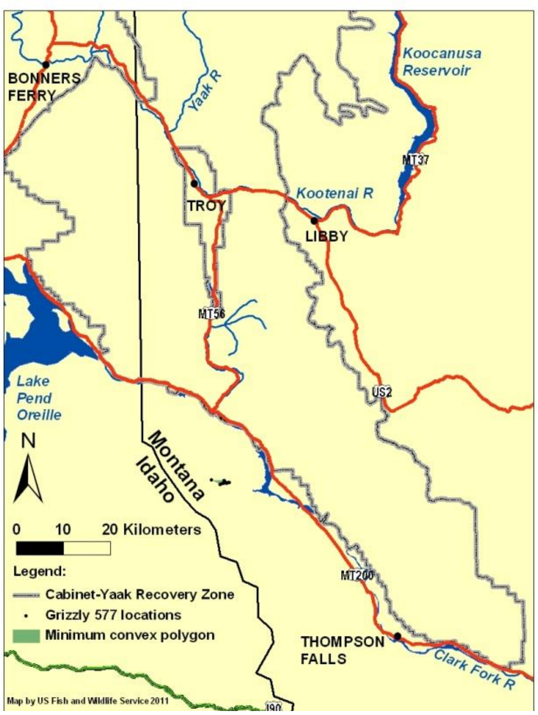


Figure 59. Radio locations and minimum convex (shaded) life range of female grizzly bear 577 in the Cabinet Mountains, 2002.

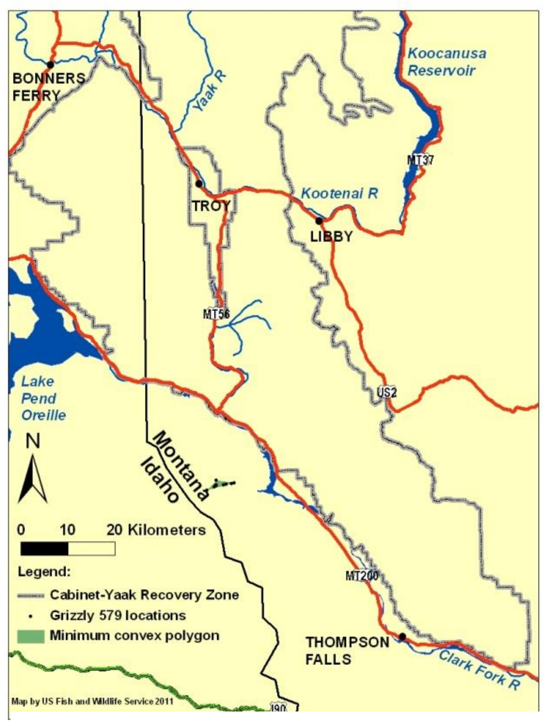


Figure 60. Radio locations and minimum convex (shaded) life range of male grizzly bear 579 in the Cabinet Mountains, 2002.

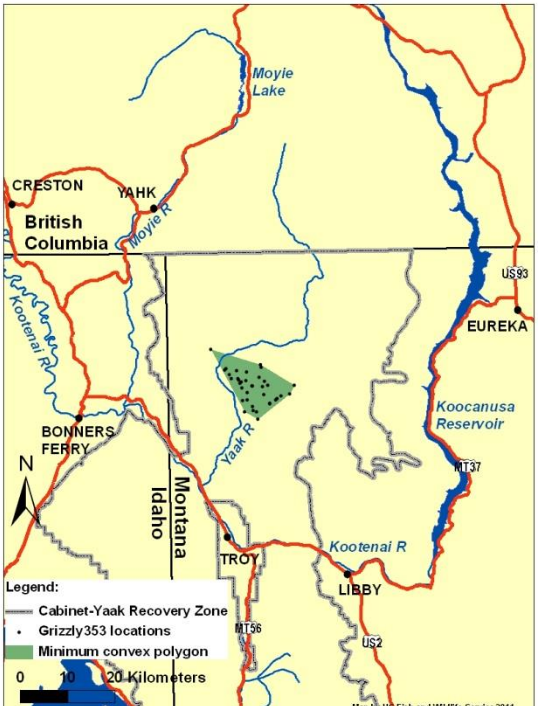


Figure 61. Radio locations and minimum convex (shaded) life range of female grizzly bear 353 in the Yaak River, 2002.

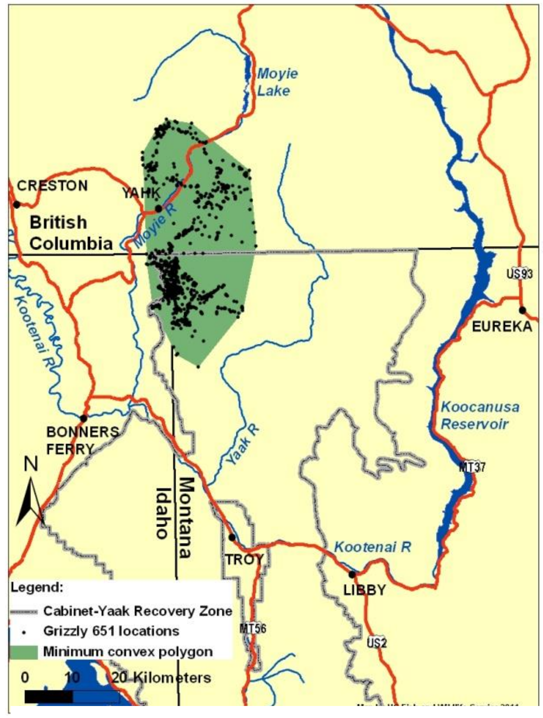


Figure 62. Radio locations and minimum convex (shaded) life range of male grizzly bear 651 in the Yaak River, 2002-06.

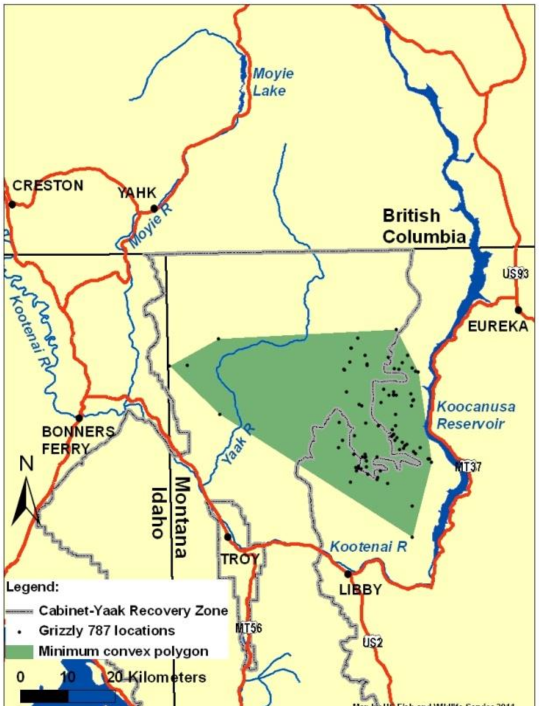


Figure 63. Radio locations and minimum convex (shaded) life range of male grizzly bear 787 in the Yaak River, 2003-04.

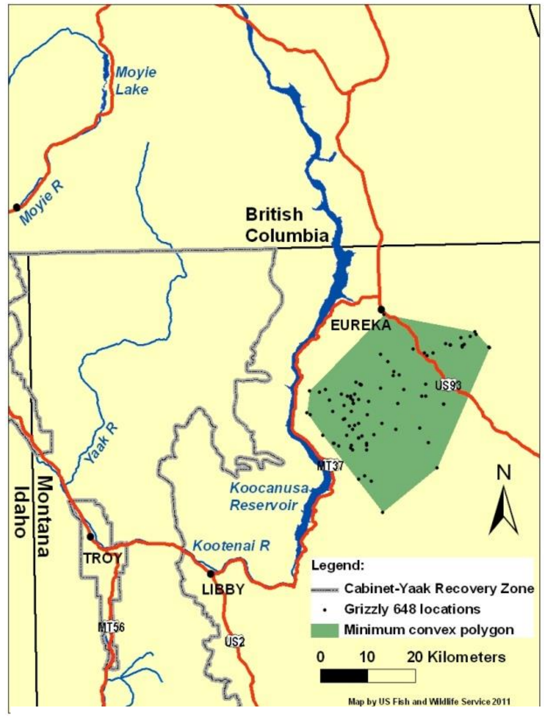


Figure 64. Radio locations and minimum convex (shaded) life range of female grizzly bear 648 in the Salish Mountains, 2003-05.

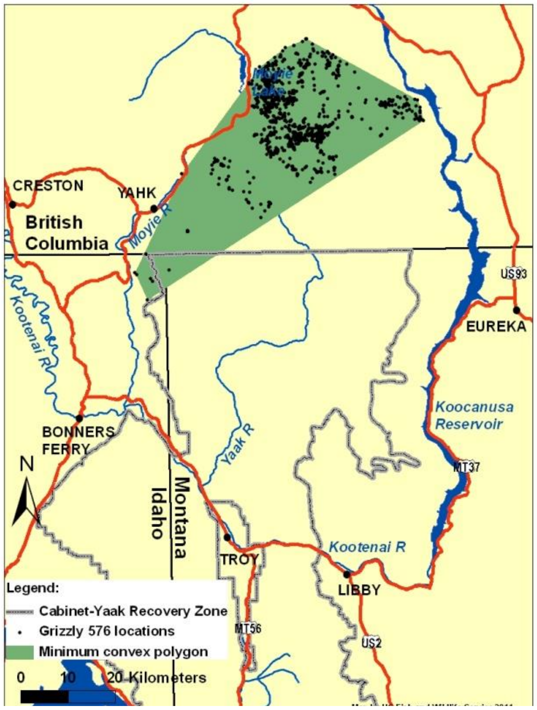


Figure 65. Radio locations and minimum convex (shaded) life range of male grizzly bear 576 in the Yaak River, 2004-06.

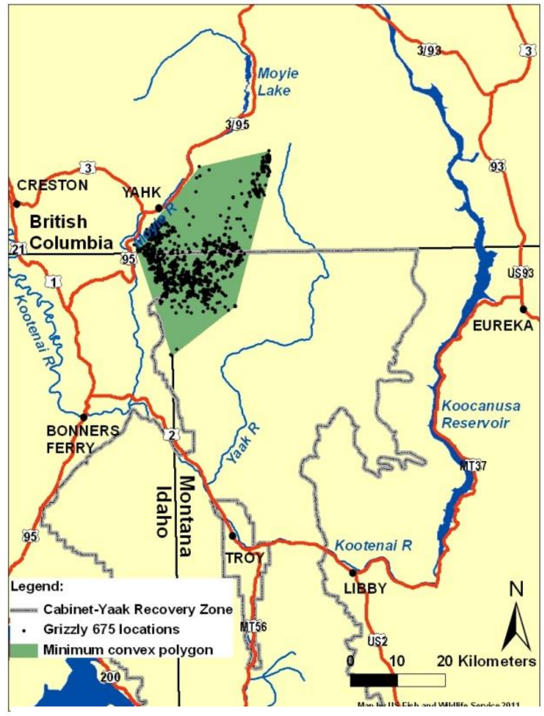


Figure 66. Radio locations and minimum convex (shaded) life range of female grizzly bear 675 in the Yaak River, 2004-10.

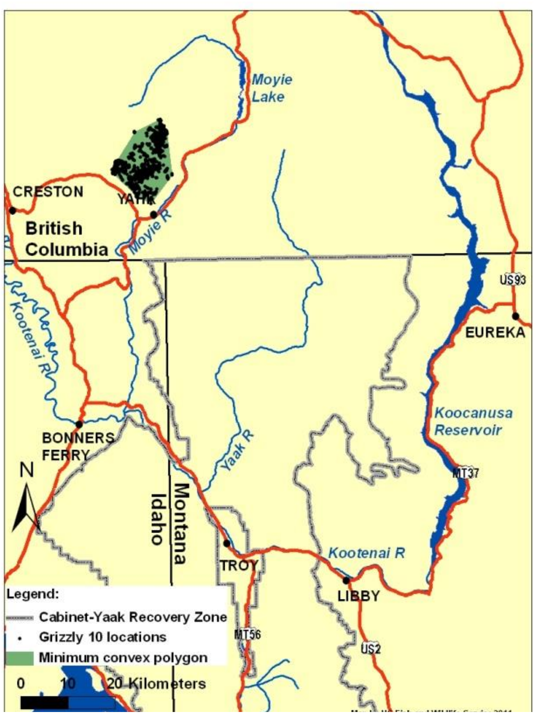


Figure 67. Radio locations and minimum convex (shaded) life range of female grizzly bear 10 in the Purcell Mountains, 2004.

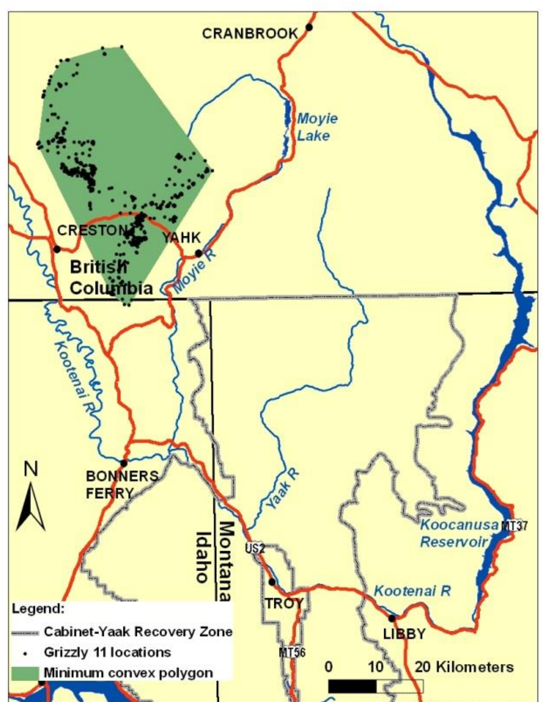


Figure 68. Radio locations and minimum convex (shaded) life range of male grizzly bear 11 in the Purcell Mountains, 2004.

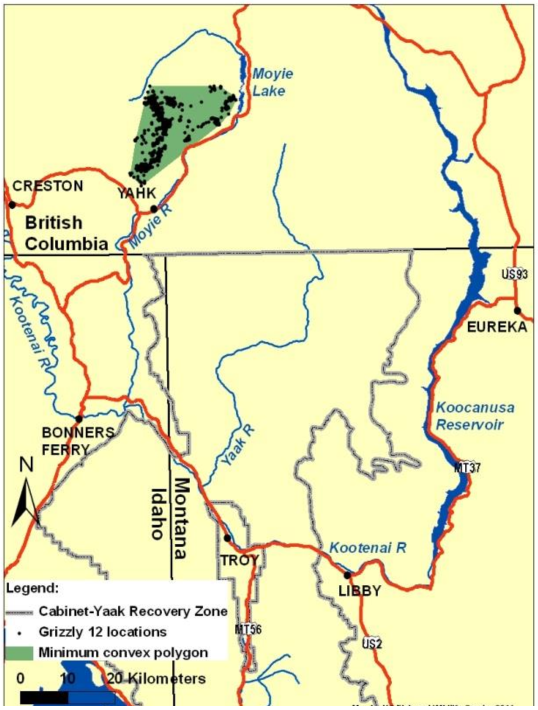


Figure 69. Radio locations and minimum convex (shaded) life range of female grizzly bear 12 in the Purcell Mountains, 2004.

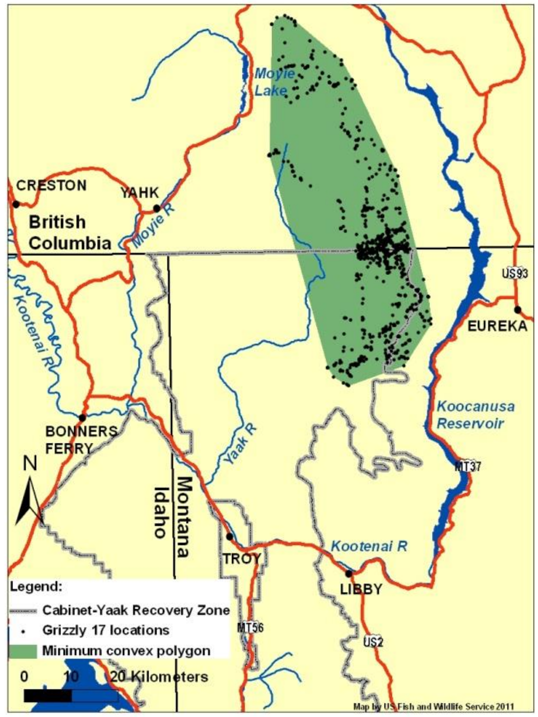


Figure 70. Radio locations and minimum convex (shaded) life range of male grizzly bear 17 in the Purcell Mountains, 2004.

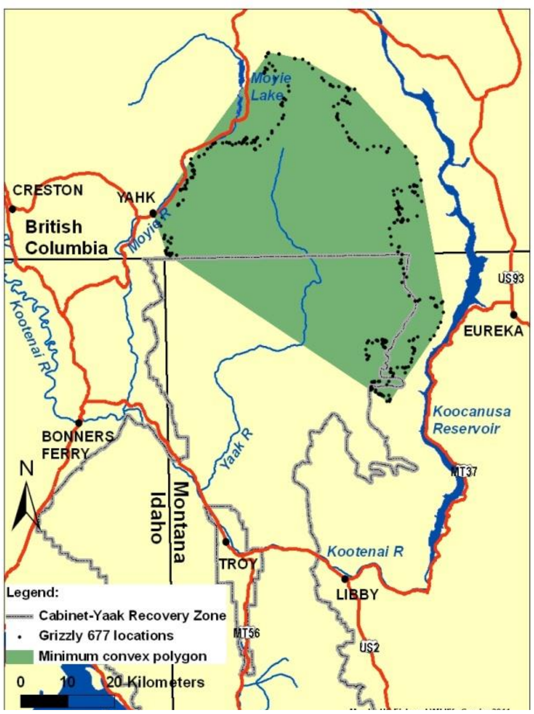


Figure 71. Radio locations and minimum convex (shaded) life range of male grizzly bear 677 in the Purcell Mountains, 2005.

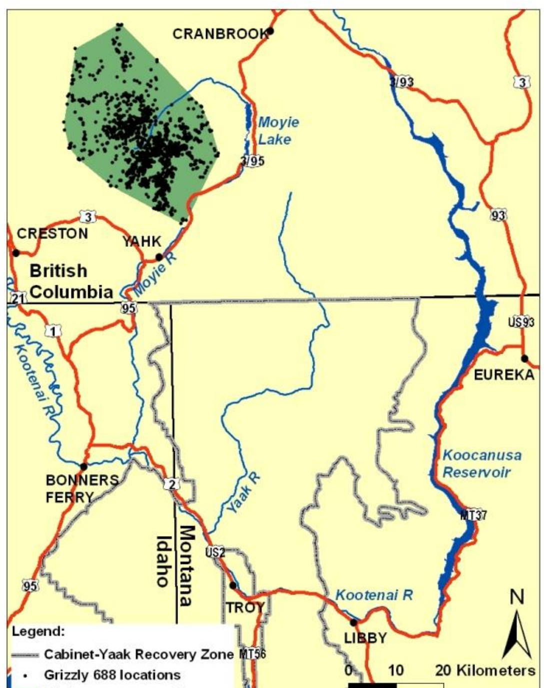


Figure 72. Radio locations and minimum convex (shaded) life range of male grizzly bear 688 in the Purcell Mountains, 2005-06.

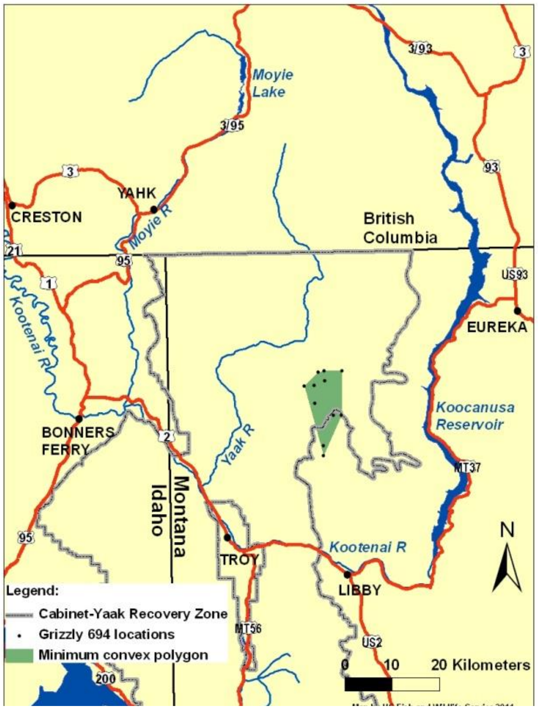


Figure 73. Radio locations and minimum convex (shaded) life range of female grizzly bear 694 in the Yaak River, 2005.

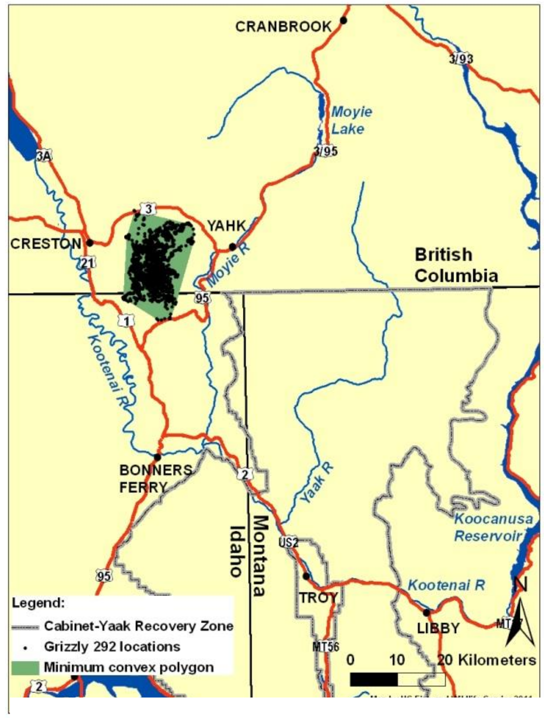


Figure 74. Radio locations and minimum convex (shaded) life range of female grizzly bear 292 in the Purcell Mountains, 2005.

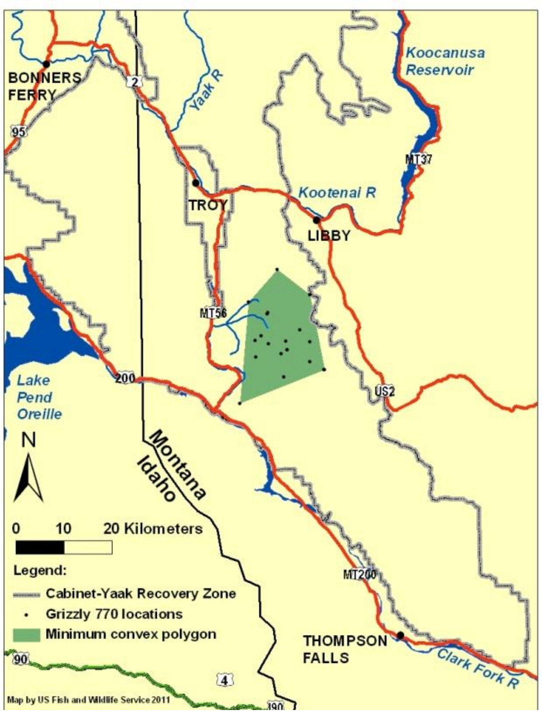


Figure 75. Radio locations and minimum convex (shaded) life range of male grizzly bear 770 in the Cabinet Mountains, 2005-06.

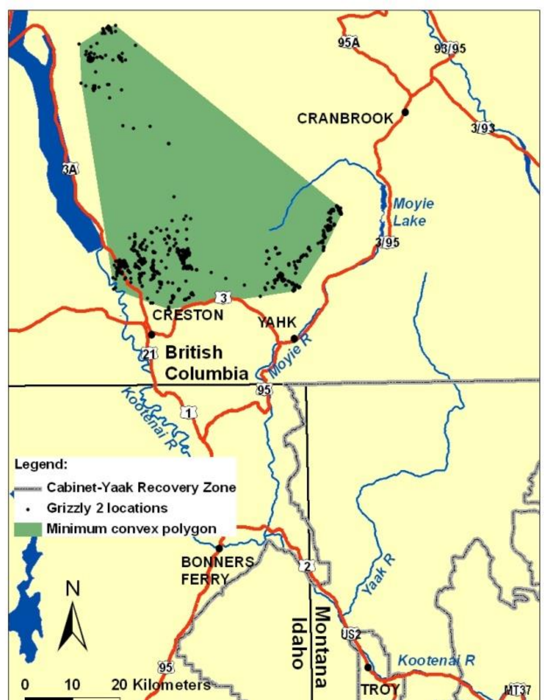


Figure 76. Radio locations and minimum convex (shaded) life ranges of male grizzly bear 2 in the Purcell Mountains, 2005.

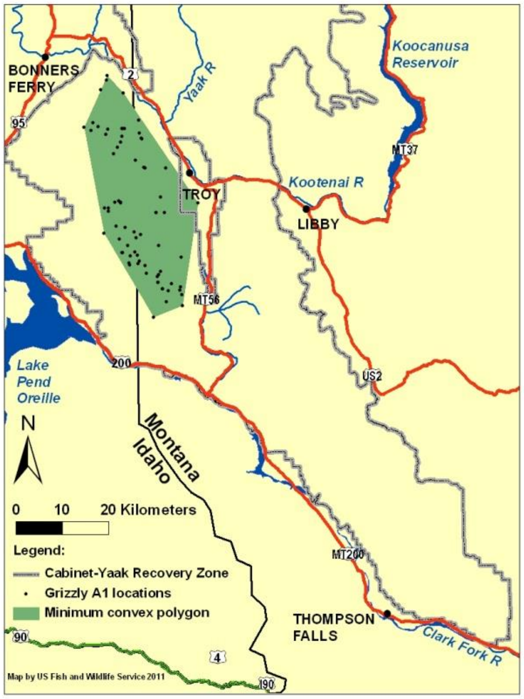


Figure 77. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear A1 in the Cabinet Mountains, 2005-07.

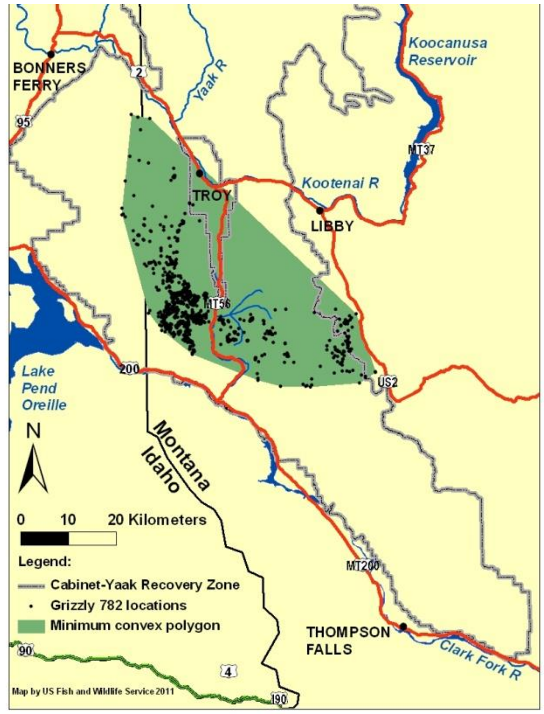


Figure 78. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 782 in the Cabinet Mountains, 2006-07.

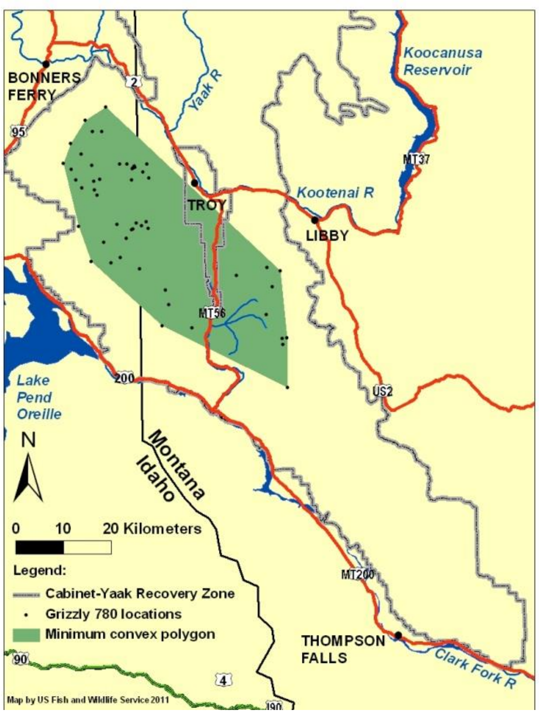


Figure 79. Radio locations and minimum convex (shaded) life range of male grizzly bear 780 in the Cabinet Mountains, 2006-08.

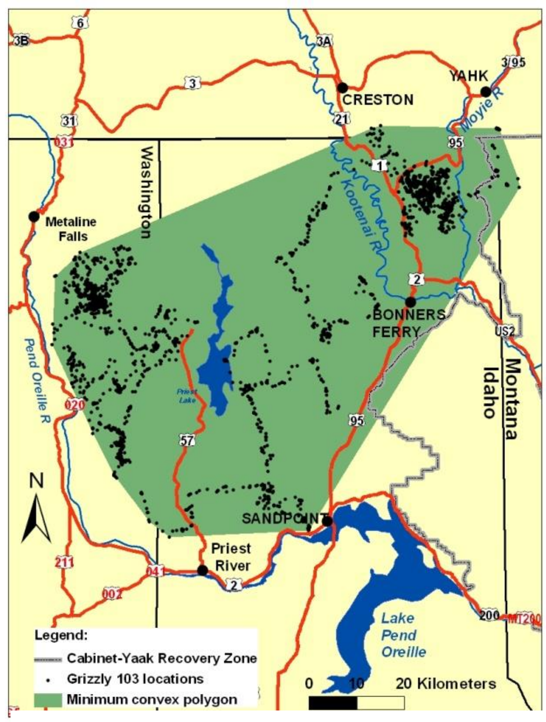


Figure 80. Radio locations and minimum convex (shaded) life range of male grizzly bear 103 in the Yaak River, 2006-07.

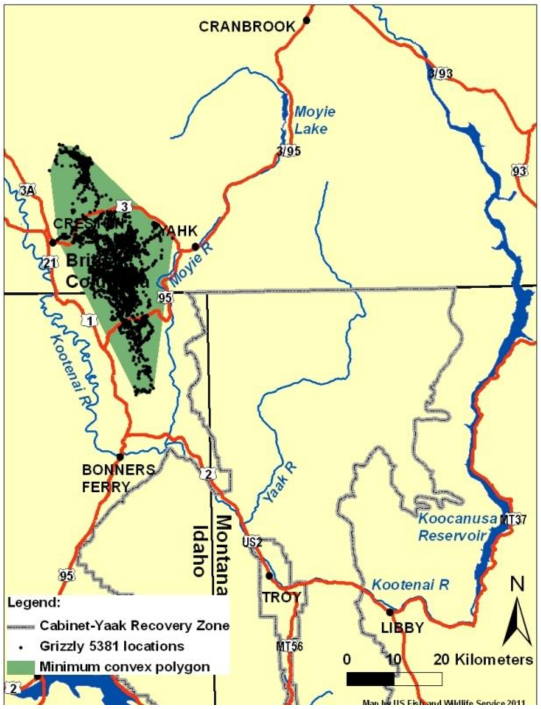


Figure 81. Radio locations and minimum convex (shaded) life range of male grizzly bear 5381 in the Purcell Mountains, 2006-07.

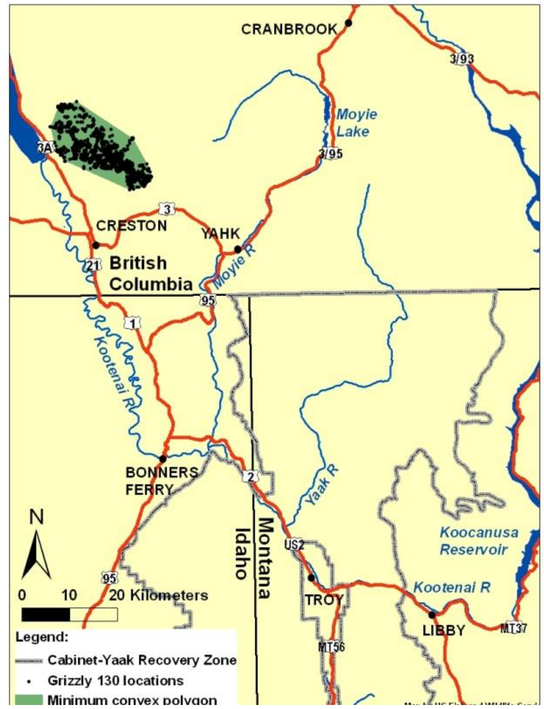


Figure 82. Radio locations and minimum convex (shaded) life range of female grizzly bear 130 in the Purcell Mountains, 2007-08.

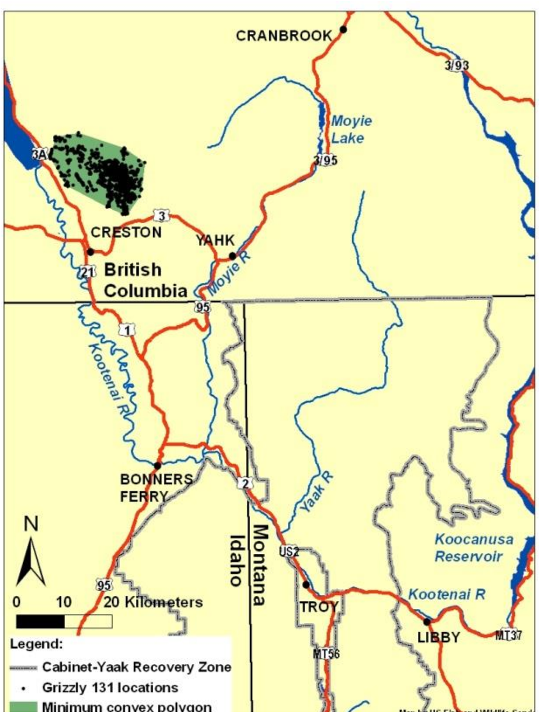


Figure 83. Radio locations and minimum convex (shaded) life range of female grizzly bear 131 in the Purcell Mountains, 2007-08.

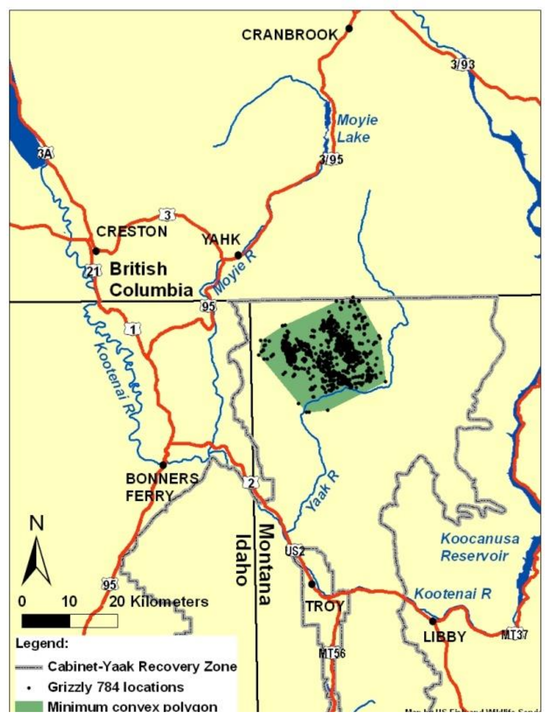
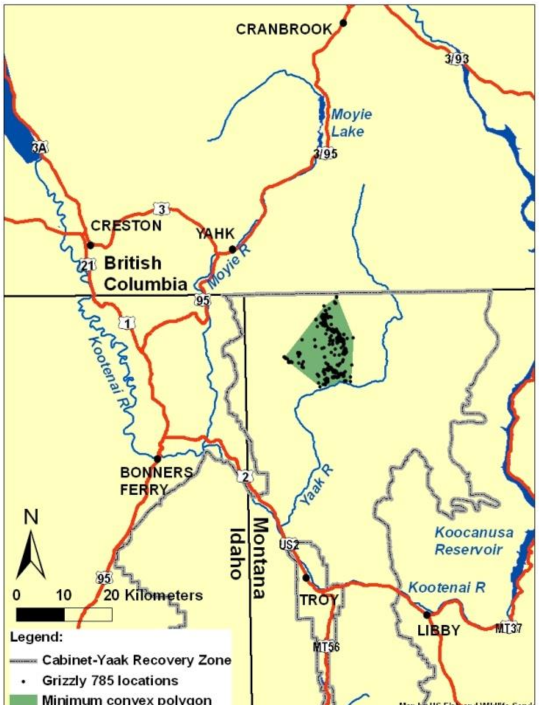


Figure 84. Radio locations and minimum convex (shaded) life range of female grizzly bear 784 in the Yaak River, 2007-09.



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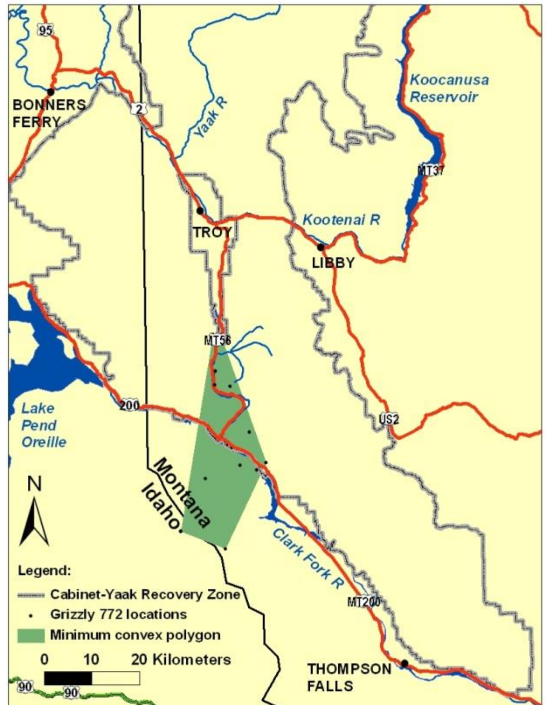


Figure 86. Radio locations and minimum convex (shaded) life range of female grizzly bear 772 in the Cabinet Mountains, 2007.

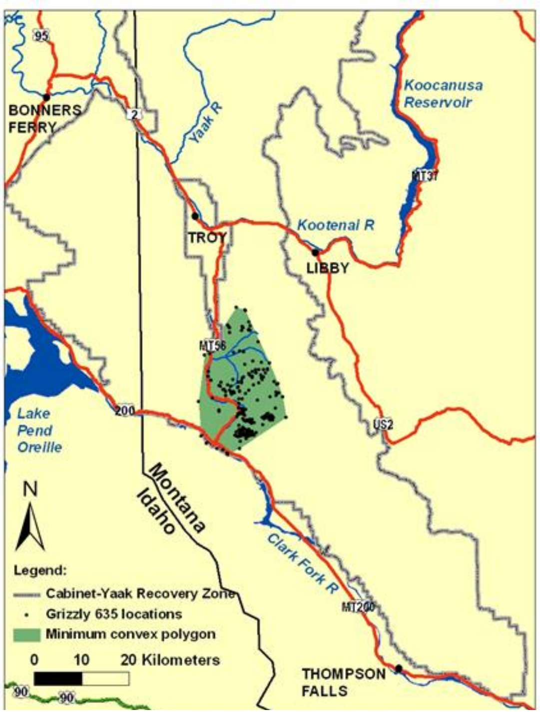


Figure 87. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 635 in the Cabinet Mountains, 2008.

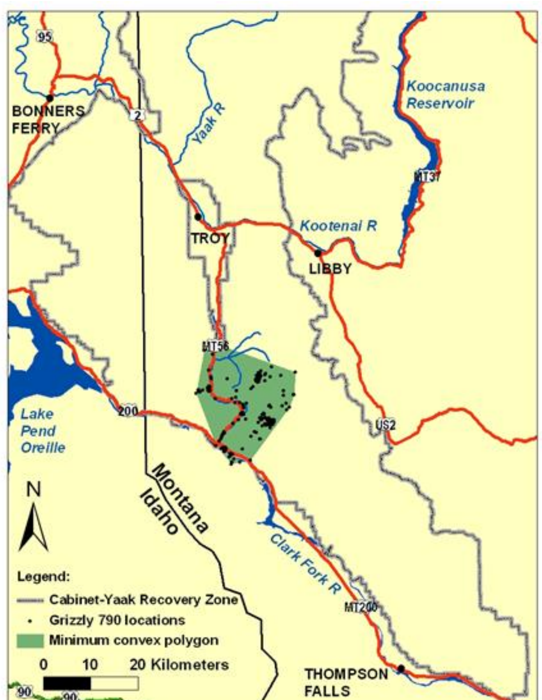


Figure 88. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 790 in the Cabinet Mountains, 2008.

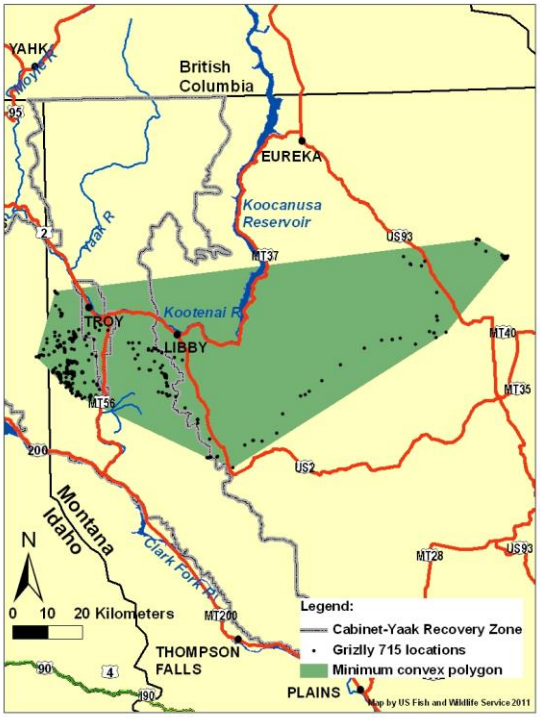


Figure 89. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 715 in the Cabinet Mountains, 2009-10.

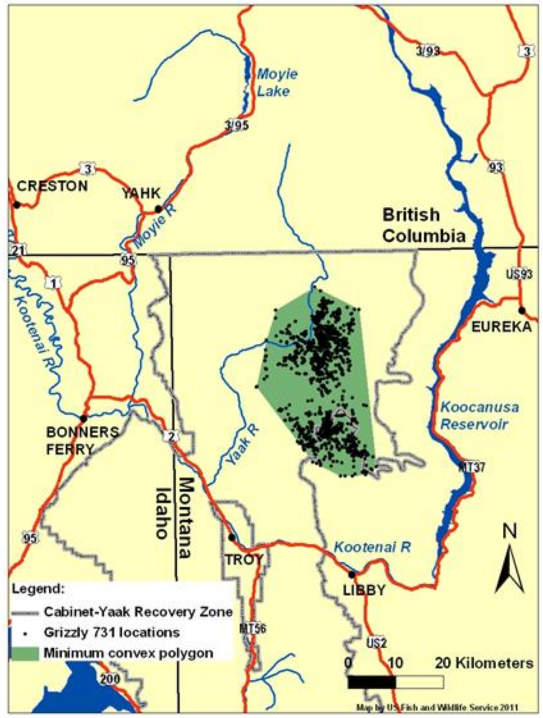


Figure 90. Radio locations and minimum convex (shaded) life range of female grizzly bear 731 in the Yaak River, 2009-11.

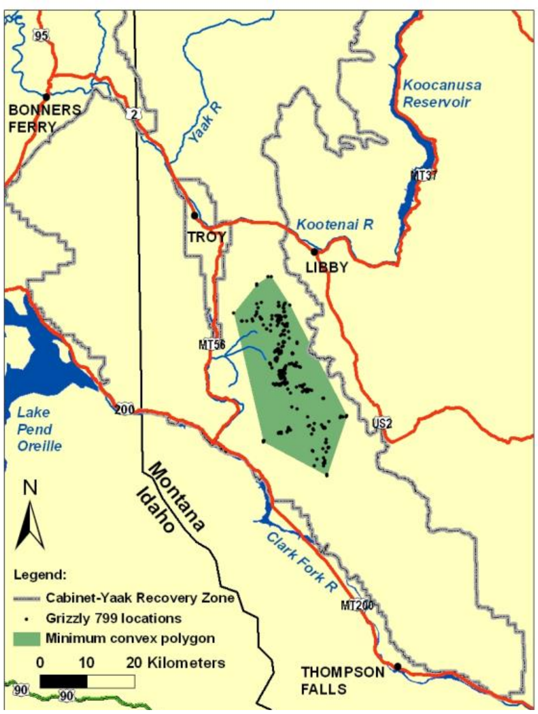


Figure 91. Radio locations and minimum convex (shaded) life range of male grizzly bear 799 in the Cabinet Mountains, 2009-10.

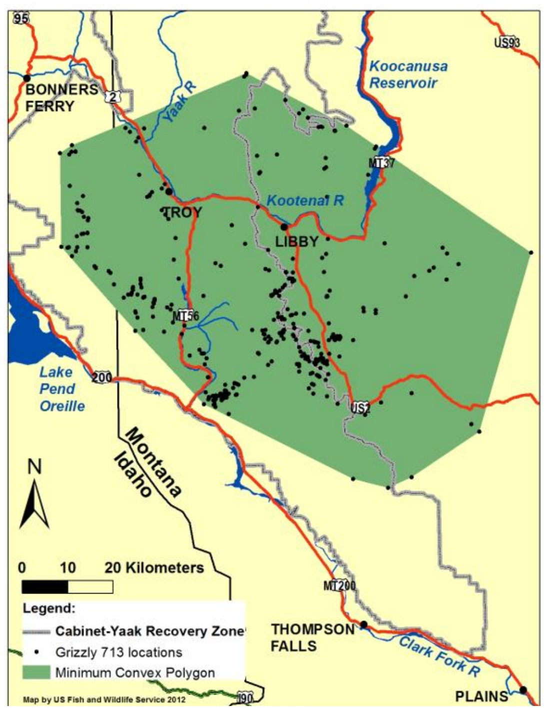


Figure 92. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 713 in the Cabinet Mountains, 2010-11.

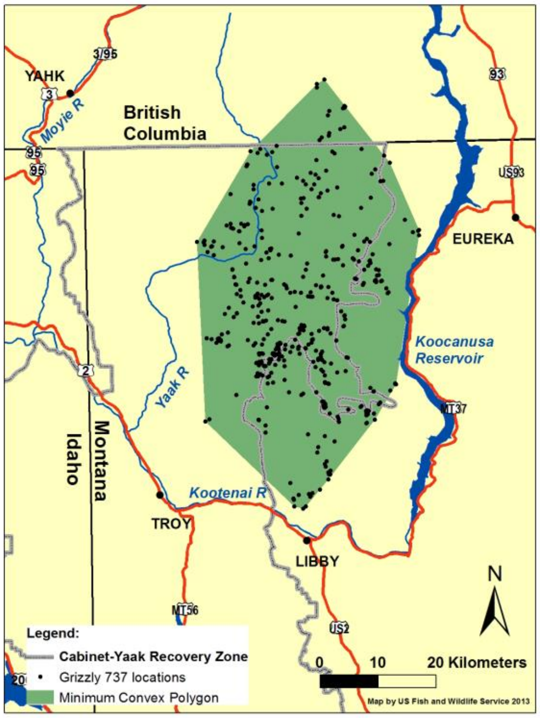


Figure 93. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 714 in the Cabinet Mountains, 2010-12.

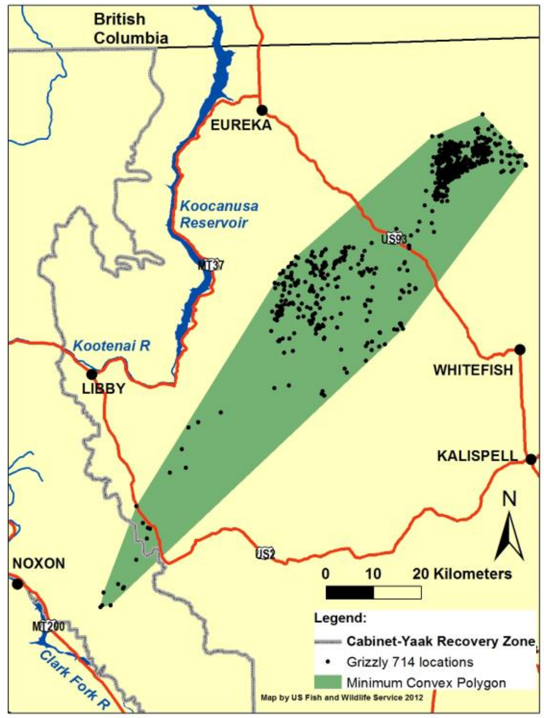


Figure 94. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 713 in the Cabinet Mountains, 2010-12.

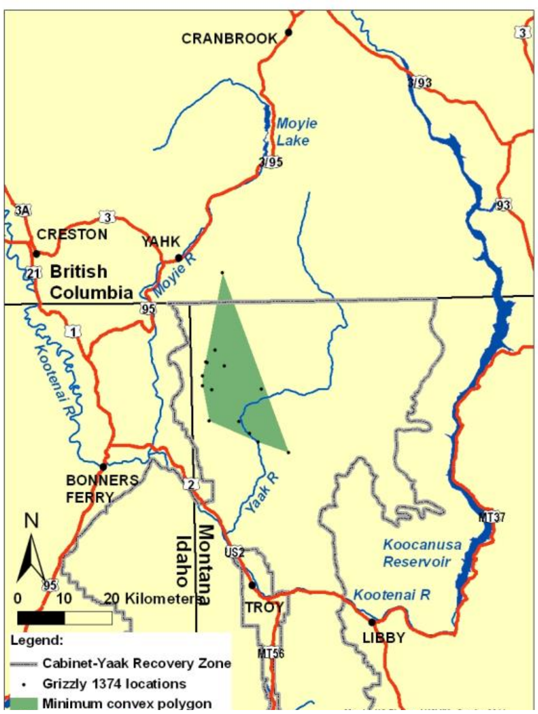


Figure 95. Radio locations and minimum convex (shaded) life range of male grizzly bear 1374 in the Yaak River, 2010.

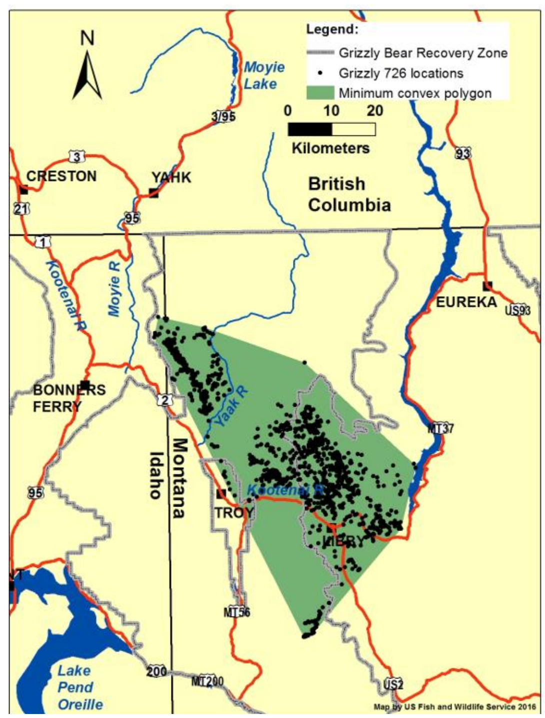


Figure 96. Radio locations and minimum convex (shaded) life range of male grizzly bear 726 in the Yaak River, 2011-12, 2015.

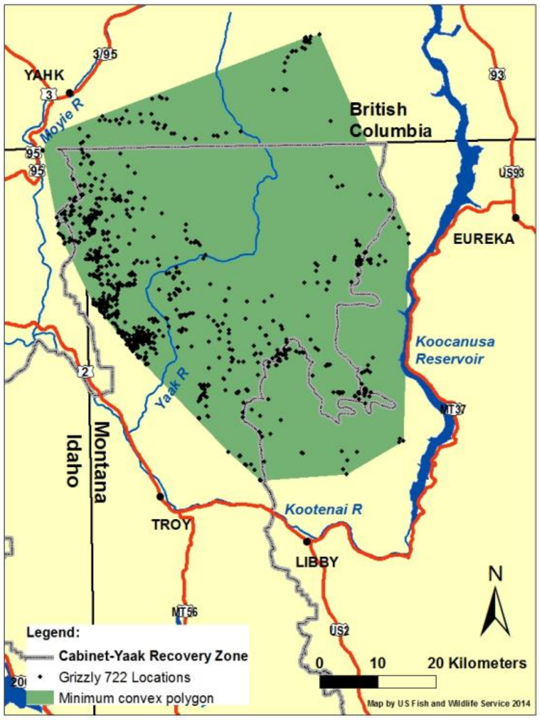


Figure 97. Radio locations and minimum convex (shaded) life range of male grizzly bear 722 in the Yaak River, 2011-12, 2014.

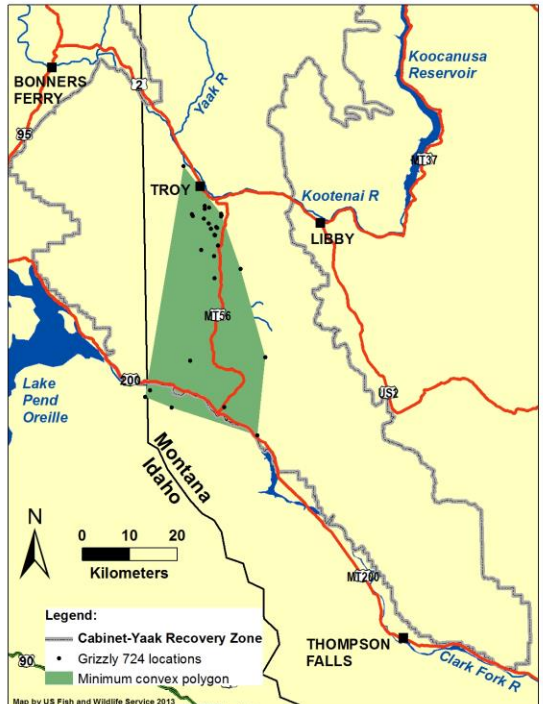


Figure 98. Radio locations and minimum convex (shaded) life range of management male grizzly bear 724 in the Cabinet Mountains, 2011-12.

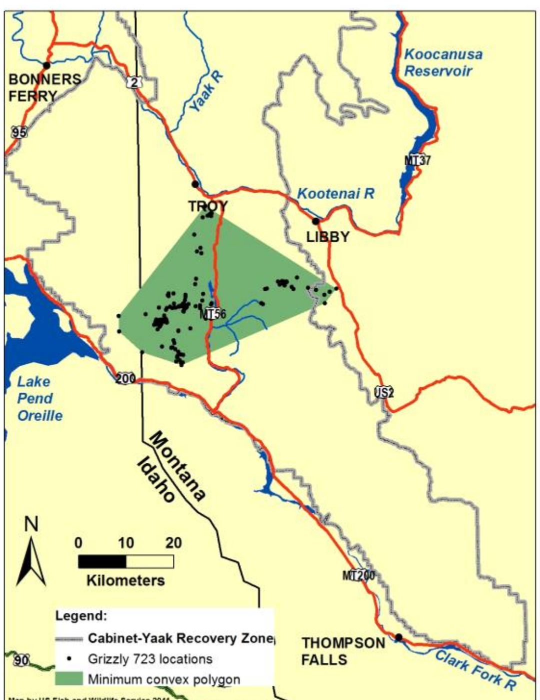


Figure 99. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 723 in the Cabinet Mountains, 2011-12.

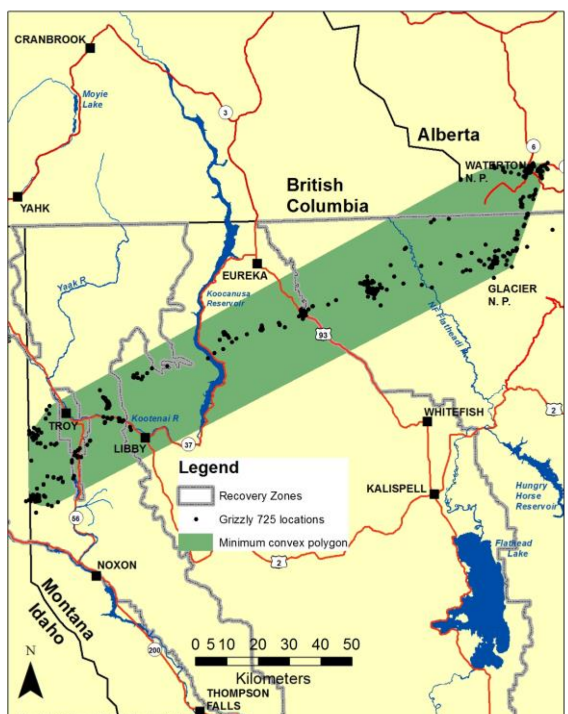


Figure 100. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 725 in the Cabinet Mountains, 2011-13.

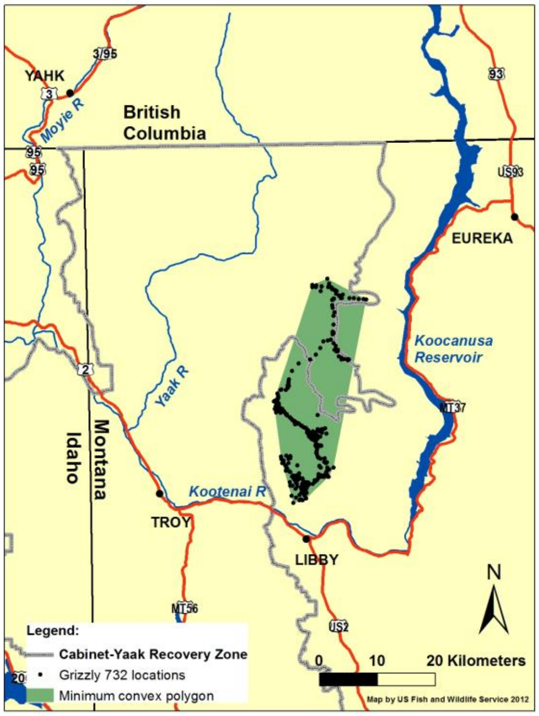


Figure 101. Radio locations and minimum convex (shaded) life range of management male grizzly bear 732 in the Yaak River, 2011.

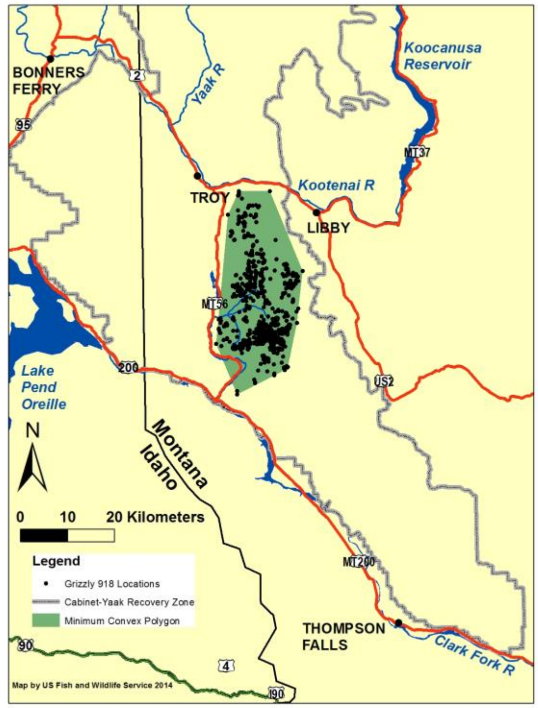


Figure 102. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 918 in the Cabinet Mountains, 2012-14.

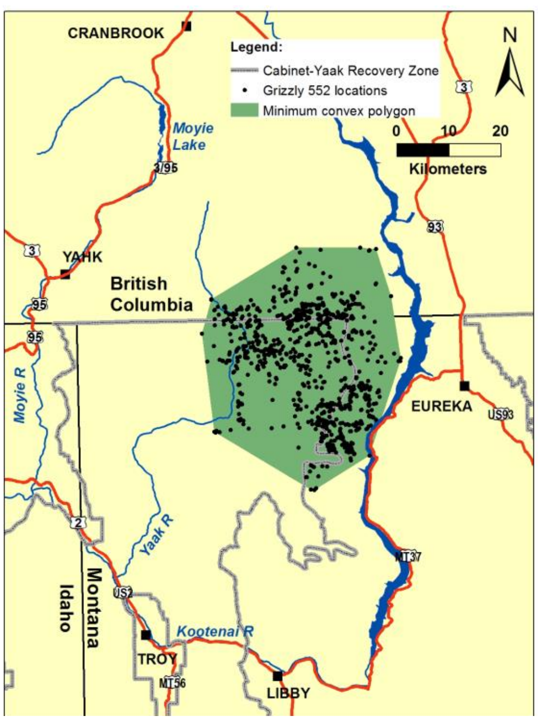


Figure 103. Radio locations and minimum convex (shaded) life range of female grizzly bear 552 in the Yaak River, 2012-15.

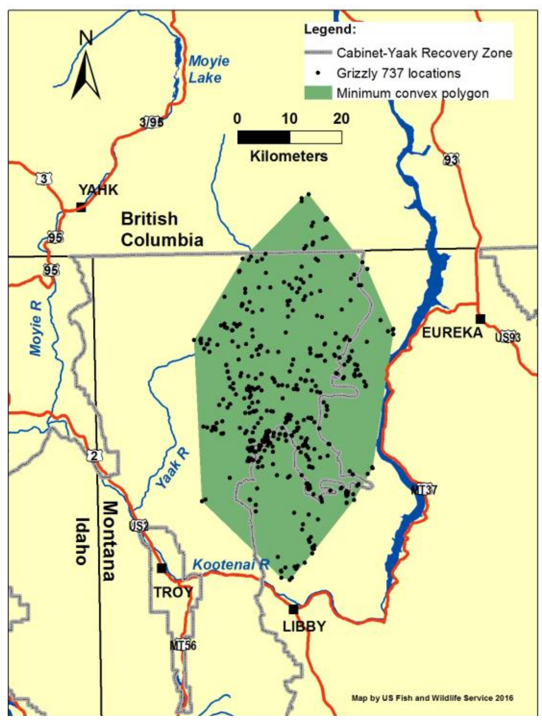
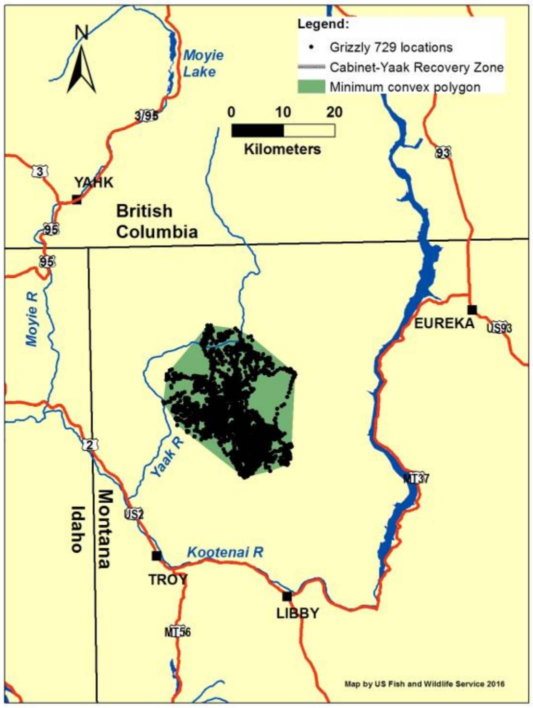


Figure 104. Radio locations and minimum convex (shaded) life range of male grizzly bear 737 in the Yaak River, 2010-13.



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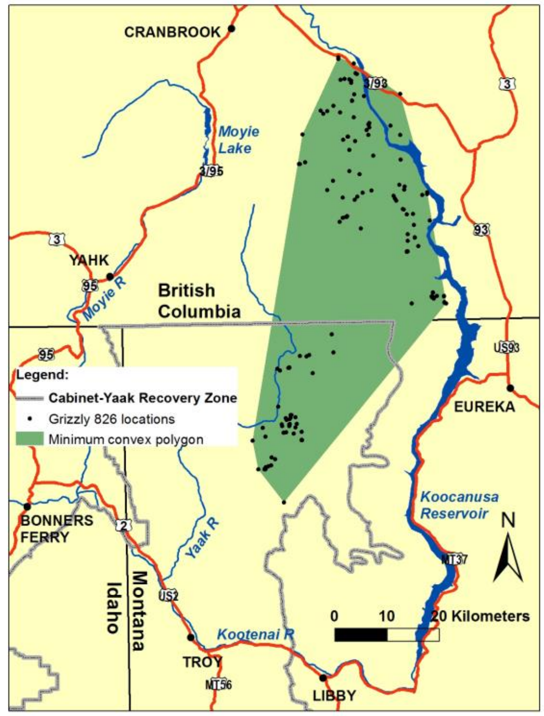

Figure 106. Radio locations and minimum convex (shaded) life range of male grizzly bear 826 in the Yaak River, 2013.

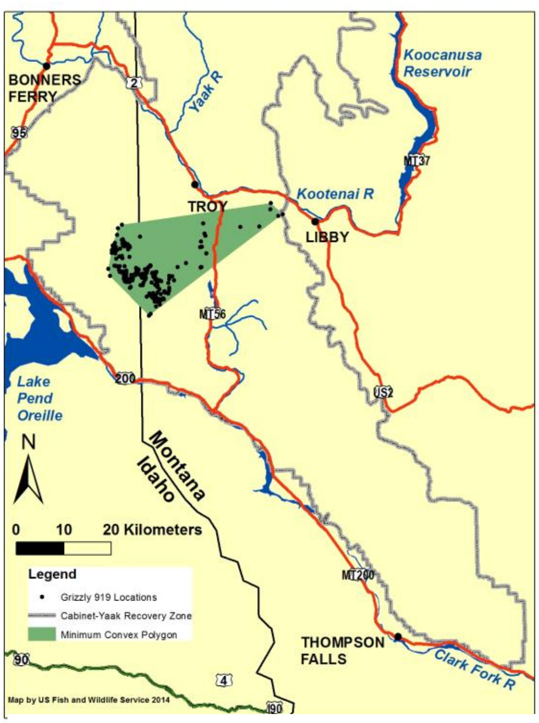

Figure 107. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 919 in the Cabinet Mountains, 2013-14.

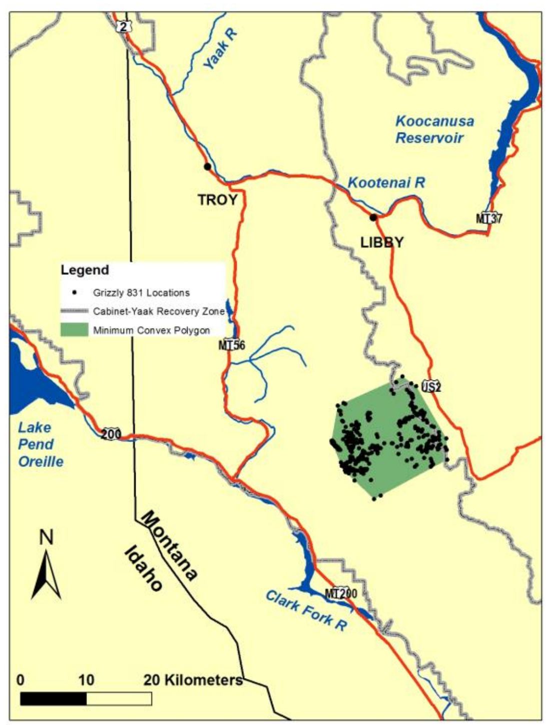

Figure 108. Radio locations and minimum convex (shaded) life range of female grizzly bear 831 in the Cabinet Mountains, 2014.

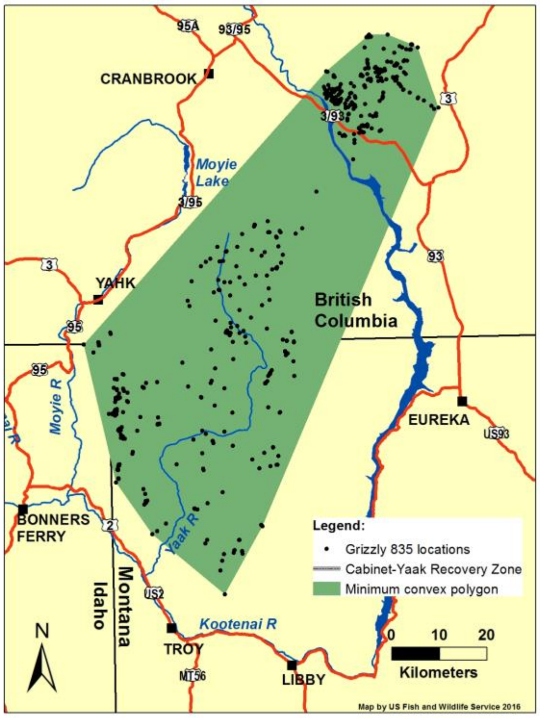

Figure 109. Radio locations and minimum convex (shaded) life range of male grizzly bear 835 in the Yaak River, 2014-15.

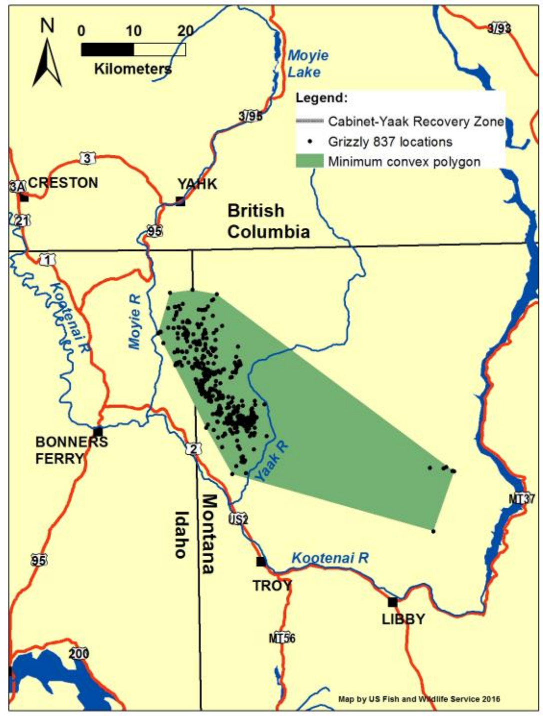

Figure 110. Radio locations and minimum convex (shaded) life range of male grizzly bear 837 in the Cabinet Mountains, 2014-15.

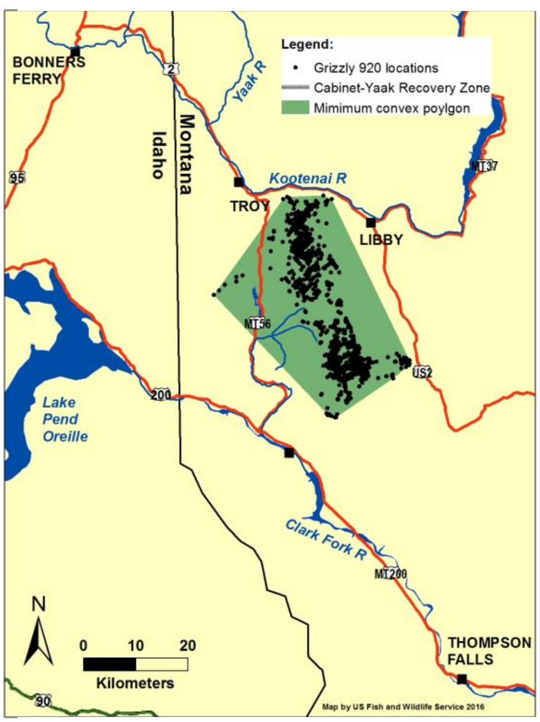

Figure 111. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 920 in the Cabinet Mountains, 2014-15.

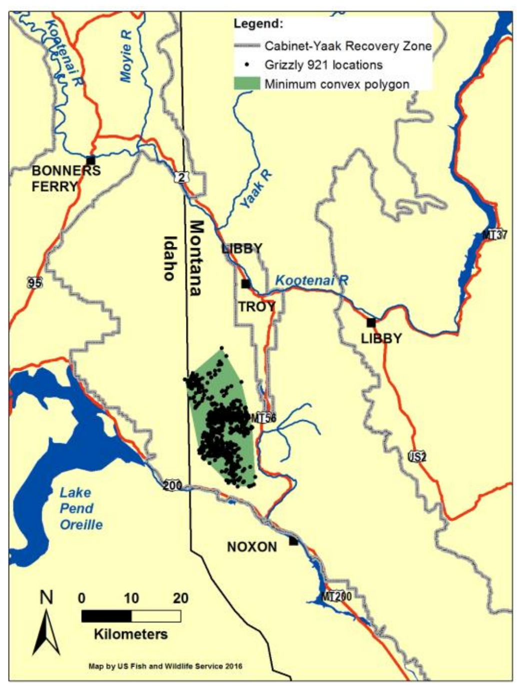

Figure 112. Radio locations and minimum convex (shaded) life range of augmentation female grizzly bear 921 in the Cabinet Mountains, 2014-15.

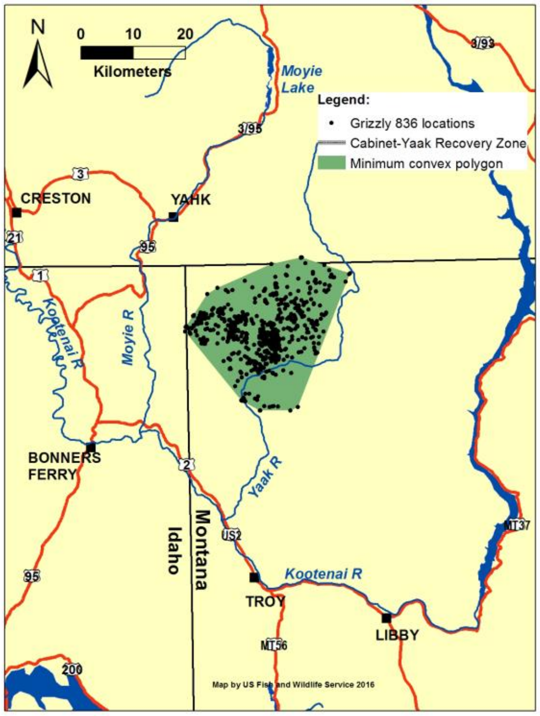

Figure 113. Radio locations and minimum convex (shaded) life range of female grizzly bear 836 in the Yaak River, 2014-15.

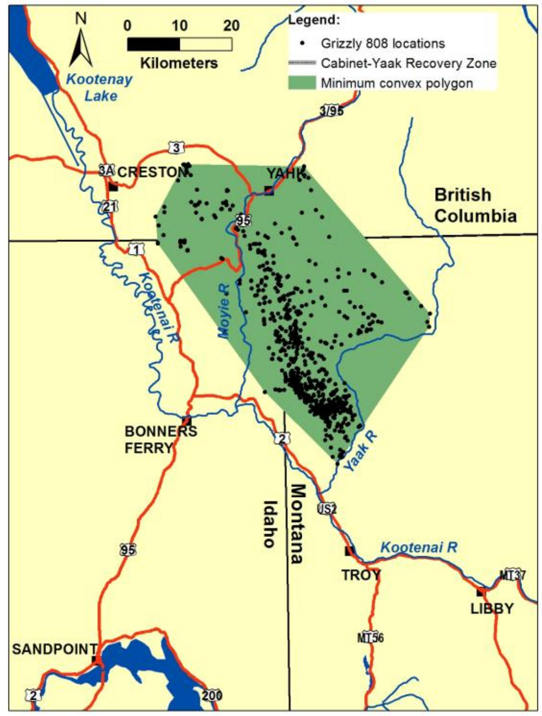

Figure 114. Radio locations and minimum convex (shaded) life range of male grizzly bear 808 in the Yaak River, 2014-15.

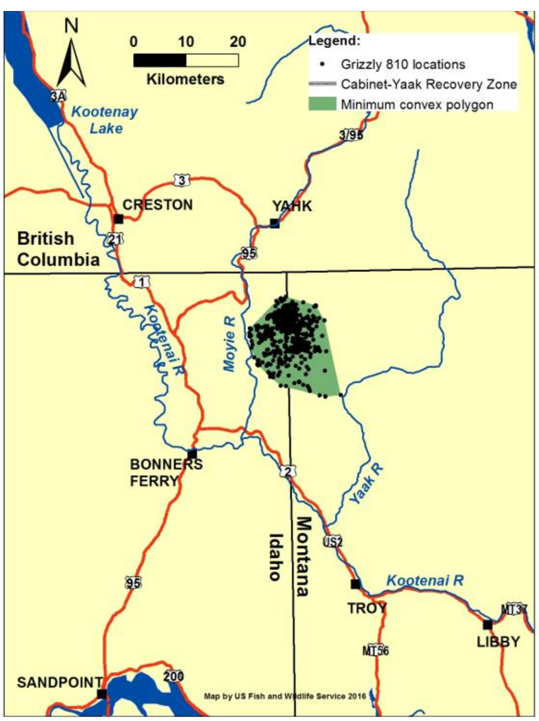

Figure 115. Radio locations and minimum convex (shaded) life range of female grizzly bear 810 in the Yaak River, 2015.

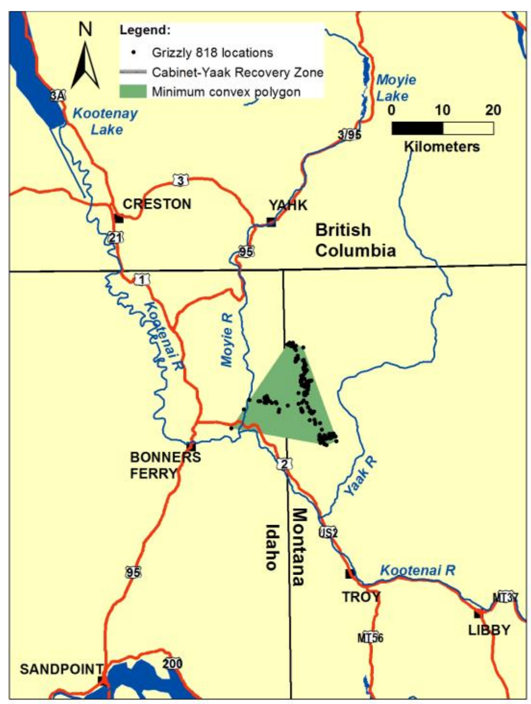

Figure 116. Radio locations and minimum convex (shaded) life range of male grizzly bear 818 in the Yaak River, 2015.

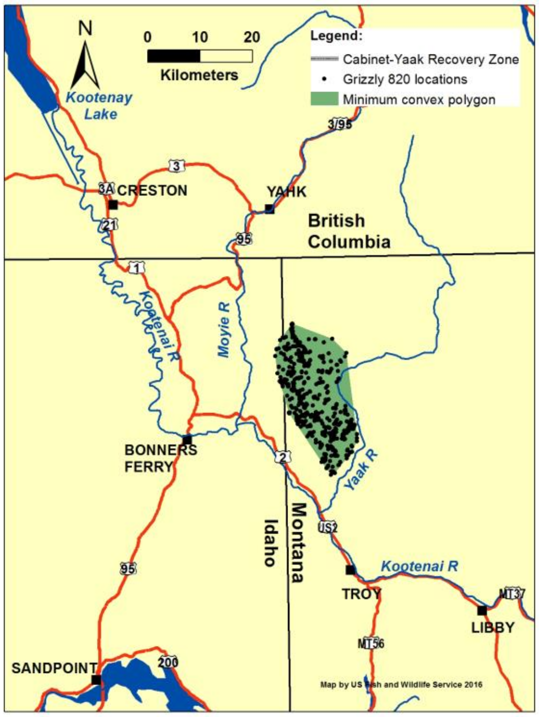

Figure 117. Radio locations and minimum convex (shaded) life range of female grizzly bear 820 in the Yaak River, 2015.

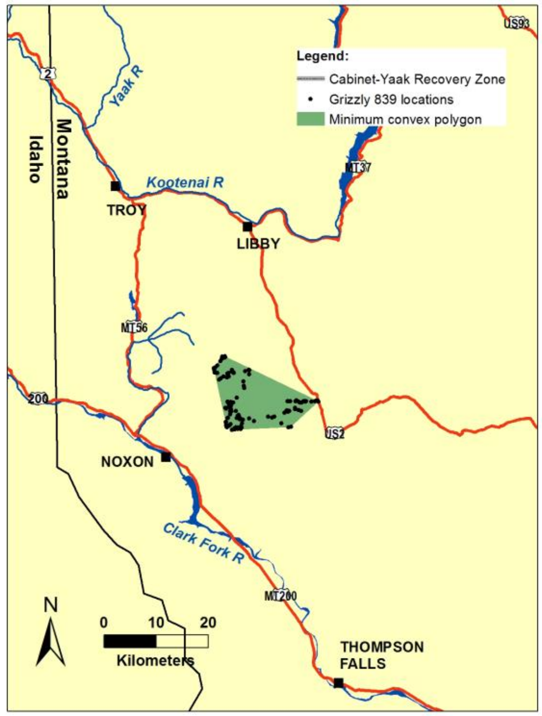

Figure 118. Radio locations and minimum convex (shaded) life range of male grizzly bear 839 in the Cabinet Mountains, 2015.

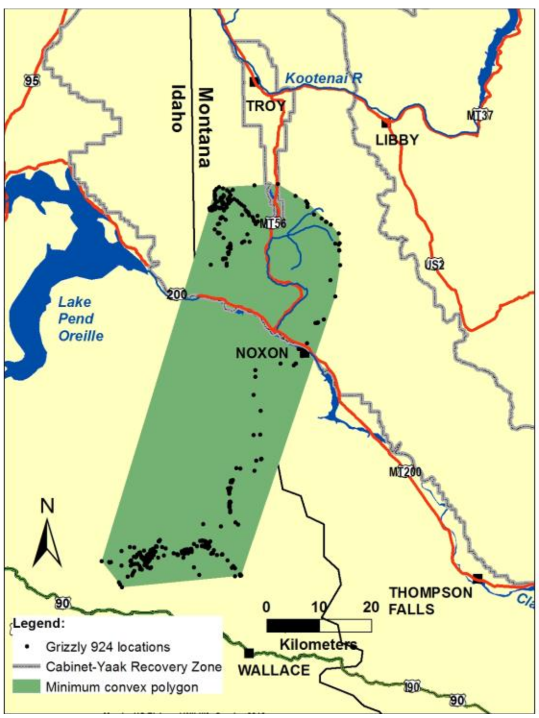

Figure 119. Radio locations and minimum convex (shaded) life range of augmentation male grizzly bear 924 in the Cabinet Mountains, 2015.

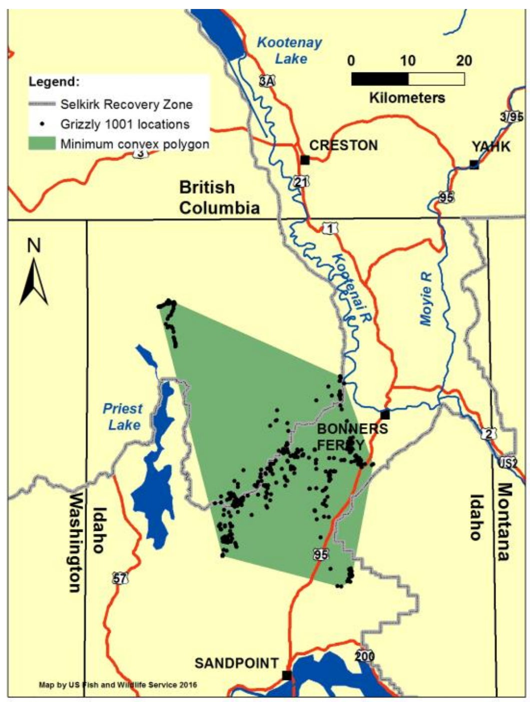

Figure 120. Radio locations and minimum convex (shaded) life range of male grizzly bear 1001 in the Selkirk and Cabinet Mountains, 2015.

Appendix 5. Description of Habitat Components.

1. Closed Timber - Timber stands with tree cover greater than 60%, and a variable but often sparse understory.

2. Open Timber - Timbered sites with tree canopy cover of 30-60% and a sparse grass -forb understory. Found on dry exposures with a limited undergrowth of a few rhizomatous species.

3. Timbered Shrub field - Open timbered sites with tree cover of 30 to 60%, and a shrub dominated understory. Except for more xeric aspects, the shrub layer is well developed, and the forb layer is characteristically sparse due to limited light penetration.

4. Mixed Shrub/Snow chute - Shrub dominated communities resulting from, and often maintained by sudden snow slides on steep timbered drainages. They exist as narrow, linear openings in the forest canopy, or as extensive, broad chutes covering an entire slope.

5. Mixed Shrub/Cutting Unit - Open sites which have been harvested and are currently dominated by shrubs. Structure and composition is variable depending on harvest method, site treatment, habitat type, topographic position and time since harvest.

6. Mixed Shrub/Burn - Open sites, dominated by shrubs, which have developed following fire. Structure and composition is dependent on fire intensity, habitat type, topographic position and time since burn.

7. Alder Shrub - Tall shrub community dominated by alder (*Alnus sinuata*), almost to the exclusion of all other shrub species, with a herbaceous understory. Component can develop as a result of disturbance, but is often restricted to mesic sites.

8. Huckleberry Shrub - Seral shrub fields dominated by *Vaccinium* species. This open, low structured shrub field is created and at times maintained by fire. Timber harvest and snow slides may have the same developmental effect.

9. Riparian Stream bottom - Stream bottom habitat is identified by riparian plant associations, which reflect the influence of increased soil moisture. Considerable variation in vegetation composition and structure, with some sites being open and some timbered. The development and extent of riparian habitat is dependent on timber canopy and stream channel gradient.

10. Marsh - Open sedge dominated communities that are perennially moist, often containing standing water. Can exist as either unbroken monotypic communities or as infringing zones around open shallow lakes and ponds.

11. Wet Meadow - Mesic graminoid dominated communities along flat low elevation watersheds, and in slightly concave depressions at high elevations. Floristic composition varies between and within open meadows depending on slight differences in soil moisture.

12. Dry Meadow - Open graminoid dominated sites with level or gradual sloping topography, most commonly occurring at low elevations. Can be created by timber harvest, livestock grazing and fire. Vegetation composition is variable depending on the severity of soil disturbance and topographic position of the site, and unless maintained, most sites reestablish shrub or regenerating conifer canopies.

13. Drainage Forb field - High elevation herbaceous fields with gradual to steep topography. Forb fields exist where sufficient soils have accumulated and where snowmelt percolating through shallow stony soils provides an endless supply of water through the growing season. Late in phenological development, a number of forbs continue to grow and flower into September and October.

14. Snow chute - Open, forb dominated snow chutes are the result of recent massive snow slides that remove both tree and shrub cover. Snow chutes in early successional herbaceous stages are uncommon, and occupy a site for a few years prior to shrub development.

15. Graminoid Sidehill Park - Graminoid dominated communities on moderate to steep slopes with convex topography, from mid to high elevations. Local topographic, edaphic and climatic influences combine to limit tree growth.

16. Beargrass Sidehill Park - Beargrass (*Xerophyllum tenex*) dominated communities on moderate to steep slopes with convex topography, from mid to high elevations. Generally located on shallow, well drained soils of south to west aspects. They exist as large homogenous openings along upper slopes and ridges, and small patches on basin headwalls.

17. Slab rock - Open sites of exposed blocks of scoured - glaciated bedrock, occurring at high elevations on steep to gentle topography.

18. Talus/Rock/Scree - Very steep to moderate slopes and benches of loose rock fragments of variable size, with very sparse vegetation.

19. Timbered Grass - Open timbered sites with 30 to 60% tree canopy coverage and a graminoid dominated understory. Generally occur on well-drained soils, with gentle to steep slopes with south to west aspects.