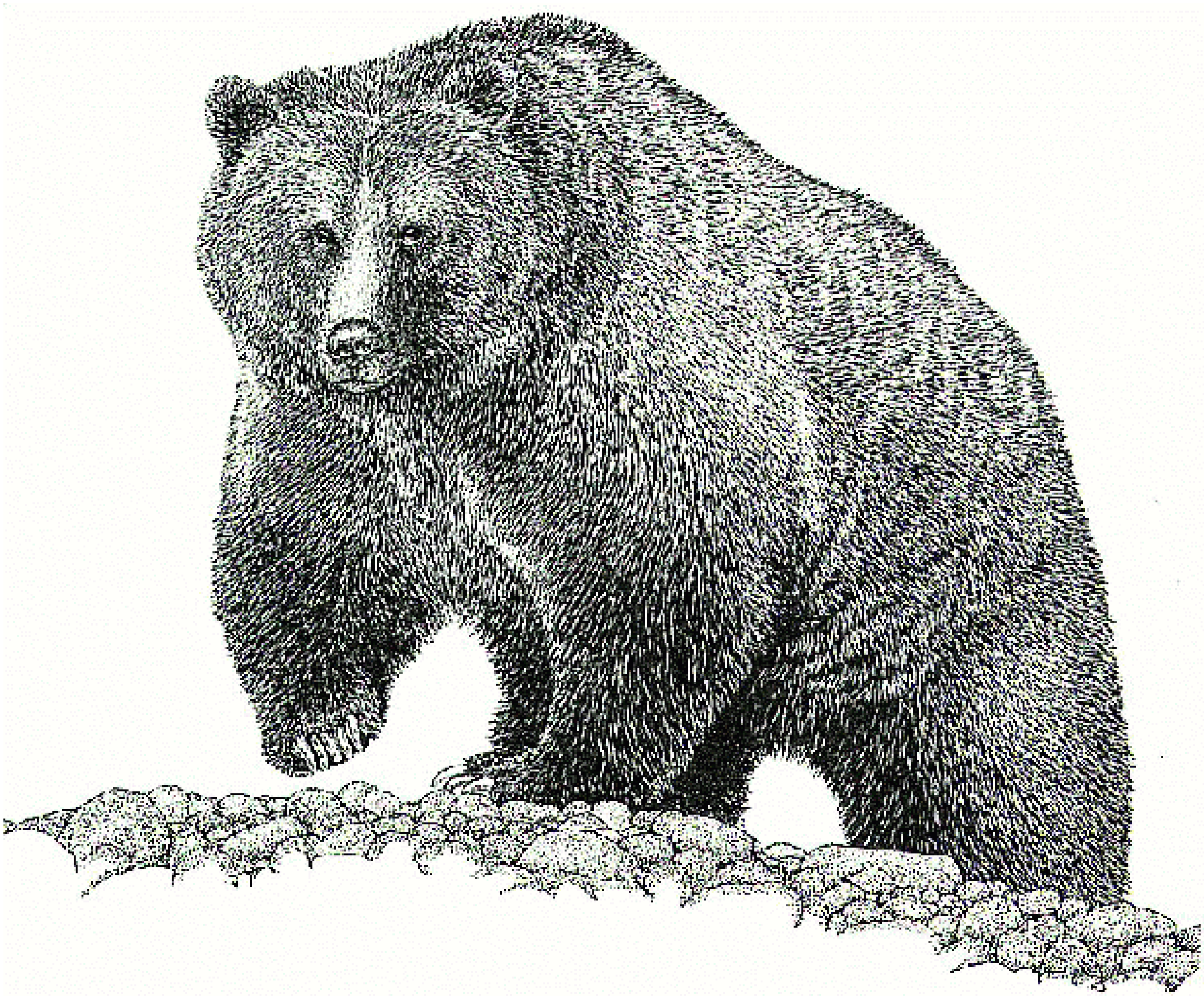
SELKIRK MOUNTAINS GRIZZLY BEAR RECOVERY AREA 2018 RESEARCH AND MONITORING PROGRESS REPORT



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ABSTRACT

The U.S. Fish and Wildlife Service (USFWS) has been leading a grizzly bear monitoring and research program in the Selkirk Mountains Ecosystem (SE) since 2012. Key research and funding cooperators include Idaho Department of Fish and Game (IDFG), the Panhandle National Forest (USFS), Idaho Department of Lands, the Kalispel Tribe, the Kootenai Tribe of Idaho, and Washington Department of Fish and Wildlife. The British Columbia (BC) effort was led by Michael Proctor with key funding provided by BC Habitat Conservation Trust Fund and BC Fish and Wildlife Compensation Fund.

Numbers of females with cubs in the SE varied from 1–6 per year and averaged 3.5 per year from 2013–18. Seven of 10 U.S. bear management units and the BC unit had sightings of females with young during 2013–18. Human-caused mortality averaged 1.5 bears per year (0.8 males and 0.7 females per year). Four females (all BC) and 5 males (one US and four BC) died due to human caused mortality during 2013–2018. Sex and age class and cause of mortality are as follows: two adult females (management removals), two adult males (vehicle collision and defense of life), two subadult females (under investigation and management removal), and three subadult males (management removal, mistaken identity, and train collision).

Eighty-three instances of known and probable grizzly bear mortality were detected inside or within 16 km of the U.S. SE and the BC South Selkirk grizzly bear population unit during the active period of research, 1980–2018. Sixty-seven were human caused, 11 natural mortality, and 5 were unknown cause. Fifty-two occurred in BC, 23 in Idaho, and 8 in Washington.

The estimated finite rate of increase (λ) for 1983–2018 using Booter software with the unpaired litter size and birth interval data option was 1.022 (95% CI = 0.949–1.093). Finite rate of change over the same period was an annual 2.2% (Caughley 1977). The probability that the population was stable or increasing was 73%.

All combined efforts (genetic, photographic, and telemetry) identified a minimum 51 individual grizzly bears (25 male, 19 female, 7 unknown) alive and within the U.S. portion of the SE grizzly bear population at some point during 2017. Many bears were known to have home ranges extending into BC and this estimate includes some bears on both sides of the international boundary. Three of these bears were known dead at the end of 2017 (3 males). Remote cameras and corrals were deployed at 129 sites and checked for pictures and hair collection 187 times during 2018. Grizzly bears were detected by cameras at 28 sites. Genetic DNA results are not yet complete from collected hair at sites in 2018. Since 2013, interagency personnel have identified and installed 399 bear rub locations in the SE. During 2018, 373 rub sites were checked a total of 1420 times.

Fifty-eight grizzly bears were trapped and radio collared for research purposes from 2007 to 2018, the most recent period of active bear research in BC (2007–2016) and the U.S. (2012–2018). Eighteen of these occurred in the U.S. and 40 occurred in British Columbia. Home range summary calculations and maps are provided. Den entrance and exit dates are also summarized.

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INTRODUCTION

Grizzly bear (*Ursus arctos*) populations south of Canada are currently listed as Threatened under the terms of the 1973 Endangered Species Act (16 U.S.C. 1531-1543). In 1993 a revised Recovery Plan for grizzly bears was adopted to aid the recovery of this species within ecosystems that they or their habitat occupy (USFWS 1993). Seven areas were identified in the Recovery Plan, one of which was the Selkirk Mountains Grizzly Bear Recovery Zone (SE) of northern Idaho, northeast Washington, and southeast British Columbia (BC) (Fig. 1). The recovery area includes the South Selkirks BC grizzly bear population unit and encompasses approximately 5,070 km^2.

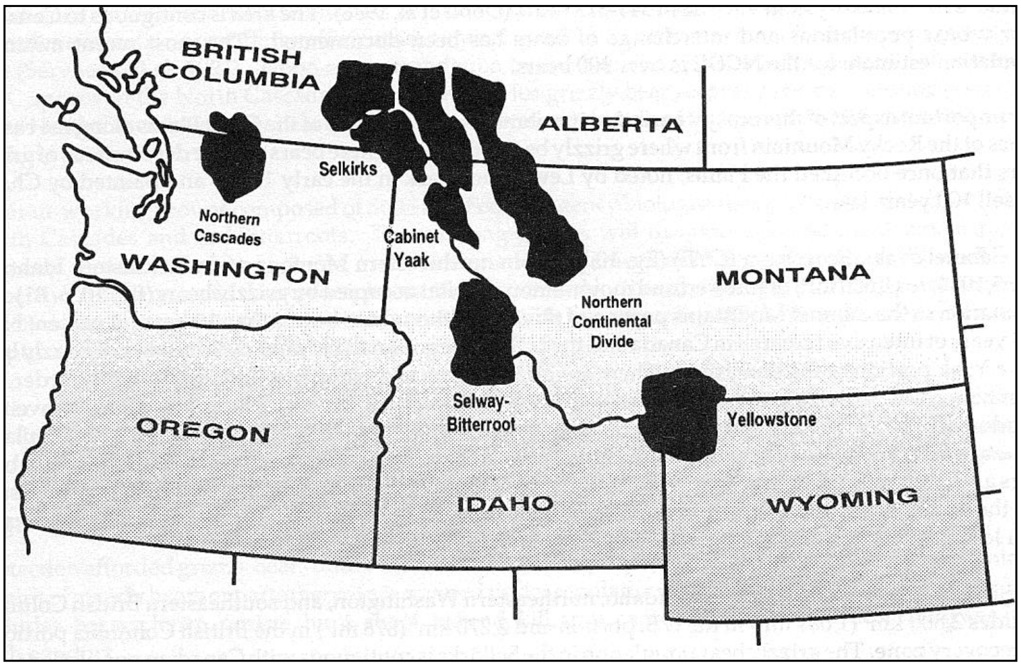

Figure 1. Grizzly bear recovery areas in the U.S., southern British Columbia, and Alberta, Canada.

Surveys of sightings, sign, and mortality have been documented by Layser (1978) and Zager (1983). Idaho Department of Fish and Game (IDFG) captured and monitored a radio collared sample of grizzly bears in the SE from 1983 until 2002 to determine distribution, home ranges, cause specific mortality, reproductive rates, and population trend (Almack 1985, Wakkinen and Johnson 2004, Wakkinen and Kasworm 2004). This effort was suspended in 2003 due to funding constraints and management decisions. In cooperation with IDFG and the Panhandle National Forest (USFS) this effort was reinitiated during 2012 with personnel from the U.S. Fish and Wildlife Service (USFWS). During 2013, the program was expanded with funding from IDFG, USFS, several sources in BC, and USFWS. This cooperative research and monitoring effort was further expanded to involve Idaho Department of Lands, the Kalispel Tribe, the Kootenai Tribe of Idaho, and Washington Department of Fish and Wildlife in 2014. USFWS began a trapping and monitoring effort to collect and update known-fate population vital rates of radio-collared grizzly bears within the SE. In 2013–18, we also collected camera and hair samples at DNA hair corral, camera, and rub post locations, adding to similar efforts conducted by IDFG and USFS personnel.

OBJECTIVES

1. Document grizzly bear distribution in the SE.
2. Describe and monitor the grizzly bear population in terms of reproductive success, age structure, mortality causes, population trend, and population estimates and monitor the targets for recovery as described in the grizzly bear recovery plan (USFWS 1993).
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 permeability of the Kootenai River valley between the SE and adjacent grizzly bear populations.
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.

STUDY AREA

The SE encompasses 5,700 km^2 of the Selkirk Mountains of northeastern Washington, northern Idaho, and southern BC. (Figure 1). Approximately 53% lies in the U.S. with the remainder in BC. Land ownership in BC is approximately 65% crown (public) land and 35% private. Land ownership in the U.S. portion is about 80% federal, 15% state, and 5% private.

Elevation on the study area ranges from 540 to 2,375 m. Weather patterns are characterized as Pacific maritime-continental climate, with long winters and short summers. Most of the precipitation falls during winter as snow, with a second peak in spring rainfall.

SE vegetation is dominated by various forested types. Dominant tree species include subalpine fir (*Abies lasiocarpa*), Englemann spruce (*Picea engelmannii*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*). Major shrub species include alder (*Alnus* spp.), fool's huckleberry (*Menziesia ferruginea*), mountain ash (*Sorbus scopulina*), and huckleberry (*Vaccinium* spp.).

Historically, wildfire was the primary disturbance factor in the SE. The 1967 Trapper Peak (6,000 ha) and Sundance (9,000 ha) fires produced large seral huckleberry shrubfields. Timber management and recreation are currently the principal land uses.

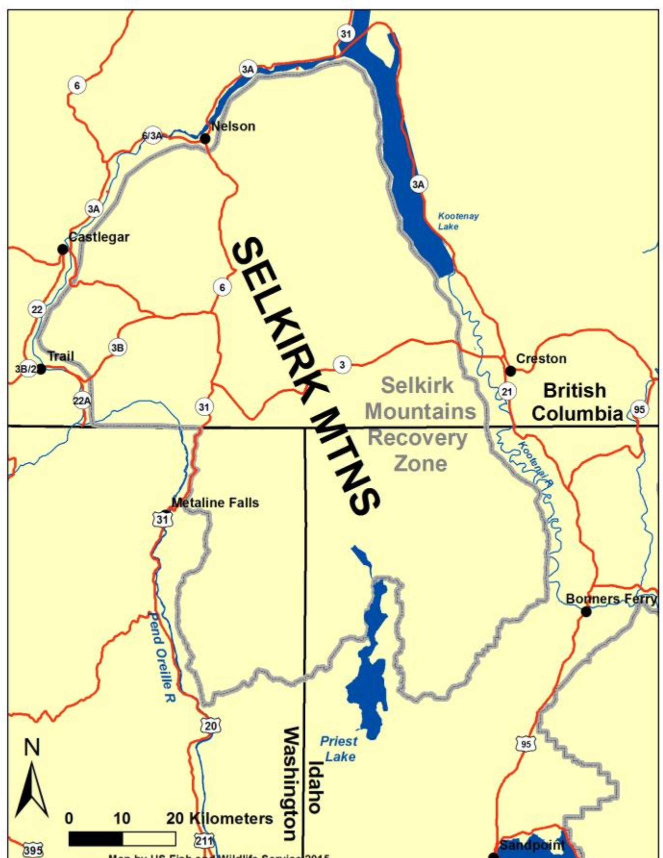

Figure 1. Selkirk Mountains grizzly bear recovery area.

METHODS

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 were accurately described.

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

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

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

1 - Lowest quality observations of animals that may not have been grizzly bears. This category may also involve 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 and management bears because of biases associated with the unknown proportion of management bears in the population and known differences in survival functions.

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

Cub recruitment rates to 1 year of age were estimated as: {1 - (cub mortalities / total cubs observed)}, based on observations of radio-collared females (Hovey and McLellan 1996). Mortality was assumed when a cub disappeared or if the mother died. Cubs were defined as bears < 1.0-year-old.

Use of known human-caused mortality counts probably results in under-estimates of total human-caused mortality. Numerous mortalities 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.

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

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

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). Lack of mortality in specific sex-age classes limited calculations for many time periods other than those shown here.

Bears captured initially as objects of conflict captures were not included. Several native bears that were captured as part of a preemptive move to avoid nuisance activity were included. Currently collared bears that became management bears while wearing a collar were included.

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 Idaho and Washington state collection permits (ID 140226 and WA18-359) and a 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. All bears were immobilized with Telazol (tiletamine hydrochloride and zolazepam hydrochloride), a mixture of Ketaset (ketamine hydrochloride) and Rompun (xylazine hydrochloride), or a combination of Telazol and Rompun. Yohimbine and Atipamezole were the primary antagonists for Rompun. Drugs were administered intramuscularly with a syringe mounted on a pole (jab-stick), homemade blowgun, modified air pistol, or cartridge powered dart gun. Immobilized bears were measured, weighed, and a first premolar tooth was extracted for age determination (Stoneberg and Jonkel 1966). Blood, tissue and/or hair samples were taken from most bears for genetic and food use studies. Immobilized bears were given oxygen at a rate of 2–3 liters per minute. Recovering bears were dosed with Atropine and Diazepam.

All grizzly bears (including management bears captured at conflict sites) 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). 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 August. Trap sites were usually located within 500 m of an open road to allow vehicle access. In a few instances, trap sites were accessed behind restricted roads within the administrative motorized access provisions of the land management agency. Further, some remote trap sites were accessed with pack livestock. Traps were checked daily or in some cases twice daily. Bait consisted primarily of road-killed ungulates and a liquid lure composed of fish and livestock blood.

Hair Sampling for DNA Analysis

Genetic information from hair-snagging with remote-camera photo verification allows us to document the number of individual grizzly bears occupying the study area and understand the level of relatedness within this population and between this and adjacent populations. Project objectives include: observations of females with young, sex ratio of sampled bears, and relatedness as well as genetic diversity measures of captured bears and source population and assessment of movement or gene flow in and out of the population.

Sampling occurred from May–September in the SE following standard hair snagging techniques with barbed wire hair corrals (Woods *et al.* 1999). Sampling sites were established based on location of previous sightings, sign, habitat quality, and radio telemetry from bears. Sites were baited with 2 liters of a blood and fish mixture to attract bears across a barb wire perimeter placed to snag hair. Sites were deployed for 2–3 weeks prior to hair collection. Hair sampling also occurred at sites where personnel observed bear hair and “rubbing” on a tree, artificial sign post, or similar object. When observed, personnel formally established these sites by attaching barbed wire at the spot of rubbing and designating the location with a unique site number. Crews then subsequently revisited these locations to collect bear hair. Hair was collected and labeled to indicate: number and color of hairs collected, site location, date, and barb number. Solid black hairs were judged to be from black bears and not analyzed further. Samples collected 1) as part of this formal hair sampling effort, 2) from captured and handled bears, and 3) opportunistically (i.e., not from established sampling sites, such as tree staubs along trail, within identified daybeds, etc.) were sent to Wildlife Genetics International Laboratory in Nelson, British Columbia for DNA extraction and genotyping. Only samples from known grizzly bears or that outwardly appeared to be grizzly bear were sent to the lab. Hairs visually identified as black bear hair by technicians on our project or at the Laboratory were not processed and hairs processed and determined to be black bear were not genotyped. Dr. Michael Proctor (Birchdale Ecological) is a cooperator on this project and assisted with genetic interpretations.

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 not in dens. Global Positioning System (GPS) collars were programmed to attempt locations every 1–2 hours depending on configuration, and data were stored within the collar and then downloaded to a lap top computer in an aircraft (Telonics Inc., Mesa AZ). Beginning in 2016, we have been using iridium collars on select males to enable remote download. All collars were equipped with a release mechanism to allow them to drop off and be retrieved prior to denning. Expected collar life varied from 1–3 field seasons over the course of the study depending upon model of collar and programming. Weekly aircraft radio monitoring was conducted to check for mortality signals and approximate location. Life home ranges (minimum convex polygons; Hayne 1959) were calculated for grizzly bears during the study period. We generated home range polygons using ArcGIS.

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 the SE, 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 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 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. Berry phenology, berry size, and plant condition were recorded. Monitoring goals identified annual trend of berry production and did not include documenting forest succession.

Temperature and relative humidity data recorders (LogTag®, Auckland, New Zealand) were placed at berry monitoring sites. These devices record conditions at 90 minute intervals and will be retrieved, downloaded, and replaced at annual intervals. We used a berries/plot 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 transect productivity indices.

RESULTS AND DISCUSSION

Grizzly Bear Observations, Mortality, and Recovery Plan Criteria

One hundred thirty-three reported sightings rated 4 or 5 (most credible) during 2018 (Table 1). Sightings occurred in all Bear Management Units (BMUs) except Lakeshore. No known mortalities occurred during 2018 (Table 2, Figure 3).

Recovery Target 1: 6 females with cubs over a running 6-year average both inside the recovery zone and within a 10 mile area immediately surrounding the recovery zone.

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 female with cub sightings within 10 miles of the recovery zone count toward recovery goals. Eight credible sightings of a female with cubs occurred during 2018 in Blue-Grass, LeClerc, and State Lands BMUs or Bears Outside Recovery Zone (BORZ) units (Tables 1, 3, 4, 5 and Fig. 4). There appeared to be 4 unduplicated females with cubs in the recovery area during 2018. Nineteen credible sightings of a female with yearlings or 2-year-olds occurred in Blue-Grass, Long-Smith, Myrtle, State Lands, Pack River, and BC BMUs or BORZ in 2018. Unduplicated sightings of females with cubs (including Canada) varied from 1–6 per year and averaged 3.5 per year from 2013–18 (Tables 3, 4). Recovery plan targets require a running 6-year average of 6.0 females with cubs per year and therefore this target has not been met.

Recovery Criteria 2: 7 of 10 BMU's occupied by females with young from a running 6-year sum of verified evidence.

Seven of 10 BMUs in the U.S. portion of the recovery zone and the BC BMU had sightings of females with young (cubs, yearlings, or 2-year-olds) during 2013–18 (Fig. 4 and Table 5). Occupied U.S. BMUs were: Blue-Grass, LeClerc, Long-Smith, Myrtle, Salmo-Priest, State Lands, and Sullivan-Hughes BMUs. Recovery plan criteria indicate the need for 7 of 10 U.S. BMUs to be occupied.

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

Eighty-three instances of grizzly bear mortality were detected inside or within 16 km of the U.S. portion of the SE and within the boundary of the BC South Selkirk grizzly bear population unit during 1980–2018 (Table 2, Fig. 3 and 4). No known human caused mortality occurred in 2018, though probable natural mortalities occurred with two yearling bears.

Nine known or probable human caused grizzly bear mortalities occurred in or within 10 miles of the SE in the U.S. or inside the South Selkirk GBPU during 2013–18, including four females (all BC) and five males (Myrtle and BC BMUs) (Table 1). Mortality included two adult females (both management removal), two adult males (vehicle collision, and defense of life), two subadult females (one under investigation and one management removal), and three subadult males (management removal, mistaken identity, and train collision). We estimated minimum population size by dividing observed females with cubs (13), minus any human-caused adult female mortality (1) from 2016–18, by 0.6 (sightability correction factor as specified in the recovery plan) then dividing by 0.333 (adult female proportion of population as specified in the recovery plan) (Tables 3, 4) (USFWS 1993). This resulted in a minimum population of 61 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 2.4 bears per year. The female limit is 0.7 females per year (30% of 1.6). Average annual human caused mortality for 2013–18 was 1.5 bears/year and 0.7 females/year. Mortality levels for total bears were less than the calculated limits and female mortality was at the calculated limit during 2013–18. 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 were updated when new information became available.

Table 1. Credible grizzly bear sightings, credible female with young sightings, and known human caused mortality by Selkirk Mountain bear management unit (BMU) or area, 2018.

BMU OR AREA	2018 Credible[1] Grizzly Bear Sightings	2018 Sightings of Females with Cubs (Total)	2018 Sightings of Females with Cubs (Unduplicated[2])	2018 Sightings of Females with Yearlings or 2-year-olds (Total)	2018 Sightings of Females with Yearlings or 2 year-olds (Unduplicated[2])	2018 Human Caused Mortality
Ball-Trout	3	0	0	0	0	0
Blue Grass	25	6	2	5	1	0
Kalsipel-Granite	2	0	0	0	0	0
Lakeshore	0	0	0	0	0	0
LeClerc	6	1	1	0	0	0
Long-Smith	64	0	0	5	2	0
Myrtle	1	0	0	1	1	0
Salmo-Priest	2	0	0	0	0	0
State Idaho	13	1	1	3	1	0
Sullivan-Hughes	4	0	0	0	0	0
Pack River	10	0	0	4	1	0
Priest River	2	0	0	0	0	0
BC	1	0	0	1	0	0
TOTAL	133	8	4	19	6	0

[1]Credible sightings are those rated 4 or 5 on a 5 point scale (see methods).
[2]Sightings may duplicate the same bear in different locations. Only the first sighting of a duplicated female with cubs was counted toward total females (Table 3), however subsequent sightings contribute toward occupancy (Table 5).

Table 2. Known and probable grizzly bear mortality in the Selkirk Mountains recovery area, 1980–2018.

Mortality Date	Tag Number	Sex	Age	Mortality Cause	Location	<500m from open road	Owner[1]
11-May-80	None	F	5.0	Human, Hunting	Barrett Creek, BC	Unk	BC
2-May-82	None	M	AD	Human, Poaching	Priest River, ID	Yes	USFS
Sept 1982	None	U	Unk	Human, Undetermined	LeClerc Creek, WA	Yes	USFS
1-Jul-85	949	M	4.5	Human, Undetermined	NF Granite Creek, WA	Yes	USFS
Autumn, 1985	867-85a	U	Cub	Natural	Cow Creek, ID	Unk	USFS
1-Sep-86	898	F	1.5	Human, Undetermined	Grass Creek, ID	Unk	USFS
10-Sep-86	None	M	7.0	Human, Management	Curtis Lake, BC	Yes	BC
June 1987	1005	M	10.5	Human, Poaching	Wall Mtn, BC	Unk	BC
8-Sep-87	962	M	7.5	Human, Poaching	Trapper Creek, ID	No	IDL
30-May-88	None	M	5.0	Human, Hunting	Monk Creek, BC	Unk	BC
Sept 1988	1050	M	1.5	Natural	Porcupine Creek, BC	No	BC
Sept 1988	1085	F	3.5	Human, Mistaken Identity	Cow Creek, ID	No	USFS
14-Aug-89	1044	F	20+	Natural	Laib Creek, BC	No	Private
22-Sep-89	None	M	2.0	Human, Management	49 Mile Creek, BC	Yes	Private
22-Sep-89	None	U	Unk	Human, Management	49 Mile Creek, BC	Yes	Private
6-Aug-90	None	M	Unk	Human, Management	Ymir Area, BC	Yes	Private
16-Sep-90	1042	F	3.5	Human, poaching	Maryland Creek, BC	Yes	BC
1-Aug-91	1076	F	20+	Natural	Next Creek, BC	No	BC
23-Apr-91	867-92a	U	1.5	Natural	Trapper Creek, ID	Unk	IDL
11-Apr-92	None	M	Unk	Unknown	Atbara, BC	Yes	BC

Mortality Date	Tag Number	Sex	Age	Mortality Cause	Location	<500m from open road	Owner[1]
22-May-92	None	M	4.0	Human, Hunting	Cottonwood, BC	Unk	BC
July 1992	None	M	Unk	Human, Management	Lost Creek, BC	Yes	BC
7-Sep-92	1090	M	5.5	Unknown	Laib Creek, BC	Yes	BC
25-Sep-92	1015	F	12.5	Human, Self Defense	Monk Creek, BC	No	BC
2-Jun-93	None	M	4.0	Human, Management	Lost Creek, BC	Yes	BC
5-Jun-93	None	M	4.0	Human, Hunting	Elmo Creek, BC	Unk	BC
2-Nov-93	867	F	15.5	Human, Poaching	Willow Creek, WA	No	USFS
2-Nov-93	867-93a	U	0.5	Human, Poaching	Willow Creek, WA	No	USFS
2-Nov-93	867-93b	U	0.5	Human, Poaching	Willow Creek, WA	No	USFS
23-May-94	None	M	12.0	Human, Hunting	Wall Mountain, BC	Unk	BC
10-May-95	None	F	1.5	Human, Undetermined	Boundary Creek, ID	Yes	USFS
31-Oct-95	1100	M	2.5	Human, Mistaken Identity	Granite Pass, WA	Yes	USFS
Autumn, 1995	None	M	AD	Human, Mistaken Identity	Mill Creek, WA[2]	Yes	USFS
Autumn, 1996	1027-96b	U	Cub	Natural	Cedar Creek, ID	Unk	USFS
10-Oct-1996	1022	M	2.5	Human, Management	Boswell, BC[2]	Yes	Private
Sept 1997	None	M	1.5	Human, Management	Salmo, BC	Yes	Private
29-May-98	1023	M	4.5	Human, Hunting	Findlay Creek, BC[2]	Yes	BC
Aug 1998	None	M	3.5	Human, Undetermined	Usk, WA	Yes	Private
Oct 1999	1032	M	18.0	Human, Management	Procter, BC	Yes	Private
Oct 1999	9810	M	10.0	Human, Undetermined	Smith Creek, ID	Unk	USFS
Autumn 2000	None	U	Unk	Unknown	Hughes Meadows, ID	Yes	USFS
29-Aug-01	7	F	13.0	Natural	Porcupine Creek, BC	Yes	BC
25-Oct-01	None	F	2.0	Human, Management	49 Mile Creek, BC	Yes	Private
Oct 2001	None	M	Unk	Human, Management	Cottonwood Creek, BC	Yes	Private
12-May-02	17	M	6.0	Human, Management	Nelway, BC	Yes	Private
15-Sep-02	None	F	10+	Human, Management	Blewett, BC	Yes	Private
15-Sep-02	None	U	0.5	Human, Management	Blewett, BC	Yes	Private
15-Sep-02	None	U	0.5	Human, Management	Blewett, BC	Yes	Private
15-Sep-02	None	U	0.5	Human, Management	Blewett, BC	Yes	Private
4-Oct-02	19	M	3.5	Human, Undetermined	Lamb Creek, ID	Yes	USFS
May 2003	None	U	1.5	Human, Mistaken Identity	Smith Creek, ID	Yes	Private
2-Sep-03	None	F	AD	Human, Management	Blewett, BC	Yes	Private
23-Sep-03	None	F	5.0	Human, Management	Blewett, BC	Yes	Private
23-Sep-03	None	F	0.5	Human, Management	Blewett, BC	Yes	Private
3-Oct-03	30	F	2.5	Human, Management	Erie Creek, BC	Yes	Private
May 2004	None	M	AD	Human, Undetermined	Hughes Meadows, ID	Yes	USFS
Autumn 2004	32	M	7.0	Human, Undetermined	Bismark Meadows, ID	Unk	Private
Spring 2005	None	U	Unk	Human, Undetermined	E F Priest River, ID	Unk	IDL
10-May-2005	31	M	6	Human, Hunting	Russell Creek, BC[2]	Yes	BC
May 2006	None	M	AD	Human, Management	Procter, BC	Yes	Private
23-Oct-06	None	F	1.0	Human, Management	Blewett Ski Hill, BC	Yes	Private
23-Oct-06	None	M	1.0	Human, Management	Blewett Ski Hill, BC	Yes	Private
1-Aug-07	29	F	AD	Vehicle Collision	Kootenay Pass, BC	Yes	BC
1-Oct-07	1000	F	AD	Human, Mistaken Identity	Pass Creek Pass, WA	Yes	USFS
4-Oct-07	5393	M	SA	Human, Management	Priest River, ID	Yes	Private
29-Sep-08	119	M	13.0	Human, Management	Salmo, BC	Yes	Private
18-Aug-10	8005	F	5	Vehicle Collision	Summit Creek, BC	Yes	BC
5-May-11	None	M	2.5	Human, Management	Porthill, ID	Yes	Private
25-May-11	0012	M	2.5	Human, Management	Nelson, BC	Yes	Private
25-May-11	None	M	2.5	Human, Management	Nelson, BC	Yes	Private
28-Aug-2011	002	M	20	Human, Management	Kootenay River, BC	Yes	Private
7-Oct-12	None	M	3.0	Human, Mistaken Identity	Beaverdale Creek, BC	Yes	BC
16-Oct-12	170	F	6.0	Human, Under investigation	Salmo River, BC	Yes	Private
6-Jun-14	12006	F	4	Human, Under investigation	Boundary Creek, BC	Yes	BC
27-Sep-14	None	F	AD?	Human, Management	Ootishenia Creek, BC	Unk	BC
Summer 2014	3023a	U	Cub	Natural	Malcolm Creek, ID	Unk	USFS
Summer 2014	3023a	U	Cub	Natural	Malcolm Creek, ID	Unk	USFS
7-May-15	None	M	AD	Vehicle Collision	Summit Creek, BC	Yes	BC
11-Oct-2015	1001	M	4	Human, Undetermined	Grouse Creek, ID[2]	Yes	Private
27-Aug-16	None	M	2.5?	Train Collision	Deep Creek, ID	Yes	Private
25-Jun-17	226	F	10	Human, Management	Kootenay River, BC	Yes	BC
25-Jun-17	None	M	0.5	Human, Management	Kootenay River, BC	Yes	BC
25-Jun-17	None	F	0.5	Human, Management	Kootenay River, BC	Yes	BC
1-Sep-17	922	M	5	Human, Self Defense	Porthill Creek, BC	Yes	BC
4-Oct-17	None	M	4	Human, Mistaken Identity	McCormick Creek, ID	No	IUSFS

Mortality Date	Tag Number	Sex	Age	Mortality Cause	Location	<500m from open road	Owner[1]
Summer 2018	None	U	1	Natural	Bugle Creek, ID	Unk	USFS
Autumn 2018	None	U	1	Natural	Smith Creek, ID	Unk	USFS

[1]BC – British Columbia Crown Lands, IDL – Idaho Department of Lands, and USFS – U.S. Forest Service.
[2]More than 10 miles outside recovery zone in the U.S or outside the BC South Selkirk grizzly bear population unit

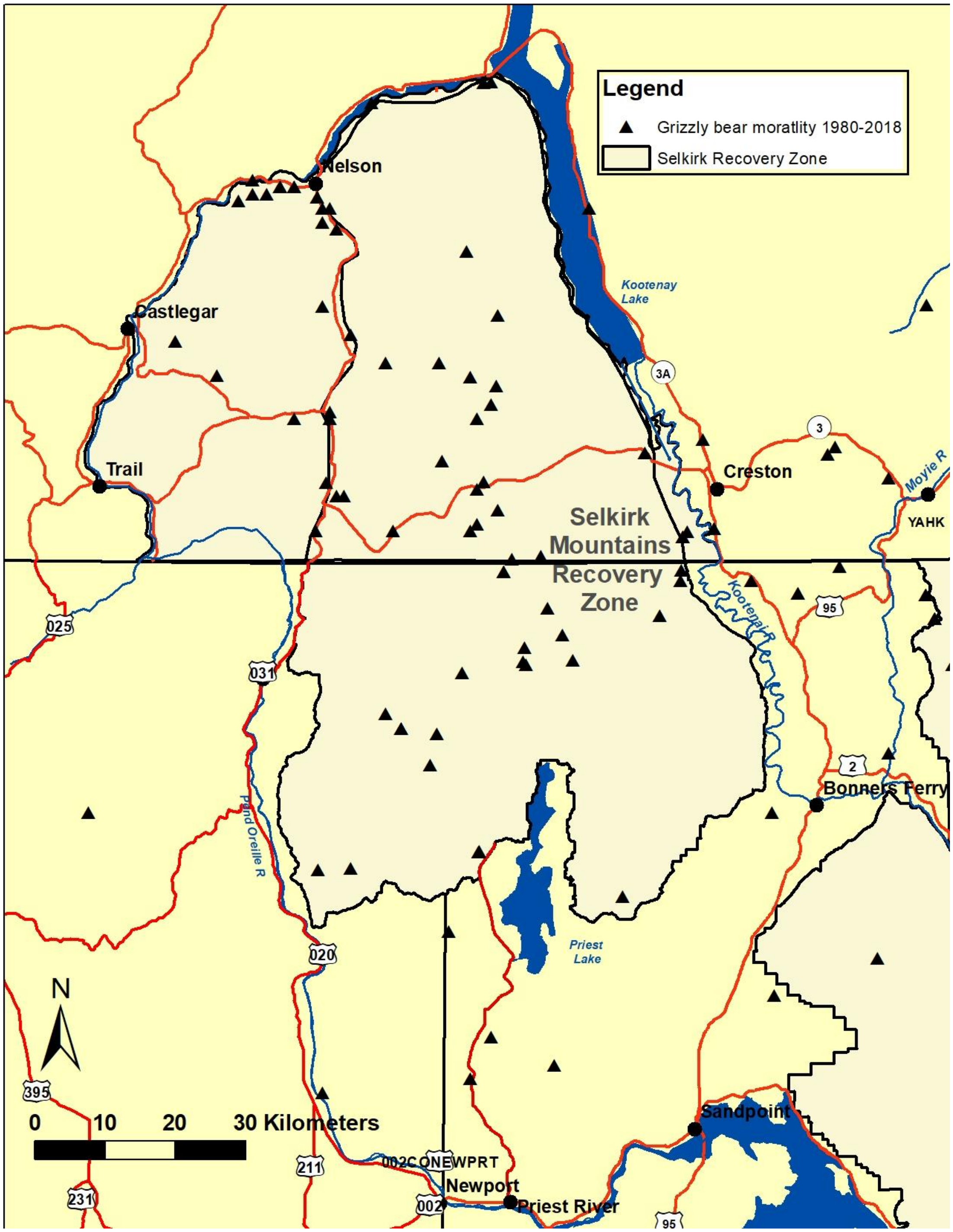

Figure 3. Grizzly bear known or probable mortalities from all causes (1980–2018) in the Selkirk Mountains recovery area.

Table 3. Status of the Selkirk Mountains recovery zone during 2013–2018 in relation to the demographic recovery targets from the grizzly bear recovery plan (USFWS 1993).

Recovery Criteria	Target	2018
Females w/cubs (6-yr avg)	6	3.5 (21/6)
Human Caused Mortality limit [1] (4% of minimum population estimate)	2.4	1.5 (6 yr avg)
Female Human Caused mortality limit [1] (30% of total mortality)	0.7	0.7 (6 yr avg)
Distribution of females w/young in the most recent 6 years [2]	7 of 10 BMUs	7 of 10 BMUs

[1] Includes both U.S. and B.C. mortalities.
[2] Includes only U.S. BMUs.

Table 4. Annual Selkirk Mountains recovery zone grizzly bear unduplicated counts of females with cubs (FWC's) and known human-caused mortality, 1988–2018. The grizzly bear recovery plan (USFWS 1993) states that the goal for human caused mortality shall be zero.

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	0	0	1	2				
1989	4	0	0	2				
1990	1	0	1	2				
1991	1	0	0	0				
1992	1	1	1	3				
1993	1	1	2	5	0.0	0.0	0.8	0.3
1994	1	0	0	1	0.2	0.1	0.2	0.0
1995	1	0	1	3	0.2	0.1	0.5	0.2
1996	1	0	0	0	0.4	0.1	0.5	0.2
1997	1	0	0	1	0.6	0.2	0.7	0.2
1998	1	0	0	1	0.6	0.2	0.8	0.2
1999	1	0	0	2	0.6	0.2	1.2	0.2
2000	2	0	0	0	0.8	0.2	1.2	0.2
2001	2	0	1	2	1.0	0.3	1.0	0.2
2002	0	1	3	6	0.6	0.2	2.0	0.7
2003	1	2	4	5	0.0	0.0	2.7	1.3
2004	1	0	0	2	0.0	0.0	2.8	1.3
2005	1	0	0	1	0.2	0.1	2.7	1.3
2006	0	0	1	3	0.4	0.1	3.2	1.5
2007	0	2	2	3	0.0	0.0	3.3	1.7
2008	0	0	0	1	0.0	0.0	2.5	1.2
2009	0	0	0	0	0.0	0.0	1.7	0.5
2010	0	1	1	1	0.0	0.0	1.5	0.7
2011	0	0	0	4	0.0	0.0	2.0	0.7
2012	1	1	1	2	0.0	0.0	1.8	0.7
2013	1	0	0	0	0.2	0.1	1.3	0.3
2014	3	2	2	2	0.4	0.1	1.5	0.7
2015	4	0	0	1	1.2	0.4	1.7	0.7
2016	3	0	0	1	1.6	0.5	1.7	0.5
2017	6	1	2	5	2.4	0.7	1.8	0.8
2018	4	0	0	0	2.4	0.7	1.5	0.7

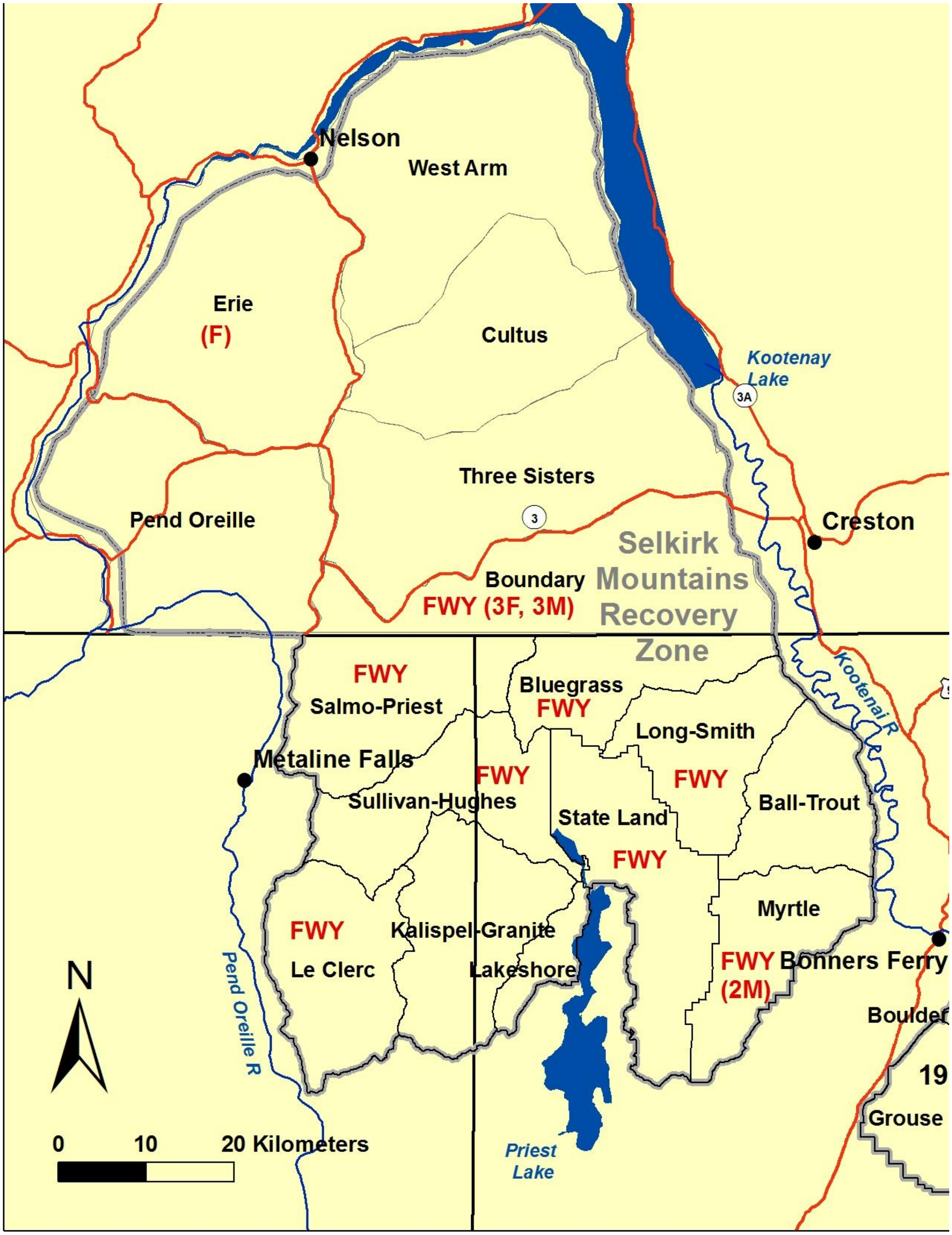

Figure 4. Female with young occupancy and known or probable mortality within Bear Management Units (BMUs) in the Selkirk Mountains recovery zone 2013–2018. FWY indicates occupancy of a BMU by a female with young, and sex of any mortality is in parentheses.

Table 5. Occupancy of bear management units by grizzly bear females with young in the Selkirk Mountains recovery zone 1996–2018.

YEAR	Ball-Trout	Blue Grass	Kalispell-Granite	Lakeshore	LeClerc	Long-Smith	Myrtle	Salmo-Priest	State Idaho	Sullivan-Hughes	BC
1996	Yes	Yes	No	No	No	Yes	Yes	No	No	No	No
1997	Yes	Yes	No	No	No	Yes	Yes	No	Yes	No	No
1998	Yes	Yes	No	No	No	Yes	No	Yes	Yes	No	No
1999	No	Yes	No	No	No	Yes	No	Yes	Yes	No	No
2000	No	No	No	No	No	No	No	No	No	No	No
2001	No	Yes	Yes	No	No	Yes	Yes	No	Yes	No	No
2002	No	Yes	Yes	No	No	Yes	Yes	No	Yes	No	No
2003	No	Yes	Yes	No	No	Yes	No	No	Yes	No	No
2004	No	Yes	Yes	No	No	Yes	No	No	Yes	No	No
2005	No	Yes	Yes	No	No	Yes	No	No	Yes	No	No
2006	No	No	Yes	No	No	Yes	Yes	No	No	Yes	No
2007	No	No	Yes	No	No	Yes	Yes	No	No	Yes	No
2008	No	No	Yes	No	No	Yes	Yes	No	No	Yes	No
2009	No	No	No	No	No	No	No	No	No	No	No
2010	No	No	No	No	No	No	No	No	No	No	No
2011	No	Yes	No	No	No	Yes	No	No	No	No	No
2012	No	Yes	No	No	No	Yes	No	No	Yes	No	No
2013	No	Yes	No	No	No	Yes	No	No	Yes	No	No
2014	No	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
2015	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes
2016	No	Yes	No	No	Yes	Yes	No	No	Yes	Yes	Yes
2017	No	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes
2018	No	Yes	No	No	Yes	Yes	Yes	No	Yes	No	Yes

Hair Collection, Remote Camera, and Genetics

Remote cameras and corrals were deployed at 129 sites and were checked for pictures and hair collection 187 times during 2018 (Tables 6 and 7, Figure 5). Grizzly bears were detected by cameras at 28 sites. Genetic DNA results are not yet complete from collected hair at sites in 2018 and we will report 2018 genetic results in the 2019 report. Cameras detected females with cubs at 3 corral sites (Blue-Grass, State Land, and LeClerc BMUs). In addition, we set up cameras at some rub sites and opportunistically along roadways and trails presumed to be on grizzly bear travel routes. This extended effort documented presence of a female grizzly bear with young in Smith Cr. (Long-Smith BMU), a female with cubs in Grass Cr. (Blue-Grass BMU), and several other single individuals. Hair samples were collected from sign posts, bridges, and rub trees, as observed opportunistically by study personnel. Since 2013, interagency personnel have identified and installed 399 bear rub locations in the SE. During 2018, 373 of rub sites were checked a total of 1420 times.

In total from corral, rub, or opportune methods, 2738 samples were collected in the SE in 2018 (41% corral, 57% rub, 2% opportune). All hair samples were visually examined by study personnel to screen out hair that appeared to be black bear and the remaining 714 samples collected in 2018 were sent to Wildlife Genetics International for analysis. Lab analysis for 2018 samples has not yet been completed.

In 2017, 76 rub sites (26% of checked) yielded grizzly bear hair. The rub effort alone identified 20 individual grizzly bears. Combined, corral and rub efforts genetically identified 39 individual grizzly bears in 2017. Six bears were identified from opportunistic hair collections (i.e., collections along trails, at trapsites, on cattle fencing or tree staubs). All but one research captured bear (1008) were also genotyped. Two photographed adult females were not detected genetically (S252F and S4208F). One radio-collared bear was monitored and photographed in 2017 in the SE but not detected genetically (922). Seven of the 13 cubs-of-the-year detected in the U.S. portion of the SE were photographed but not genetically detected. In total, all combined efforts identified a minimum 51 individual grizzly bears (25 male, 19 female, 7 unknown) alive and within the U.S. portion of the SE grizzly bear population at some point during 2017. Three of these bears were known dead at the end of 2017 (3 males). New genotypes from these individuals were added to the grizzly bear genetic database from the South Selkirk Mountains that contains 179 individuals, 1983–2017.

Table 6. Grizzly bear hair rubs and success in the Selkirk study area, 2014–2018.

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
2014	8	11 (9)	9 (11)	1	1	1	0
2015	31	266 (1)	14 (21)	1	1	0	1
2016	166	529 (10)	118 (47)	40	13	9	4
2017	292	1035 (15)	274 (58)	76	20	15	5
2018	373	1575 (--)	471 (--)	--	--	--	--
Total[2]	399[3]	1842 (12)	416 (53)	95[3]	28[4]	19[4]	9[4]

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

[2] Totals are through 2017. 2018 genetic results from the lab are not yet complete.

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

[4] Some individuals captured multiple times among years.

Table 7. Grizzly bear hair snagging corrals and success in the Selkirk Mountains study area, 2013–2018. DNA genetic results not yet complete for 2018 samples.

Year	Number of sites	Sites with grizzly bear DNAs(%[1])	Sites with grizzly bear photos or DNA(%[1])	Individual grizzly bear genotypes	Locations with grizzly bear pictures or hair	Comments
2013	29	0(3)	4(17)	0	Apache Ridge, Italian Peak, Sema Meadows, Plowboy Ridge	
2014	47	4(9)	13(28)	4	Beaver Cr., Boundary Cr., Cascade Cr., Cow Cr., Floss Cr. , Granite Cr., Grass Cr., Harvey Cr., Italian Cr., Smith Cr., Soldier Cr., Trapper Cr.	Female with cubs at Burton Ridge (Cascade Cr.), Boundary Cr., and Italian Peak (Italian Cr.)
2015	189	20(11)	28(15)	20	Beaver Cr., Bog Cr., Boundary Cr., Caribou Cr. (East), Cascade Cr., Cow Cr., Fall Cr., Grass Cr., Hellroaring Cr., Highland Cr., Horton Cr., Hughes Fork, Jeru Cr., Jim Cr., Jungle Cr., Lime Cr., Malcom Cr., Marsh Cr., Pearson Cr., Ruby Cr., Stony Cr., Trapper Cr.	Female with cubs at Jungle Cr., Boundary Cr., and Grass Cr.
2016	181	12(7)	19(10)	14	Beaver Cr., Boundary Cr., Caribou Cr. (West), Cow	Female with young at Beaver

Year	Number of sites	Sites with grizzly bear DNAs(%[1])	Sites with grizzly bear photos or DNA(%[1])	Individual grizzly bear genotypes	Locations with grizzly bear pictures or hair	Comments
					Cr., Fall Cr., Grass Cr., Hellroaring Cr., High Rock Cr., Jeru Cr., Pearson Cr., Smith Cr., Trapper Cr.	Cr. Female with cubs at Boundary Cr. and Grass Cr.
2017	121	21(17)	32(26)	26	Beaver Cr., Boundary Cr., Branch Cr., Bugle Cr., Cascade Cr., Cow Cr., Fall Cr., Gold Cr., Grass Cr., Jeru Cr., Malcom Cr., Molybdenite Cr., Pack R.Pearson Cr., Roman Nose Cr., Ruby Cr. (East), SF Granite Cr., Smith Cr., Trapper Cr., Trout Cr., WB LeClerc Cr.	Female with young at Boundary Cr., Molybdenite Cr., and Cow Cr. Female with cubs at Boundary Cr., Branch Cr., Bugle Cr., Cow Cr., Fall Cr., Jeru Cr., Roman Nose Cr., Ruby Cr., and Trapper Cr.
2018	129	--	28(22)[2]	--	Abandon Cr., Boundary Cr., Blue Joe Cr., Bugle Cr., Caribou Cr. (East), Cow Cr., Fall Cr., Gold Cr., Grass Cr., Lime Cr., Molar Cr., Onata Cr.,Roman Nose Cr., Ruby Cr. (West), Ruby Cr. (East), Smith Cr., Soldier Cr., Trapper Cr., Trout Cr., WB LeClerc Cr.	Female with young at Boundary Cr., Bugle Cr., Cow Cr., Fall Cr., Molar Cr., Soldier Cr., Trapper Cr. Female with cubs at Blue Joe Cr., Ruby Cr. (West), and WB LeClerc Cr.
Total	696	58	125	43 [3]		

[1]Percent success out of total number of sites deployed within the year

[2]Numbers represent sites with photos only. Awaiting 2018 genetic results.

[3]Some individuals captured multiple times among years.

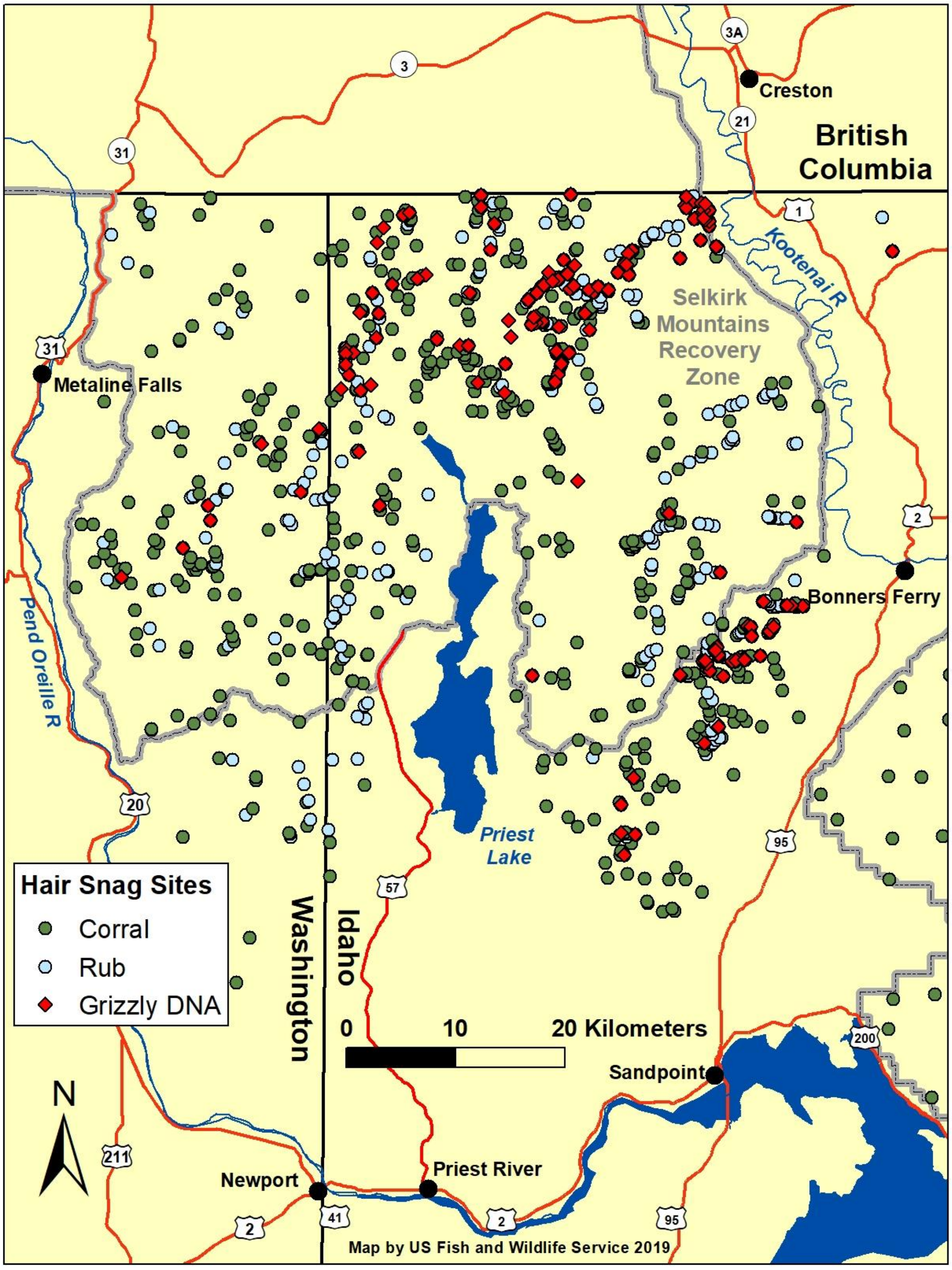

Figure 5. Location of hair snag corral and rub sampling sites in the U.S. Selkirk Mountains, 2007–17. "Grizzly DNA" represents a site where collected hair was genetically identified as grizzly bear.

Movements and Gene Flow

The SE population was previously identified as having low genetic diversity as determined by heterozygosity calculations (*H*=0.54, Proctor et al. 2012). This 2007 level was among the lowest of all interior North American grizzly bear populations. Low heterozygosity was believed to be the result of a small remnant population that has grown by reproduction with little emigration and gene flow from adjacent populations. Capture, telemetry, and genetic data were analyzed to evaluate movement and subsequent reproduction resulting in gene flow into and out of the SE. Twenty-seven grizzly bears were identified as immigrants, emigrants, or were the offspring of immigrants to the SE (Appendix Table T1). While movement and gene flow out of the SE may benefit other populations, gene flow into the SE is most beneficial to genetic health. Seven individuals (6 males and 1 female) are known to have moved into the SE from adjacent populations; however two males and one female were killed or removed (Figure 6). Known gene flow has been identified through reproduction by two immigrants (two males) resulting in 9 offspring in the SE (Appendix Table T1). Additional analysis of changes in heterozygosity and other genetic measures is planned.

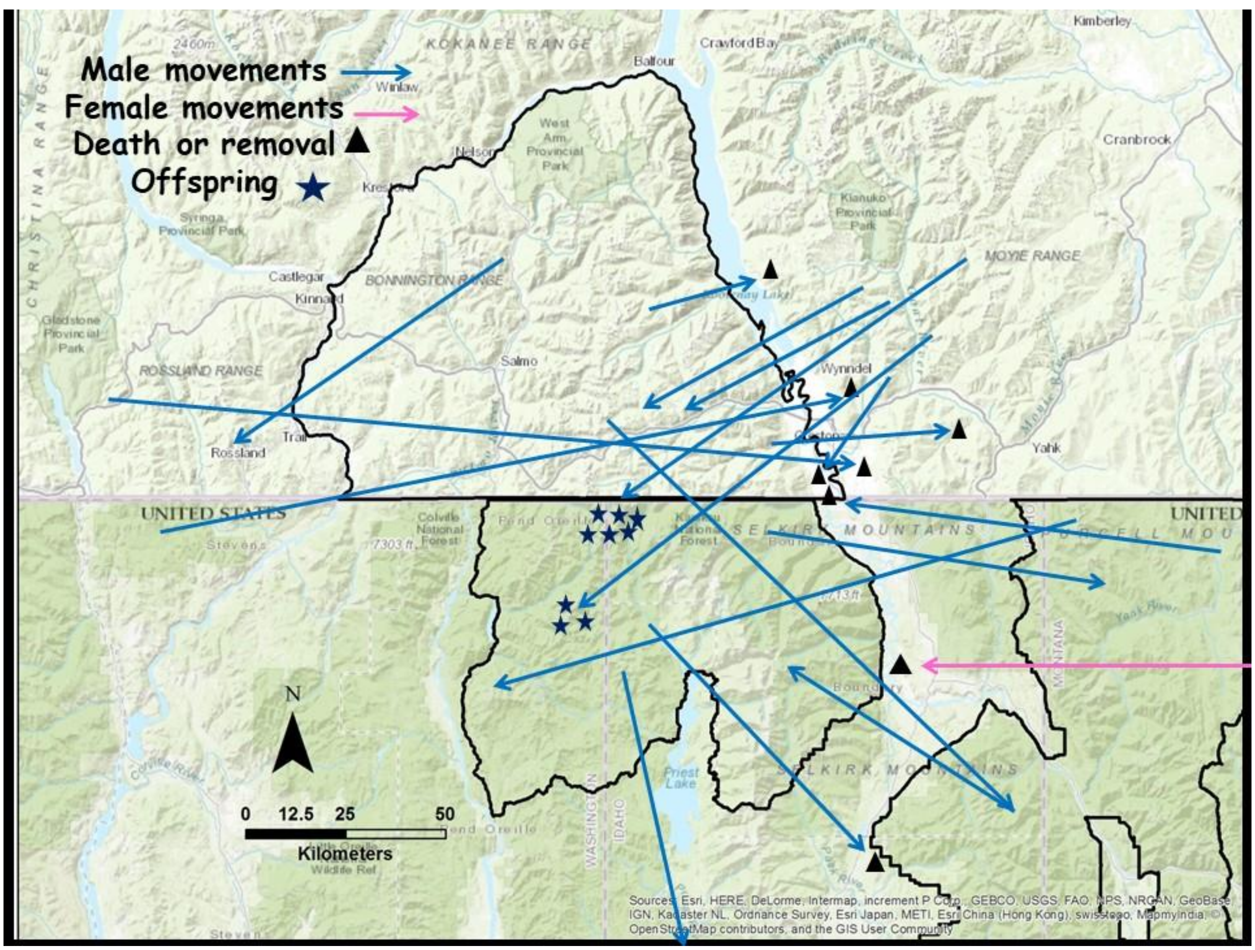

Figure 6. Known immigration, emigration, and gene flow in the Selkirk Mountains, 2000–17.

Known Grizzly Bear Mortality

In 2018 there were no known human-caused grizzly bear mortalities, but there were two natural mortalities of yearlings (young of unknown sex from a radio collared female). Eighty-three instances of known and probable grizzly bear mortality were detected inside or within 16 km of the U.S. SE and the BC South Selkirk grizzly bear population unit during 1980–2018 (Tables 2 and 7, Figure 3 and 7). Sixty-seven were human caused, 11 were natural mortality, and 5 were unknown cause. Fifty-two occurred in BC, 23 in Idaho, and 8 in Washington.

Seventy-three individuals were of known sex and age (Table 7). Fifteen were adult females, 18 adult males, 5 subadult females, 15 subadult males, 10 yearlings, and 12 cubs. Mortality causes (frequency) were management removal (33), natural (11), unknown but human-caused (9), poaching (7), mistaken identity (6), BC legal hunting (5), unknown (5), vehicle/train collision (4), and defense of life (3). Fifteen mortalities occurred in spring (April 1 to May 31), 21 in summer (June 1 to August 31), 44 in autumn (September 1 to November 30), and 4 on unknown dates.

Table 7. Cause, timing, and location of known or probable grizzly bear mortality in or within 16 km of the Selkirk Mountains recovery zone (with South Selkirk Population Unit), 1980–2018.

	Mortality cause									
Age / sex / season / ownership	Defense of life	Legal Hunt	Management removal	Mistaken identity	Natural	Poaching	Vehicle/Train Collision	Unknown, human	Unknown	Total
BC Adult female	1	1	5		3		2	1		13
US Adult female				1		1				2
BC Subadult female			2			1		1		4
US Subadult female				1						1
BC Adult male	1	2	6			1	1	1		12
US Adult male				1		2		3		6
BC Subadult male		2	5	1						8
US Subadult male	1		2	1			1	2		7
BC Yearling			3		1					4
US Yearling				1	3				2	6
BC Cub			6							6
US Cub					4	2				6
BC Unknown			4						1	5
US Unknown								1	2	3
Total	3	5	33	6	9	7	4	9	5	83
Season[1]										
Spring		4	5	1		1	1	1	2	15
Summer		1	7		7	1	3	2		21
Autumn	3		21	5	3	5		4	2	43
Unknown					1			2	1	4
Ownership										
BC Private			28		1			1		30
BC Public	2	5	3	1	3	2	3	2	1	22
US Private			2	1			1	2		6
US Public	1			4	7	5		4	4	25

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

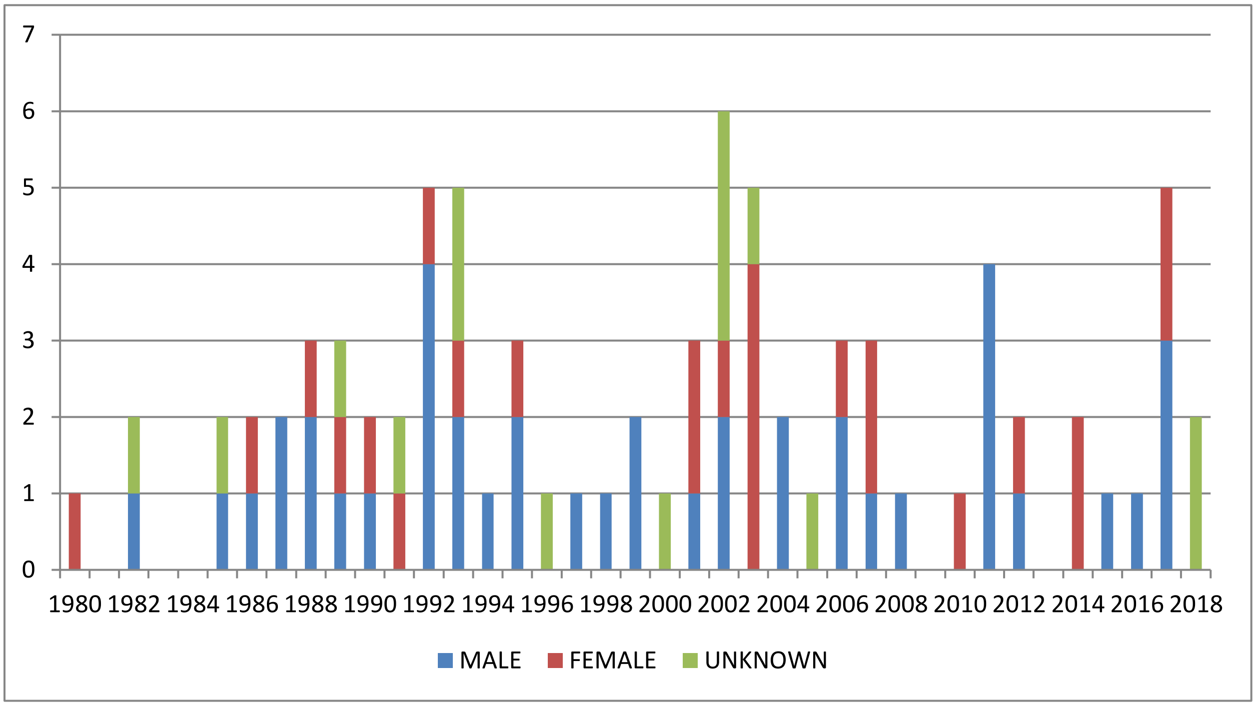

Figure 7. Known grizzly bear annual mortality from all causes in Selkirk Mountains recovery area (including Canada), 1980–2018.

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

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

Grizzly Bear Survival and Cause-Specific Mortality

Kaplan-Meier survival and cause-specific mortality rates were calculated for six sex and age classes of native grizzly bears from 1983–2018 (Table 8). We calculated survival and mortality rates for management bears separately (see below).

Table 8. Survival and cause-specific mortality rates of native grizzly bear sex and age classes based on censored telemetry data in the Selkirk Mountains recovery zone, 1983–2018.

	Demographic parameters and mortality rates					
Parameter	Adult female	Adult male	Subadult female	Subadult male	Yearling	Cub
Individuals / bear-years	45 / 96.8	36 / 44.9	21 / 17.1	25 /23.2	39 / 24.9	45 / 45
Survival[b] (95% CI)	0.928 (0.876–0.980)	0.940 (0.868-1.0)	0.855 (0.705–1.0)	0.889 (0.770-1.0)	0.845 (0.703–0.988)	0.844 (0.709-0.926)
Mortality rate by cause						
Natural	0.026	0	0	0	0	0.111
Defense of life	0.009	0	0	0	0	0
Mis-ID	0	0	.047	0.037	0	0
Management	0.002	0	0.045	0	0	0
Poaching	0.007	0041	0	0	0	0.044
Unknown human	0.010	0.019	0.053	0.050	0.034	0
Unknown	0	0	0	0.012	0.034	0
Unknown probable	0.018	0	0	0.012	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.

Management Grizzly Bear Survival and Cause-Specific Mortality

Kaplan-Meier survival rates were calculated for 16 adult or subadult management grizzly bears from 1994–2018. Twelve bears were males aged 2–20, four were females aged 6–13, and four were cubs of unknown sex. Survival rate for males was 0.489 (95% CI=0.247–0.731) with three instances of management removal, two unknown but human-caused mortality, and one probable mortality among 12 radio-collared bears monitored for 8.6 bear-years. Survival rate for females was 0.833 (95% CI=0.561–1.0) with one instance of management removal among 4 radio-collared bears monitored for 5.6 bear-years.

Grizzly Bear Reproduction

Reproductive parameters originated from all bears monitored from 1983–2018. Mean age of first parturition among 11 female grizzly bears was 6.4 years (95% CI=6.1–6.7, Table 9). First age of parturition was determined by observation of radio-collared bears and genetic parentage analysis and known age of offspring. Twenty-five litters comprised of 54 cubs were observed through both monitoring radio-collared bears and known genetic parentage analysis paired with remote camera observation, for a mean litter size of 2.16 (95% CI=1.94–2.38, Table 9). Seventeen reproductive intervals were determined through both monitoring radio-collared bears and known genetic parentage analysis paired with remote camera observation (Table 9). Mean inter-birth interval was calculated as 3.00 years (95% CI=2.66–3.34). 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 0.351 female cubs/year/adult female (95% CI=0.287–0.444, n=19 adult females, Table 10). In all calculations, the sex ratio of cubs born was assumed 1:1.

Table 9. Grizzly bear reproductive data from the Selkirk Mountains 1985–2018.

Bear	Year	Age	Age at first reproduction	Cubs	Reproductive Interval[1]	Cubs (relationship and fate, if known)
867	1985	7	7	2	2	♀ 898
867	1987	9		2	4	♀ 1042, ♂ 1077
867	1991	13		1	2	
867	1993	15		2	2	♀ 867 and 2 cubs killed
1000	1995	6	6	2		
21	2001	11		3		♂ 28 one of 3 cubs original tag 1000
1015	1987	7	7	2	3	♂ 1090, ♂ 1091
1015	1990	10		2		
1015	2004	12			2	at least 1 cub
1015	2006	14			4	At least 2 cubs
1015	2010	18				At least 2 cubs
1024	1997	6	6	2		
1029	1998	6	6	2	3	cubs became ♀ 4 and ♂ 10
1029	2001	9		2	3	2 cubs
1029	2004	12			3	At least 1 cub
1029	2007	15			3	At least 2 cubs
1029	2010	18			3	At least 1 cub

Bear	Year	Age	Age at first reproduction	Cubs	Reproductive Interval[1]	Cubs (relationship and fate, if known)
1029	2013	21			3	At least 1 cub
1029	2016	24				At least 2 cubs
1027	1996	6	6	2		2 cubs
1045	1989	9		2		
1047	1989	11		2		2 cubs
1056	1987	7		3	4	3 cubs
1076	1989	20+		2		2 cubs
1087	1989	9		3		
1089	1992	7	7	3		3 cubs
2003	2010	6	6		4	At least ♀ S3021F
2003	2014	10		2	3	2 cubs ♀ 19021F,♂ 16521M
2003	2017	13		3		3 cubs at capture 7/24/17
2016	2012	9			3	At least 2 cubs
2016	2015	13		2		observe with 2 cubs 6/1/15
3017	2017	6	6	3		photo 3 cubs 8/8/17
3021	2017	7	7	2		photo 2 cubs 8/9/17
3023	2014	10		2		observe with 2 cubs 5/15/14
1003	2016	6	6	1		♂ 1006 at capture

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

Population Trend

The estimated finite rate of increase (λ) for 1983–2018 using Booter software with the unpaired litter size and birth interval data option was 1.022 (95% CI=0.949–1.093, Table 10). Finite rate of change over the same period was an annual 2.2% (Caughley 1977). Subadult female survival and adult female survival accounted for most of the uncertainty in λ, with reproductive rate, yearling survival, cub survival, and age at first parturition contributing much smaller amounts. The sample sizes available to calculate population trend are small and yielded wide confidence intervals around our estimate of trend (i.e., λ). The probability that the population was stable or increasing was 73%.

Finite rates of increase calculated for the period 1983–2002 (λ = 1.019) suggested an increasing population (Wakkinen and Kasworm 2004). Lack of mortality in specific sex-age classes limited calculations for many time periods other than those shown here. Annual survival rates for adult and subadult females were 0.935 and 0.878 for the period of 1983-2002, respectively and similar to 1983–2018 rates (Table 10). Maintaining or improving survival by reducing human-caused mortality is crucial for recovery of this population (Proctor *et al*. 2004).

Table 10. Booter unpaired method estimated annual survival rates, age at first parturition, reproductive rates, and population trend of native grizzly bears in the Selkirk recovery zone, 1983–2018.

Parameter	Sample size	Estimate (95% CI)	Std Error	Variance (%)[a]
Adult female survival[b] (S_a)	45 / 97.8[c]	0.926 (0.876–0.970)	0.024	13.7
Subadult female survival[b] (S_s)	21 / 16.3[c]	0.848 (0.683–1.0)	0.080	75.3
Yearling survival[b] (S_y)	39 / 24.3[c]	0.846 (0.694–0.964)	0.071	3.1
Cub survival[b] (S_c)[d]	45/45	0.844 (0.733–0.933)	0.053	1.8
Age first parturition (*a*)	11	6.4 (6.1–6.8)	0.145	0.4
Maximum age (*w*)	Fixed	27		
Unpaired Reproductive rate (*m*)[e]	19/17/25[f]	0.351 (0.287–0.444)	0.040	5.8
Unpaired Lambda (λ)	5000 bootstrap runs	1.022 (0.949–1.093)	0.037	

[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.

Capture and Marking

Two male grizzly bears were captured during research trapping in 2018 (both in the U.S.). One subadult male was captured for management purposes near Rathrum ID. Fifty-three grizzly bears were captured during 1534 trap-nights in BC and the U.S. during 2007–18 (Table 8, 9). Fifty-six individual black bears were captured during these efforts (Appendix Table T2). Largely, we base our trapsite selection, effort, and distribution on known or suspected grizzly bear spatial density, occupancy, DNA monitoring success, and past trap success (Figure 8).

Rates of grizzly bear capture were higher in BC than the U.S. Thirty-seven individual grizzly bears have been captured in BC at a rate of 1 new individual every 16 trap-nights. Rates of capture of grizzly bears in the U.S. were 1 new individual every 60 trap-nights. Rates of capture for black bears were similar in BC and the U.S. at 1 new individual every 25 and 29 trap-nights, respectively. Black bear data are provided for comparison purposes.

Table 11. Research capture effort and success for grizzly bears and black bears within the Selkirk Mountains study areas, 2007–2018.

Area / Year(s)	Trap-nights	Grizzly Bear Captures	Black Bear Captures	Trap-nights / Grizzly Bear	Trap-nights / Black Bear
Selkirks, US, 2012–18					
ID Total Captures	628	17	22	37	29
WA Total Captures	327	3	11	109	30
US Individual bears[1]	955	16	33	60	29
Selkirks, BC, 2007–17					
Total Captures	579	42	28	14	21
BC Individual bears[1]	579	37	23	16	25

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

Table 12. Grizzly bear capture information from the Selkirk Mountain study area, 2007–2018. Multiple captures of a single bear during a given year are not included.

Bear	Capture Date	Sex	Age (Est.)	Mass kg	Location	Capture Type
119	4/21/07	M	19	205	Duck Lake, BC	Research
138	5/20/08	F	2	100	Corn Cr., BC	Research
144	6/16/08	M	12	(205)	Next Cr., BC	Research
150	6/21/08	F	7	71	Elmo Cr., BC	Research
151	6/23/08	F	20	82	Cultus Cr., BC	Research
155	6/27/08	M	11	(170)	Next Cr., BC	Research
149	6/12/09	M	10	216	Wildhorse Cr., BC	Research
161	6/15/09	F	18	82	Wildhorse Cr., BC	Research
163	6/16/09	F	7	(102)	Wildhorse Cr., BC	Research
8005	6/16/09	F	4	(90)	Salmo River, BC	Management, pig feed
165	6/19/09	F	14	(80)	Apex Cr., BC	Research
169	6/23/09	F	20	(80)	Wildhorse Cr., BC	Research
171	6/25/09	F	14	91	Seaman Cr,, BC	Research
177	6/22/10	F	9	84	Hidden Cr., BC	Research
183	6/29/10	F	11	102	Sheep Cr., BC	Research
17	9/17/10	M	3	100	Nelson Golf Course, BC	Management, non-target capture
154	9/18/10	M	(4)	(91)	Summit Cr., BC	Research
7	9/25/10	F	13	132	Nelson Golf Course, BC	Management, grease bin
152	5/26/11	M	10	148	Cottonwood Cr., BC	Research
149	5/31/11	M	12	(205)	Cottonwood Cr., BC	Research
2	8/19/11	M	26	178	Creston Valley, BC	Management, animal feed
174	5/25/12	M	6	84	Cottonwood Cr., BC	Research
166	5/30/12	M	3	56	Cottonwood Cr., BC	Research
170	6/5/12	F	6	130	Salmo River, BC	Management, cat food
183	6/8/12	F	11	--	Lost Cr., BC	Research
156	8/17/12	M	2	125	Creston Valley, BC	Management, fruit trees
12003	8/15/12	F	8	111	Trapper Cr., ID	Research
12008	8/26/12	F	15	114	Trapper Cr. ID	Research
12006	8/29/12	F	2	60	Trapper Cr. ID	Research
221	8/29/12	M	6	149	Creston Valley, BC	Research
226	6/6/13	F	6	115	Creston Valley, BC	Management, frequenting dump
9037	6/11/13	F	(10)	(91)	Creston Valley, BC	Management, animal feed
13017	7/22/13	F	2	58	Trapper Cr., ID	Research
13021	7/30/13	F	3	76	Bugle Cr., ID	Research
13023	7/30/13	F	9	94	Trapper Cr., ID	Research
12016	8/23/13	F	10	104	Grass Cr., ID	Research
232	5/17/14	M	5	130	Apex Cr., BC	Research
174	5/22/14	M	8	116	Apex Cr., BC	Research
234	5/23/14	M	7	75	Ymir Cr., BC	Research
240	5/26/14	M	22	>245	Cottonwood Cr., BC	Research
150	6/14/14	F	14	70	Hidden Cr., BC	Research
248	6/19/14	M	4	93	Apex Cr., BC	Research
250	6/21/14	M	7	123	Wildhorse Cr., BC	Research
14327	6/21/14	M	7	195	Jackson Cr., ID	Research
227	6/24/14	M	8	112	Hidden Cr., BC	Research
229	6/26/14	F	4	72	Apex Cr., BC	Research
4250	10/6/14	F	(6)	(145)	Creston Valley, BC	Research
1019	5/30/15	F	3	221	Creston Valley, BC	Research
1020	6/7/15	F	6	144	Cultus Cr., BC	Research
150	6/13/15	F	14	182	Next Cr., BC	Research
1001	6/20/15	M	6	215	Trapper Cr., ID	Research
247	5/29/16	M	3	79	Creston Valley, BC	Research
1019	5/29/16	F	3	115	Creston Valley, BC	Research
1021	5/31/16	M	11	242	Creston Valley, BC	Research

Bear	Capture Date	Sex	Age (Est.)	Mass kg	Location	Capture Type
1024	6/1/16	M	(2)	74	Creston Valley, BC	Research
1002	6/29/16	M	8	166	Willow Cr., WA	Research
4-070	8/6/16	F	(10)	(182)	Creston Valley, BC	Research
1003	8/14/16	F	6	128	Boundary Cr., ID	Research
4-011	8/15/16	F	>5	(68)	Kootenay R., BC	Management; fruit trees
4-002	8/15/16	F	(0.5)	(34)	Kootenay R., BC	Management; captured with mother 4-011
4-004	8/15/16	F	(0.5)	(34)	Kootenay R., BC	Management; captured with mother 4-011
1006	5/26/17	M	1	46	Boundary Cr., ID	Research
1028	6/5/17	F	2	58	Corn Cr., BC	Management; garbage
1026	6/5/17	F	2	60	Corn Cr., BC	Management; garbage
1030	6/10/17	F	4	110	Kootenay R., BC	Research
1031	6/14/17	F	(1)	40	Kootenay R., BC	Research
1007	6/19/17	M	8	170	Cow Cr., ID	Research
1008	6/21/17	M	1	86	Boundary Cr., ID	Research
1009	6/21/17	M	3	151	Cow Cr., ID	Research
1010	6/25/17	F	25	123	Cow Cr., ID	Research
12008	7/23/17	F	20	113	Trapper Cr., ID	Research
12003	7/24/17	F	13	97	Bugle Cr., ID	Research
1002	6/21/18	M	10	178	W. Branch LeClerc, WA	Research
14327	6/26/18	M	11	216	W. Branch LeClerc, WA	Research
865	8/16/18	M	(2)	80	Rathdrum, ID	Management

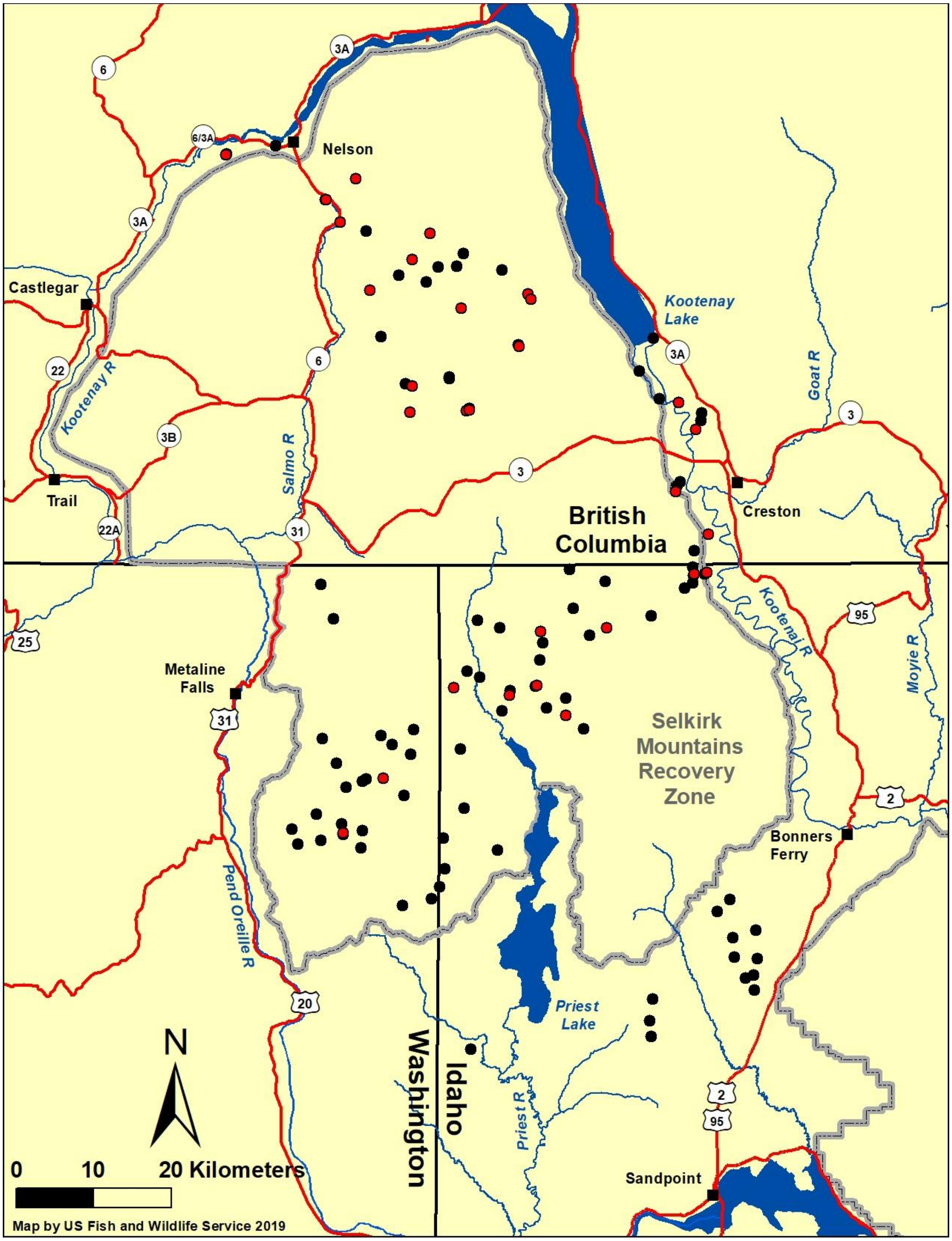

Figure 8. Trapsite locations in the Selkirk Mountains study area 2007–2018. Red dots represent sites with ≥ 1 grizzly bear capture.

Grizzly Bear Monitoring and Home Ranges

Nine grizzly bears were monitored by GPS radio collars during portions of 2018 in the SE study area. Monitoring included five females (all adults) and four males (2 adults and 2 subadults).

Specific and general locations were obtained on collared bears, but only aerial, specific locations and GPS collar locations were used to calculate home ranges. Convex polygon life ranges were computed for bears monitored during 2007–2018 (Table 13, Appendix, Figs. A1-A49). Bears with multiannual home range estimates and sample sizes in excess of 50 locations were used to calculate basic statistics. Adult male life range averaged 1,055 km^2 (95% CI ± 459, *n* = 18) using the minimum convex polygon. Adult female life range averaged 626 km^2 (95% CI ± 410, *n* = 23) using the minimum convex polygon estimator.

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 13. Home range sizes of grizzly bears in the Selkirk Mountains of northern Idaho and southern British Columbia, 2006–2018.

Bear	Sex	Age (Est)	Years	Collar Type	Number of fixes	100% Convex polygon (km^2)	Area of use
103	M	3-4	2006-07	GPS	4,872	6,545	Kootenai, & Pend Oreille River, BC, ID, & WA
119	M	19-20	2008-09	GPS	2,115	1,830	Selkirk Mtns., BC
138	F	2-3	2008-09	GPS	3,232	750	Kootenay River, BC
144	M	9	2008	GPS	1,648	883	Selkirk Mtns., BC
7005	M	4	2008	GPS	229	1,144	Selkirk Mtns., BC
150	F	6-14	2008-09, 2014-16	GPS	5,919	1,354	Selkirk Mtns., BC
155	M	11-13	2008-10	GPS	2,175	1,479	Selkirk Mtns., BC
161	F	6-7	2009-10	GPS	2,008	126	Selkirk Mtns., BC
163	F	6-7	2009-10	GPS	4,144	271	Selkirk Mtns., BC
165	F	15-16	2009-10	GPS	416	169	Selkirk Mtns., BC
171	F	15-16	2009-10	GPS	2,740	227	Selkirk Mtns., BC
8005	F	4-5	2009-10	GPS	1,649	4,511	Selkirk Mtns., BC
177	F	9	2010	GPS	486	72	Selkirk Mtns., BC
154	M	4	2010	GPS	396	178	Selkirk Mtns., BC
183	F	9-12	2010, 12-13	GPS	616	362	Selkirk Mtns., BC
7	F	9	2010	GPS	35	75	Selkirk Mtns., BC
17	M	3	2010	GPS	255	106	Selkirk Mtns., BC
152	M	6-7	2011-12	GPS	1,189	340	Selkirk Mtns., BC
149	M	11	2011	GPS	737	2,114	Selkirk Mtns., BC
12003	F	5-7,13-14	2012-13,17-18	GPS	3005	458	Selkirk Mtns, ID
12006	F	2-4	2012-14	GPS	626	532	Selkirk Mtns, ID
12008	F	15-17,20-21	2012-14,17-18	GPS	3,317	849	Selkirk Mtns, ID
221	M	6-7	2012-13	GPS	47	140	Selkirk Mtns., BC
174	M	4-6	2012-14	GPS	972	621	Selkirk Mtns., BC
12016	F	10-13	2013-16	GPS	742	216	Selkirk Mtns, ID
13017	F	2-5	2013-16	GPS	1,707	859	Selkirk Mtns, ID
13021	F	3-5	2013-15	GPS	1,187	1,801	Selkirk Mtns, ID

Bear	Sex	Age (Est)	Years	Collar Type	Number of fixes	100% Convex polygon (km²)	Area of use
13023	F	9-11	2013-15	GPS	1,109	472	Selkirk Mtns, ID
226	F	6-9	2013-16	GPS	2,578	482	Selkirk Mtns, Creston Valley, BC
229	F	3-5	2014-16	GPS	489	71	Selkirk Mtns, BC
232	M	5	2014	GPS	1,354	353	Selkirk Mtns, BC
234	M	7-9	2014-16	GPS	3,560	446	Selkirk Mtns, BC
248	M	4-6	2014-16	GPS	4,418	2,321	Selkirk Mtns, BC
250	M	7-8	2014-15	GPS	3,224	829	Selkirk Mtns, BC
4250	F	(6-7)	2014	GPS	1,722	395	Selkirk Mtns, BC
227	M	8-9	2014-15	GPS	2,227	771	Selkirk Mtns, BC
14327	M	7-11	2014-18	GPS	1,944	3,532	Selkirk Mtns, BC, ID&WA
807	M	4-7	2014-17	GPS	2,568	3,319	Selkirk Mtns, ID&Yaak River, MT
1001	M	6	2015	GPS	1,352	1,357	Selkirk Mtns, BC
1019	F	3-4	2015-16	GPS	894	187	Selkirk Mtns, Creston Valley
1020	F	5-6	2015-16	GPS	3,366	196	Selkirk Mtns, BC
1002	M	9-11	2016,18	GPS	4,015	2,927	Selkirk Mtns, ID&WA
1003	F	6	2016-18	GPS	5,704	638	Selkirk Mtns, ID& Creston Valley BC
1024	M	(2)	2016	GPS	594	80	Selkirk Mtns, Creston Valley, BC
4011	F	(10-12)	2016-18	GPS	2,729	312	Selkirk Mtns, BC
4070	F	(10)	2016	GPS	600	60	Selkirk Mtns, Creston Valley, BC
247	M	3	2016	GPS	601	129	Selkirk Mtns, Creston Valley, BC
1021	M	11	2016	GPS	139	945	Selkirk Mtns, Creston Valley, BC
922[2]	M	4-5	2016-17	GPS	938	2,148	Kootenai Rr., ID Yaak Rr, MT
1006	M	1-2	2017-18	GPS	2,968	8,092	Selkirk Mtns, ID&BC, Yaak & Cabinets, MT
1007	M	8	2017	GPS	118	74	Selkirk Mtns, ID&BC
1008	M	1	2017	GPS	152	52	Selkirk Mtns, ID& Creston Valley BC
1009	M	3	2017	GPS	180	216	Selkirk Mtns, ID&BC
1010	F	25-26	2017-18	GPS	166	423	Selkirk Mtns, ID
23	M	(3)	2017	GPS	427	114	Selkirk Mtns, BC
865	M	(2)	2018	GPS	2,604	1,312	Kootenai Rr., ID Yaak Rr, MT

Grizzly Bear Denning Chronology

We used VHF and GPS location data from radio-collared grizzly bears during 1998–2018 to summarize den entry and exit dates by month and week. Den entry dates (n = 74) ranged from the first week of October to the second week of December. Sixty-eight (92%) entries occurred between the 2nd week of October and the 4th week of November (Fig. 8). SE grizzly bears (median entry during 1st week of November) entered dens 1 and 3 weeks earlier than bears in the Cabinet Mountains and Yaak River drainage (Kasworm *et al.* 2019), respectively (median entry during 2nd week of November for Cabinet bears and 4th week of November for Yaak bears). Males enter dens one week later than females (Fig. 8). By December 1, 96% of monitored SE grizzly bears had entered winter dens. By this same date, only 63% of Cabinet and Yaak grizzly bears had entered dens.

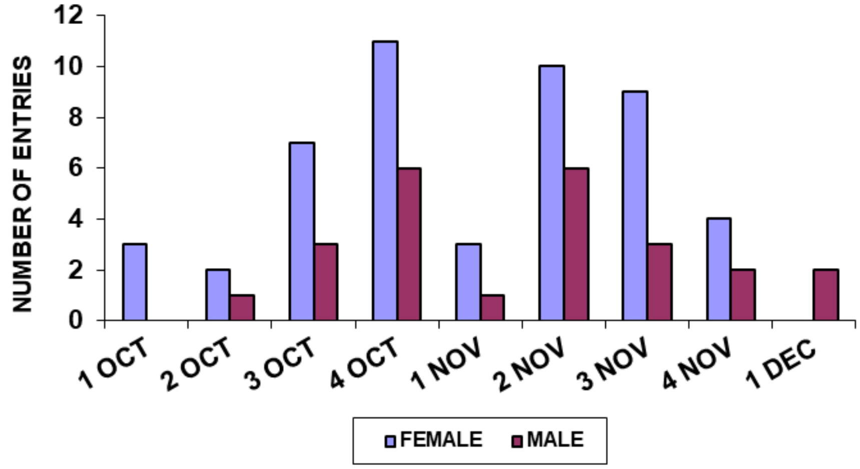

Figure 8. Month and week of den entry for male and female radio-collared grizzly bears in the Selkirk Ecosystem, 1998–2018.

We have far fewer den exit dates for SE radio-collared grizzly bears (*n* = 28), and a majority of emergence data is from female grizzly bears (82%). Exit dates for female SE grizzly bears ranged from the third week of March to the second week of May (median of 3rd week in April) (Fig. 9). Exit dates for females are similar to those of females in the Cabinet Mountains and Yaak drainage (Kasworm et al. 2019). In general, Cabinet and Yaak female grizzly bears typically exit dens in a similar pattern to female bears in the SE.

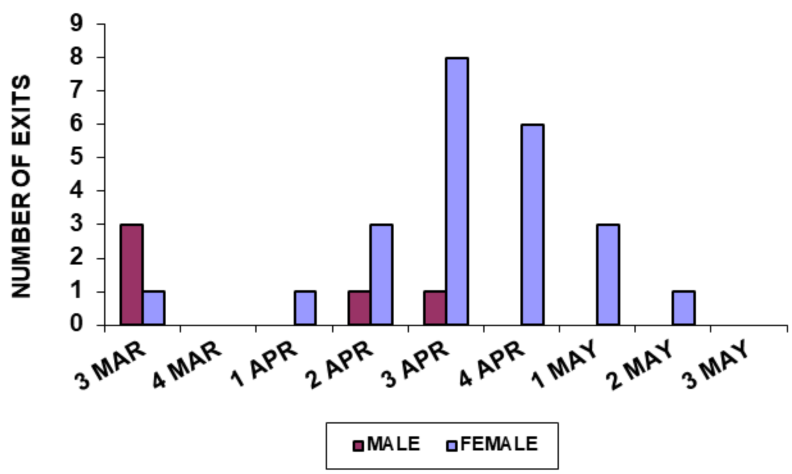

Figure 9. Month and week of den exit for male and female radio-collared grizzly bears in the Selkirk Ecosystem, 2013-2018.

Inter-ecosystem Isotope Analysis

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 across the Cabinet-Yaak and SE 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 SE (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 SE 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). Previous studies have emphasized the importance of splitting these hair types due to temporal differences in growing period (Jones *et al*. 2006). We currently have 45 bear capture events with paired guard hair and underfur samples collected at capture. In all cases, grizzly bears have either 1) the same dietary meat proportion in summer vs. fall or 2) have higher amounts of meat in their fall diet. On average, grizzly bears' meat consumption nearly doubles from summer to fall (10.7% summer to 17.6% fall). Fall shifts toward meat use were not isolated to a specific sex-age class. Larger shifts include: an adult male (4327) shifting from 31% meat in summer to 82% meat in fall, an adult female (mortality 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.

Berry Production

Huckleberries are an important summer and early-fall food for SE grizzly bears, as they are high in sugar content and effective in contributing to necessary fat gains for winter denning and reproduction. In an effort to index year-to-year production of huckleberries, we established and evaluated one huckleberry transect in the SE in 2014. In 2015, we established and evaluated four additional transects in the SE. Surveys were repeated on these five sites in 2016–18 (Fig. 10). In 2018, SE transect counts were lower than the 2015–18 average, at 1.7 berries per frame (range = 1.0–3.0; 95% CI = 0.65) (Table 11). In comparison, huckleberry indices in the Cabinet-Yaak Ecosystem were slightly higher in 2018, at 1.9 berries per plot (n = 15 transects; range = 1.0–2.9; Table 11), with both Ecosystem indices tracking one another year-to-year (i.e., estimates overlapping confidence intervals, 2015–18) (Kasworm *et al*. 2019).

Table 11. Berry production indices (berries per plot) at transect locations within the Selkirk Mountains

study area, 2014–18. At bottom, yearly mean indices and 95% confidence intervals (CI), with comparison to Cabinet-Yaak transects. Selkirk grand average across all transects is 2.2 berries per plot.

	Berries per plot				
Huckleberry transect	2014	2015	2016	2017	2018
Cow Creek	2.2	1.0	1.0	2.9	1.4
Caribou Creek	–	1.8	2.4	3.1	1.4
East Ruby Creek	–	2.2	3.0	3.7	3.0
Pass Creek Pass	–	2.0	1.3	3.6	1.0
Bunchgrass Meadows	–	1.5	2.0	2.9	1.9
Selkirk Annual Mean (CI)	2.2 (–)	1.7 (0.45)	1.9 (0.79)	3.3 (0.35)	1.7 (0.65)
Cabinet-Yaak Annual Mean (CI)	3.4 (1.09)	1.3 (0.33)	1.8 (0.33)	2.8 (0.49)	1.9 (0.32)

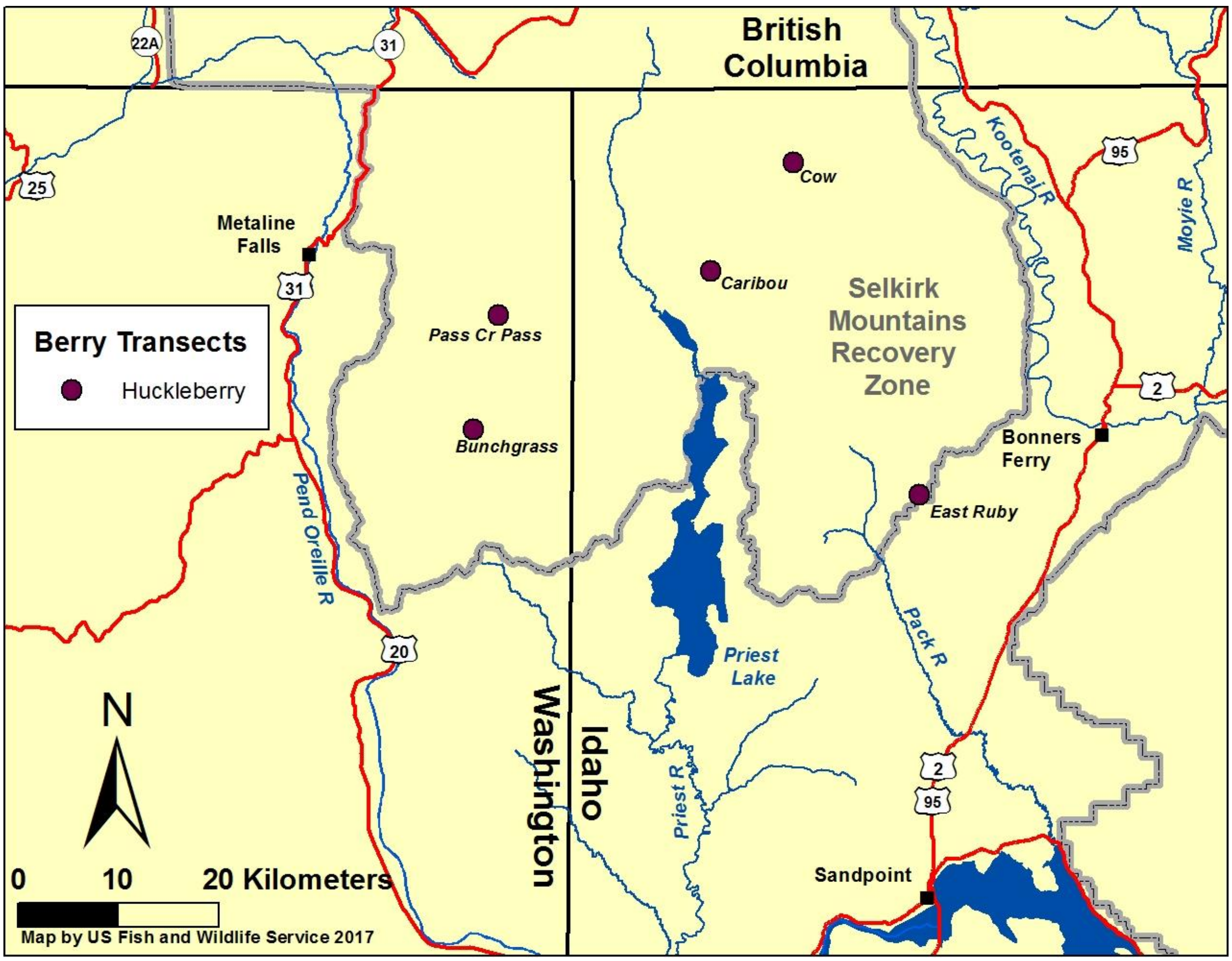

Figure 10. Locations of huckleberry transects surveyed within the Selkirk Mountain study area, 2014–18.

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APPENDIX 1

Table T1. Movement and gene flow to or from the Selkirk Mountains recovery area.

Area Start / Finish[1]	Action	Bear ID	Sex	Age	Year	Basis	Comments
NCDE / SSelk	Movement	None	F	2	2000	Telemetry, capture	Relocated several times in NCDE. Recaptured north of Bonners Ferry, ID relocated to NCDE.
NPur / SSelk	Movement	SCptHM	M	19	2008	Telemetry, Genetics	Born in NPur but traveled to SSelk and captured. Genetics determine parents in NPur
SPur / SSelk	Movement	YHydeM	M	3	2006-07	Telemetry	Captured in SPur 2006. Bear traveled to SSelk 2006, denned then lost collar 2007.
KG / NPur	Movement	Wilf(156)	M	4	2012	Capture, Genetics	Traveled from KG in WA to NPur. Management removal 2012
SSelk / Bitt	Movement	B90307M	M	?	2007	Genetic assignment	Killed in Bitterroot September 2007. Genetic analysis indicates origin in SSelk
SSelk / Cabs / SSelk	Movement	928442	M	5	2012	Genetics	Father SSelk S9058aM, Mother SSelk SBettyF, Hair snagged 2012 in Cabs and in SSelk 2015
SSelk / NPur	Movement	S1022M	M	1	1994, 1996	Telemetry, Mortality	Captured in SSelk 1994, Management removal 1996 Boswell, BC NPur.
SSelk / SPur	Movement	S31M	M	6	2004-05	Telemetry, Mortality	Father SSelk SS3KM, Mother SSelk S1MF, Collared 2003 SSelk. Hunter kill 2005 SPur
NPur / SSelk	Movement	PBobM	M	26	2011	Telemetry, Mortality	Collared in NPurs, but recaptured later in SSelk and Management removal 2011
SSelk / KG	Movement	ApexS248M	M	4	2014-15	Telemetry	Radio collared and traveled west to KG from SSelk 2015
SSelk / Cabs	Movement	S1001M	M	6	2015	Telemetry, Mortality	Travel east from SSelk to Cabs. Mortality 2015
SPur / SSelk	Movement	Y11048M	M	4	2017	Telemetry, Mortality	Travel west from SPur to SSelk. Mortality 2017
SPur / SSelk	Movement	YGB807M	M	5	2015-17	Telemetry	Travel west from SPur to SSelk.
NPur / SSelk	Movement	S14151M	M	6	2014	Genetics	Parents both NPur, Father NPur PKiddM, Mother NPur PKellyF
NPur / SSelk	Gene flow	SFoccacia170F	F	6	2012	Genetics	Father NPur SCptHM, Mother SSelk SCulveF
NPur / SSelk	Gene flow	S92231M	M	1	2016	Genetics	Father NPur SCptHM, Mother SSelk JillS226F
NPur / SSelk	Gene flow	S25793M	M	0.5	2016	Genetics	Father NPur SCptHM, Mother SSelk S1029F
NPur / SSelk / Cabs	Gene flow Movement	S21285M	M	0.5-2	2016-18	Genetics, Telemetry	Father NPur SCptHM, Mother SSelk S11675F, S21285M moved to Cabs 2018, dropped collar
NPur / SSelk	Gene flow	S21690M	M	0.5	2016	Genetics	Father NPur SCptHM , Mother SSelk SMaya4208F
NPur / SSelk	Gene flow	S21698M	M	0.5	2016	Genetics	Father NPur SCptHM , Mother SSelk SMaya4208F
SSelk / KG	Movement	9305a	?	Unk	Unk	Genetics	Father SKirkM, Mother SSelk S10991F, Origin of father probably SSelk
SSelk / KG	Movement	JC12-23	M?	Unk	2012	Genetics, Mortality	Father Sunk1M, Mother S10739F Both SSelk Male offspring JC12-23 in KG
SSelk / SPur	Movement	16749	M	2	2015	Genetics	Father C134B2V2, Mother JillS226F Both SSelk. Male offspring 16749 in SPur
NPur / SSelk	Gene flow	S28776M	M	Unk	2017	Genetics	Father NPur S14151M, Mother SSelk S2008F
NPur / SSelk	Gene flow	S25506M	M	0.5	2015	Genetics	Father NPur S14151M, Mother SSelk S252F
NPur / SSelk	Gene flow	15124	F	0.5	2015	Genetics	Father NPur S14151M, Mother SSelk S252F

[1]Cabs – Cabinet Mountains, KG - Kettle Granby , NCDE – Northern Continental Divide, NPur – Purcell Mountains north of Highway 3, SPur – Purcell Mountains south of Highway 3, SSelk – South Selkirk Mountains south of Nelson, BC

Table T2. Black bears captured by study personnel in the Selkirk Ecosystem, 2007–17.

Bear	Tag Color	Capture Date	Sex	Age (Est.)	Mass kg (Est)	Location	Capture Type
116	BLACK	4/24/2007	M	13	(125)	Corn Cr., BC	Research
118	BLACK	4/26/2007	M	3	(57)	Corn Cr., BC	Research
120	BLACK	4/28/2007	M	UNK	163	Corn Cr., BC	Research
120	BLACK	4/30/2008	M	UNK	(136)	Corn Cr., BC	Research
118	BLACK	4/30/2008	M	(4)	(73)	Duck Lake, BC	Research
136	BLACK	5/17/2008	M	(6)	(79)	Leach Cr., BC	Research
146	BLACK	6/17/2008	M	UNK	(59)	Cultus Cr., BC	Research
148	BLACK	6/20/2008	M	UNK	76	Laib Cr., BC	Research
142	BLACK	6/21/2008	M	UNK	(68)	Cultus Cr., BC	Research
153	BLACK	6/24/2008	M	UNK	67	Elmo Cr., BC	Research
143	BLACK	5/17/2009	M	20	(109)	Corn Cr., BC	Research
145	BLACK	5/24/2009	UNK	UNK	(79)	Corn Cr., BC	Research
143	BLACK	5/27/2009	M	20	(109)	Dodge Cr., ID	Research
401	GREEN	6/22/2011	F	5	56	Fall Cr., ID	Research
403	GREEN	6/26/2011	F	9	79	Fall Cr., ID	Research
405	GREEN	6/29/2011	M	4	58	Fall Cr., ID	Research
407	GREEN	7/13/2011	M	2	47	Dodge Cr., ID	Research
409	GREEN	7/15/2011	M	3	54	Trail Cr., ID	Research
411	GREEN	7/18/2011	M	2	52	Fall Cr., ID	Research
417	GREEN	7/21/2011	M	UNK	37	Fall Cr., ID	Research
8006	GREEN	8/18/2011	F	2	41	Roman Nose Cr., ID	Research
155	GREEN	9/19/2011	F	8	(73)	Dodge Cr., ID	Research
165	GREEN	9/25/2011	M	11	139	SF Dodge Cr., ID	Research
160	BLACK	5/26/2012	M	4	(68)	Blewett Cr., BC	Research
2001	GREEN	5/29/2012	M	11	95	Fedar Cr., ID	Research
162	BLACK	5/29/2012	M	3	60	Blewett Cr., BC	Research
2005	GREEN	8/23/2012	M	3	61	Abandon Cr., ID	Research
3016	GREEN	7/21/2013	M	10	74	Hughes Meadows, ID	Research
3019	GREEN	7/22/2013	M	4	49	Upper Priest Rv., ID	Research
3020	GREEN	7/29/2013	M	3	49	Bugle Cr., ID	Research
3013	GREEN	8/20/2013	F	16	75	Silver Cr., ID	Research
238	BLACK	5/25/2014	M	9	58	Porcupine Cr., BC	Research
236	BLACK	5/25/2014	M	8	90	Clearwater Cr., BC	Research
236	BLACK	6/12/2014	M	6	93	Apex Cr., BC	Research
4326	GREEN	6/13/2014	M	6	61	Jackson Cr., ID	Research
246	BLACK	6/17/2014	M	8	102	Wildhorse Cr., BC	Research
244	BLACK	6/17/2014	M	15	76	Wildhorse Cr., BC	Research
392	RED	6/28/2014	M	(4)	72	Hemlock Cr., WA	Research
388	RED	7/19/2014	M	(6)	96	LeClerc Cr., WA	Research
389	RED	7/25/2014	F	(9)	57	Le Clerc Cr., WA	Research
391	RED	7/26/2014	M	(5)	63	Jungle Cr., WA	Research
390	RED	7/26/2014	F	(4)	61	Sema Meadows, WA	Research
4330	GREEN	8/22/2014	M	8	103	Trapper Cr., ID	Research
4331	GREEN	8/24/2014	F	(8)	(79)	Bugle Cr., ID	Research

Bear	Tag Color	Capture Date	Sex	Age (Est.)	Mass kg (Est)	Location	Capture Type
4332	GREEN	8/26/2014	M	16	105	Trapper Cr., ID	Research
4333	GREEN	8/28/2014	M	3	53	Trapper Cr., ID	Research
4305	GREEN	6/24/2015	F	6	47	Lime Cr., ID	Research
4306	GREEN	7/18/2015	M	(12)	113	Bugle Cr.,ID	Research
4307	GREEN	8/23/2015	M	(7)	(125)	Grass Cr., ID	Research
601	RED	5/27/2016	M	7	88	SF Granite, WA	Research
602	RED	6/9/2016	M	6	74	NF Harvey, WA	Research
603	RED	6/27/2016	M	6	74	Willow Cr., WA	Research
---	---	8/23/2016	---	(1)	(18)	Boundary Cr., ID	Research culvert, not tagged
4308	GREEN	7/17/2017	M	5	62	Bugle Cr., ID	Research
4309	GREEN	7/19/2017	M	4	52	Trapper Cr., ID	Research
4310	GREEN	7/19/2017	M	14	65	Bugle Cr., ID	Research
4329	GREEN	7/21/2017	M	8	63	Trapper Cr., ID	Research
4334	GREEN	7/23/2017	M	3	(68)	Trapper Cr., ID	Research
4335	GREEN	8/1/2017	M	9	96	Trapper Cr., ID	Research
4336	GREEN	8/24/2017	M	(3)	61	Caribou Cr., ID	Research
9050	---	6/18/2018	---	(---)	---	Harvey Cr., WA	Research, grizzly predation
604	RED	6/20/2018	M	(8)	(113)	White Man Cr., WA	Research
605	RED	6/24/2018	M	(10)	101	WB Le Clerc Cr., WA	Research

APPENDIX 2. Grizzly Bear Home Ranges

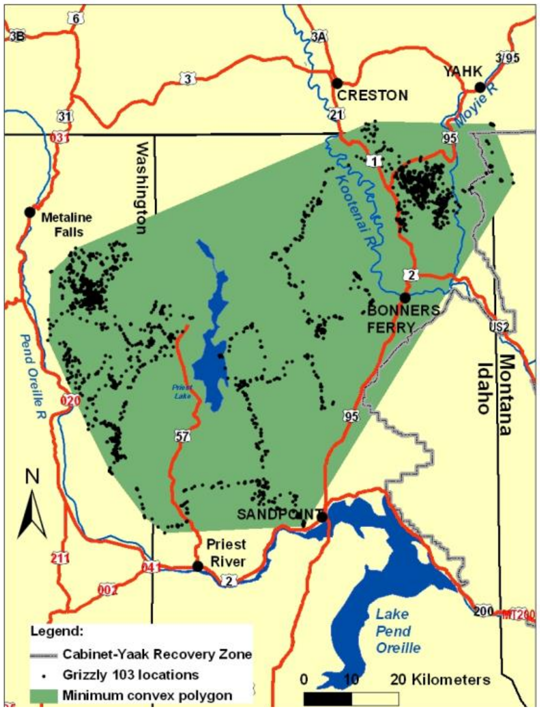

Figure A1. Radio locations and minimum convex (shaded) life range of male grizzly bear 103 in the Yaak River and Selkirk Mountains, 2006-07.

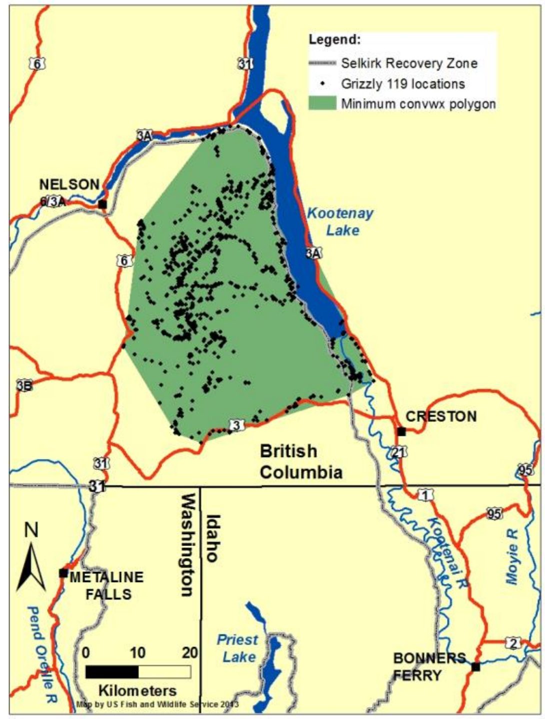

Figure A2. Radio locations and minimum convex (shaded) life range of male grizzly bear 119 in the Selkirk Mountains, 2008-09.

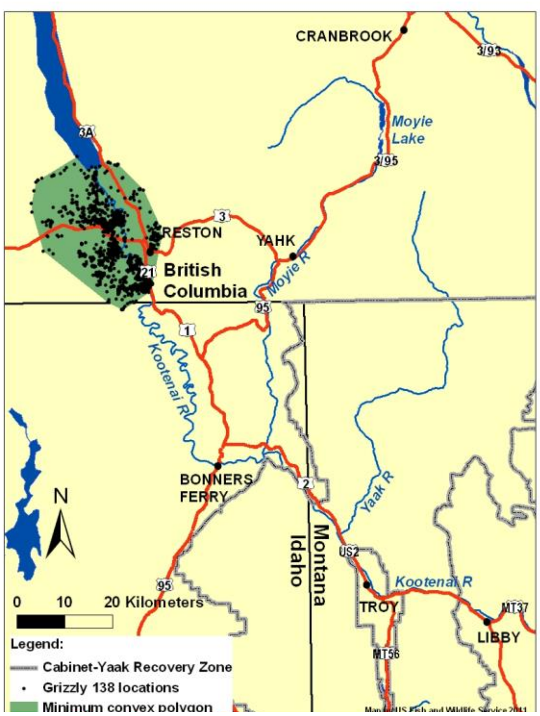

Figure A3. Radio locations and minimum convex (shaded) life range of female grizzly bear 138 in the Selkirk Mountains, 2008-09.

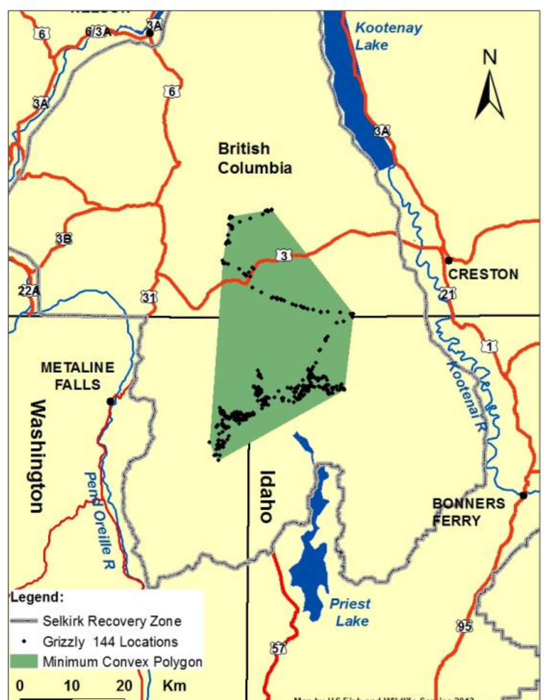

Figure A4. Radio locations and minimum convex (shaded) life range of male grizzly bear 144 in the Selkirk Mountains, 2008.

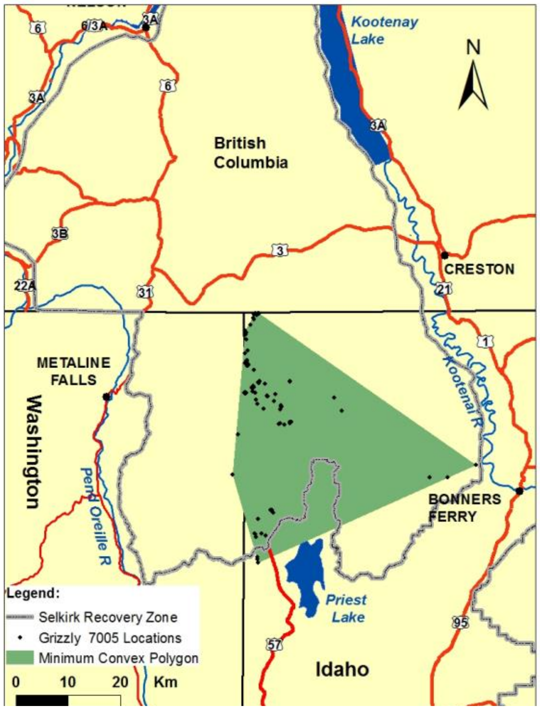

Figure A5. Radio locations and minimum convex (shaded) life range of management male grizzly bear 7005 in the Selkirk Mountains, 2008.

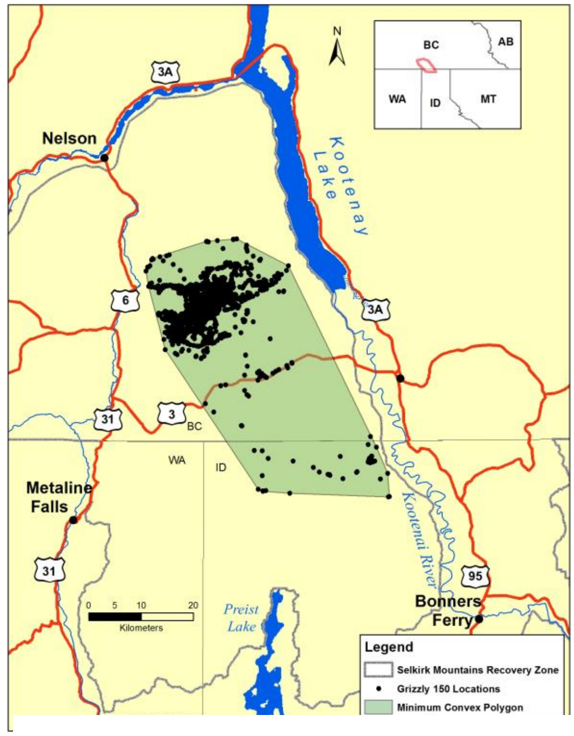

Figure A6. Radio locations and minimum convex (shaded) life range of female grizzly bear 150 in the Selkirk Mountains, 2008-09, 2014-16.

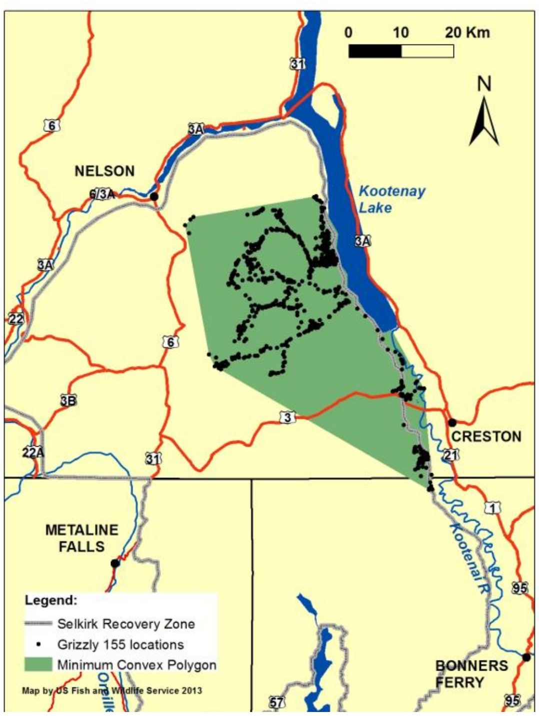

Figure A7. Radio locations and minimum convex (shaded) life range of male grizzly bear 155 in the Selkirk Mountains, 2008-10.

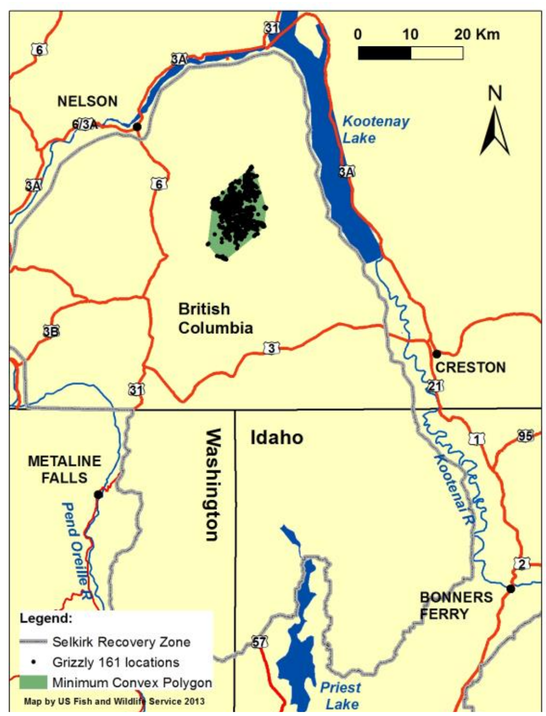

Figure A8. Radio locations and minimum convex (shaded) life range of female grizzly bear 161 in the Selkirk Mountains, 2009-10.

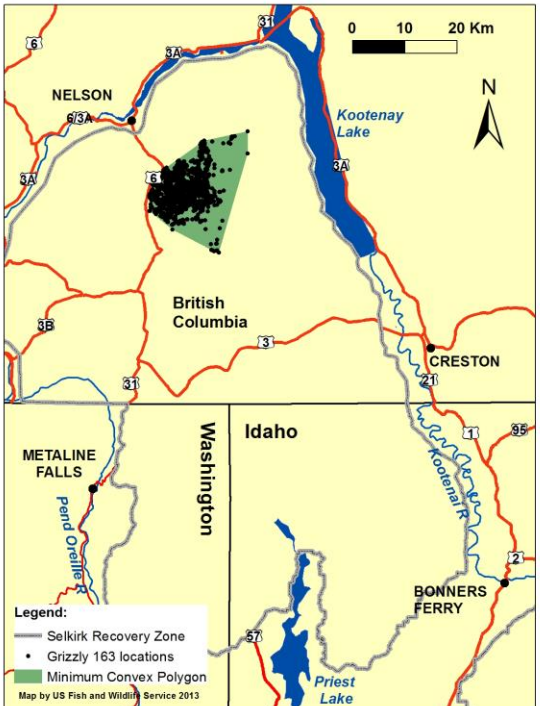

Figure A9. Radio locations and minimum convex (shaded) life range of female grizzly bear 163 in the Selkirk Mountains, 2009-10.

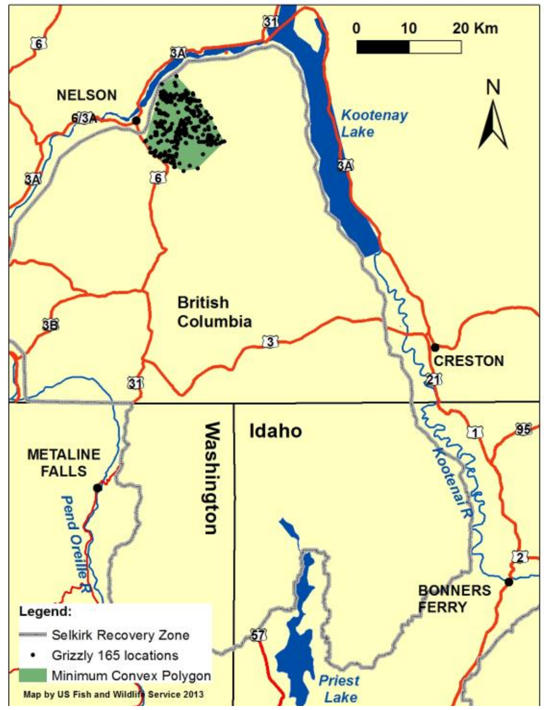

Figure A10. Radio locations and minimum convex (shaded) life range of female grizzly bear 165 in the Selkirk Mountains, 2009-10.

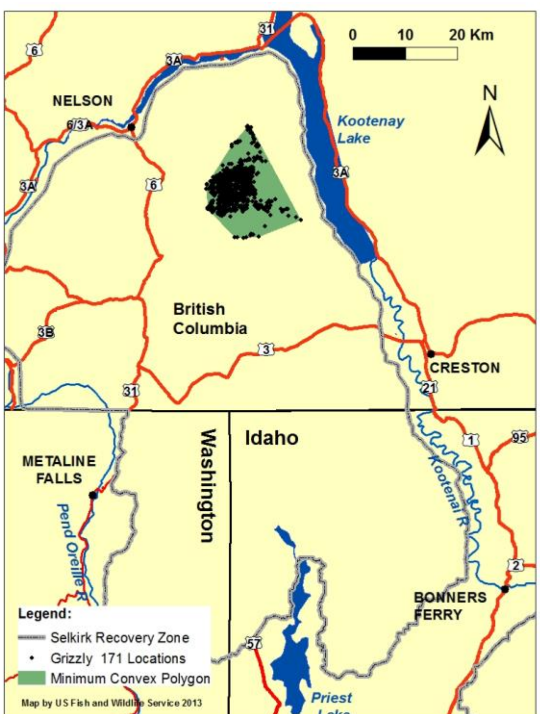

Figure A11. Radio locations and minimum convex (shaded) life range of female grizzly bear 171 in the Selkirk Mountains, 2009-10.

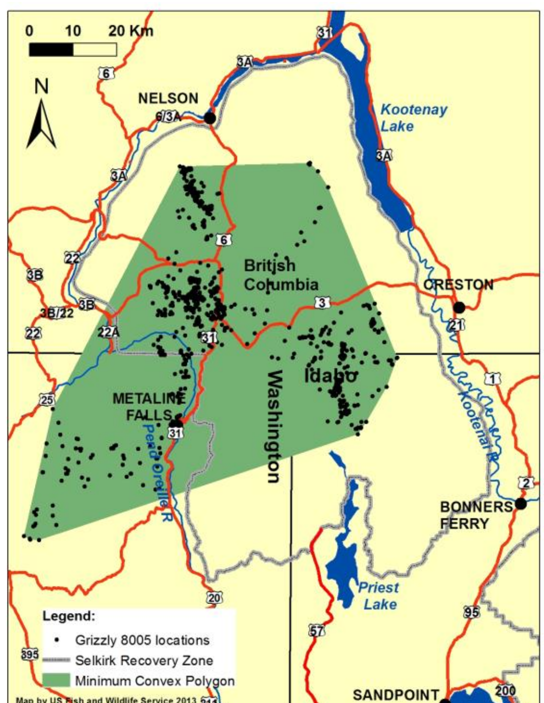

Figure A12. Radio locations and minimum convex (shaded) life range of female grizzly bear 8005 in the Selkirk Mountains, 2009-10.

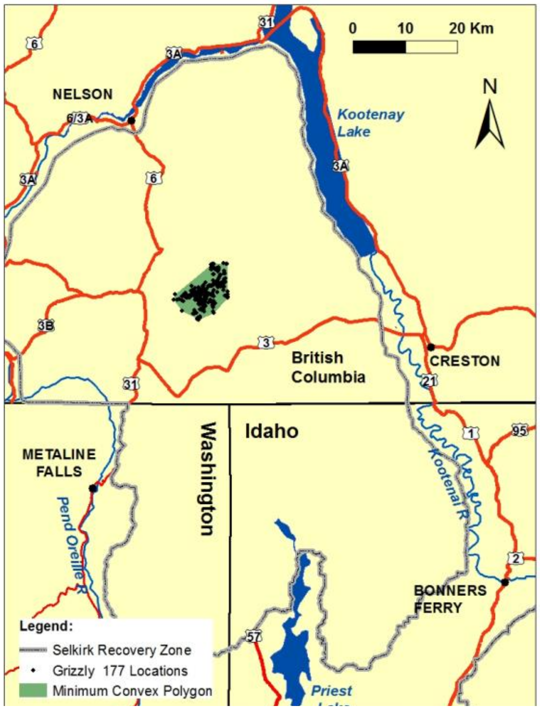

Figure A13. Radio locations and minimum convex (shaded) life range of female grizzly bear 177 in the Selkirk Mountains, 2010.

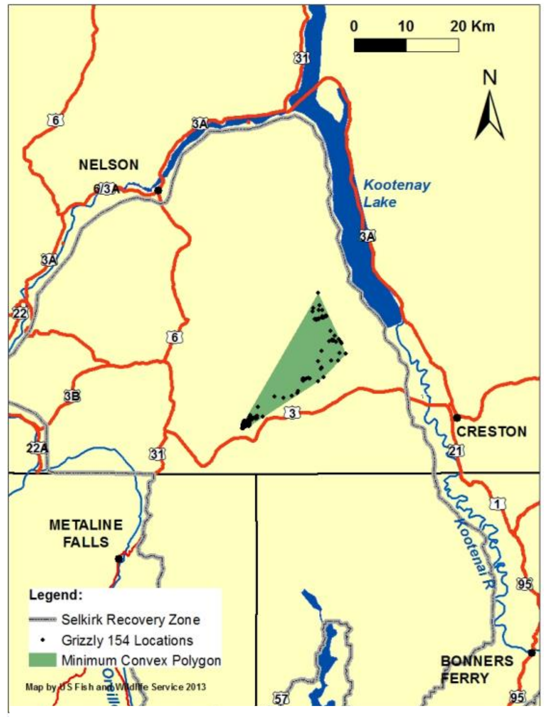

Figure A14. Radio locations and minimum convex (shaded) life range of male grizzly bear 154 in the Selkirk Mountains, 2010.

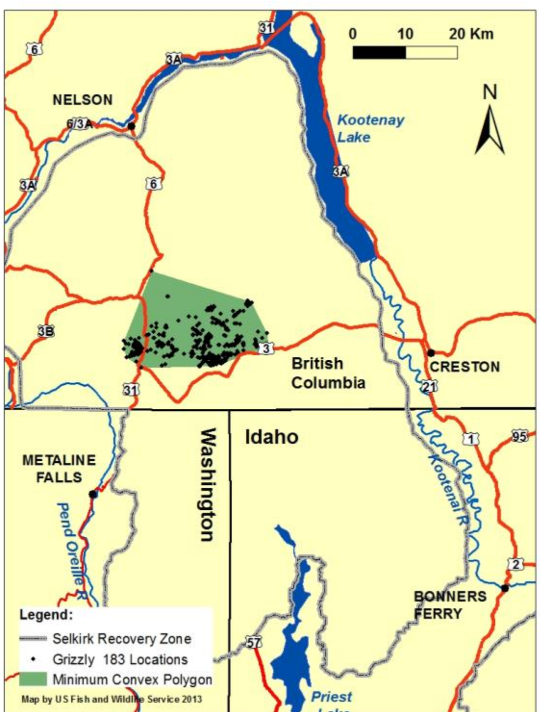

Figure A15. Radio locations and minimum convex (shaded) life range of female grizzly bear 183 in the Selkirk Mountains, 2010 and 2012-13.

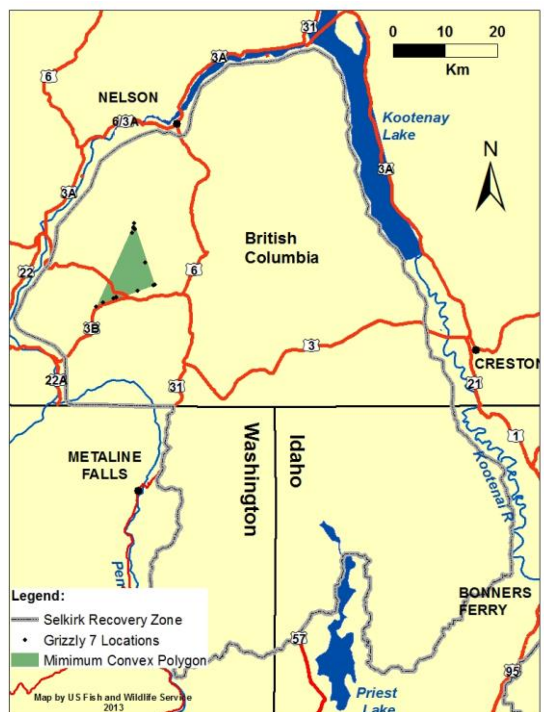

Figure A16. Radio locations and minimum convex (shaded) life range of management female grizzly bear 7 in the Selkirk Mountains, 2010.

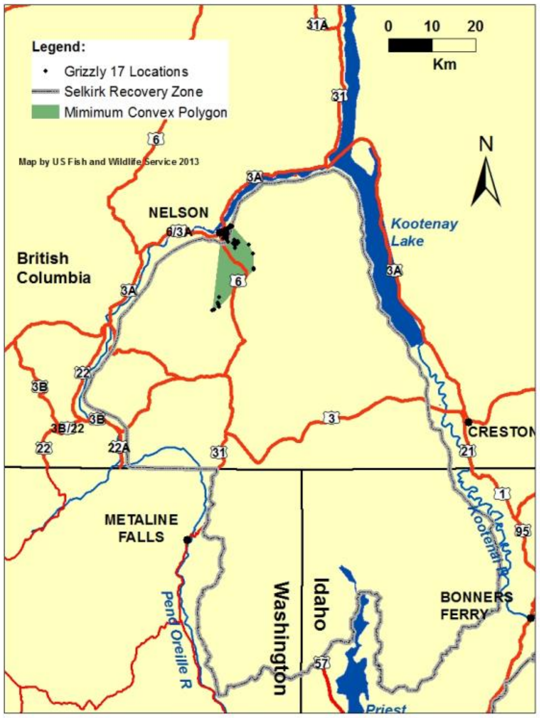

Figure A17. Radio locations and minimum convex (shaded) life range of management male grizzly bear 17 in the Selkirk Mountains, 2010.

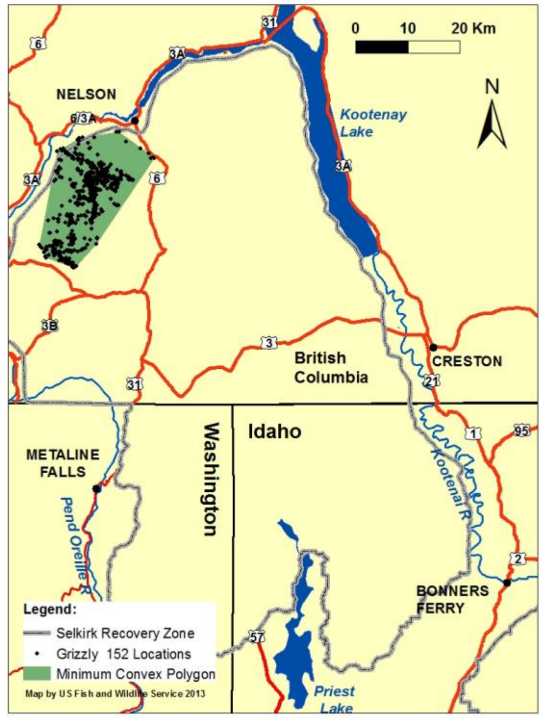

Figure A18. Radio locations and minimum convex (shaded) life range of male grizzly bear 152 in the Selkirk Mountains, 2011-12.

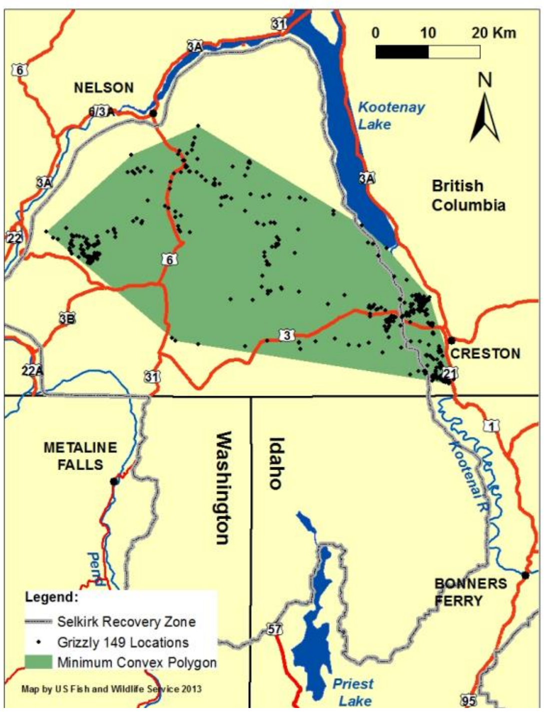

Figure A19. Radio locations and minimum convex (shaded) life range of male grizzly bear 149 in the Selkirk Mountains, 2011.

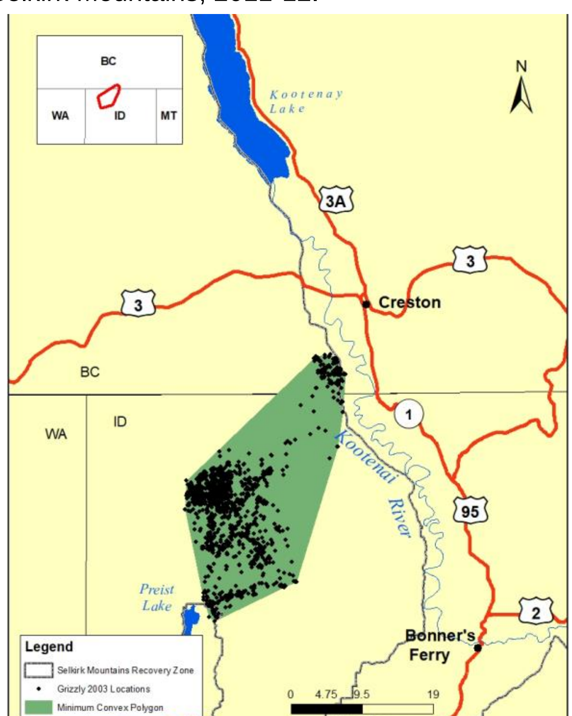

Figure A20. Radio locations and minimum convex (shaded) life range of female grizzly bear 12003 in the Selkirk Mountains, 2012-14, 2017-18.

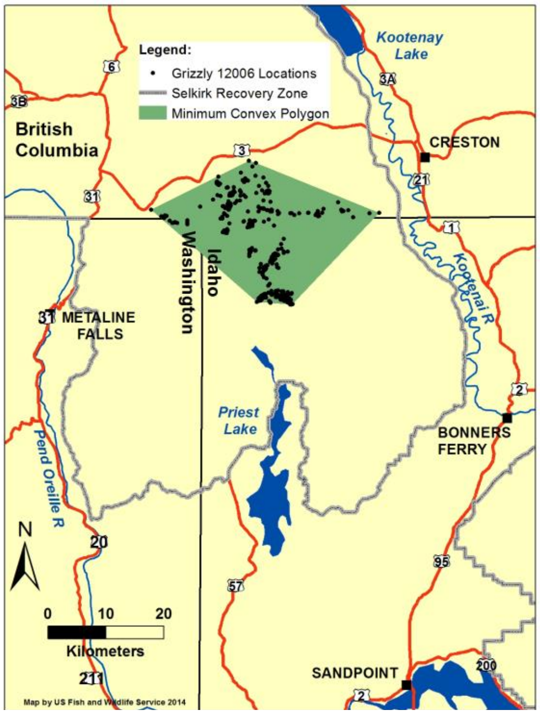

Figure A21. Radio locations and minimum convex (shaded) life range of female grizzly bear 12006 in the Selkirk Mountains, 2012-14.

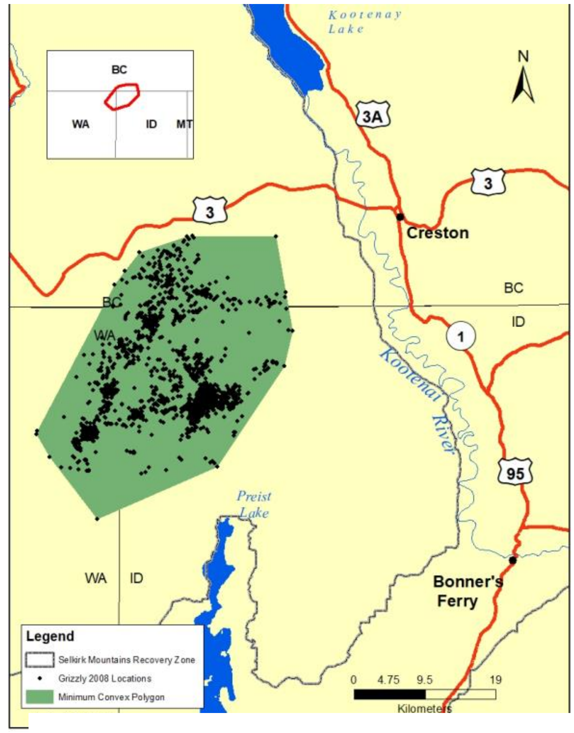

Figure A22. Radio locations and minimum convex (shaded) life range of female grizzly bear 12008 in the Selkirk Mountains, 2012-14, 2017-18.

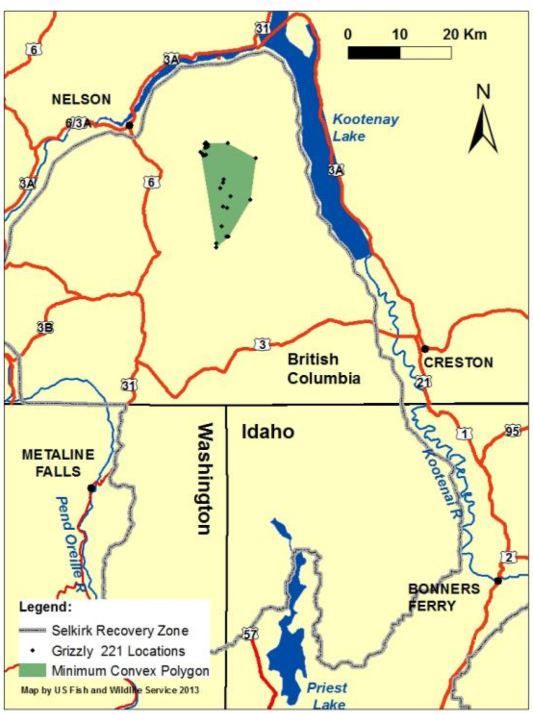

Figure A23. Radio locations and minimum convex (shaded) life range of male grizzly bear 221 in the Selkirk Mountains, 2012-13.

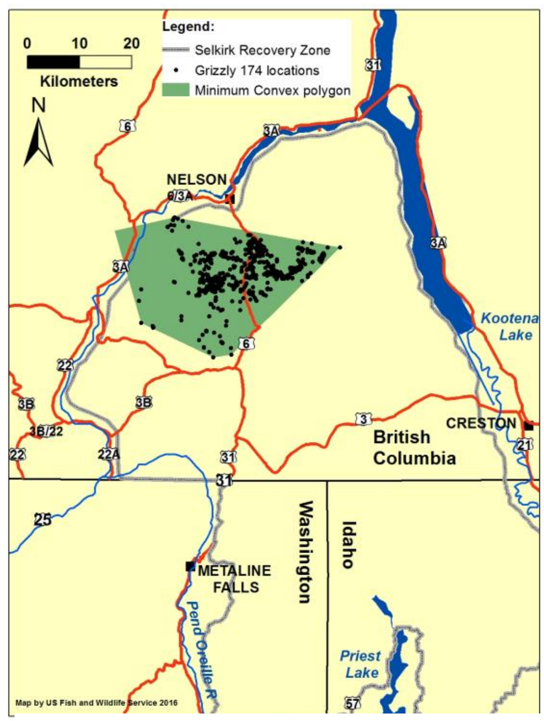

Figure A24. Radio locations and minimum convex (shaded) life range of male grizzly bear 174 in the Selkirk Mountains, 2012-13, 2015.

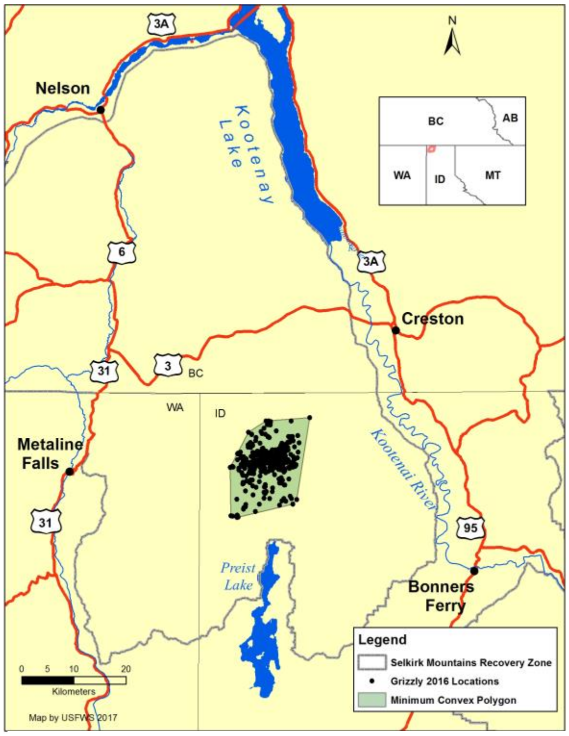

Figure A25. Radio locations and minimum convex (shaded) life range of female grizzly bear 12016 in the Selkirk Mountains, 2013-16.

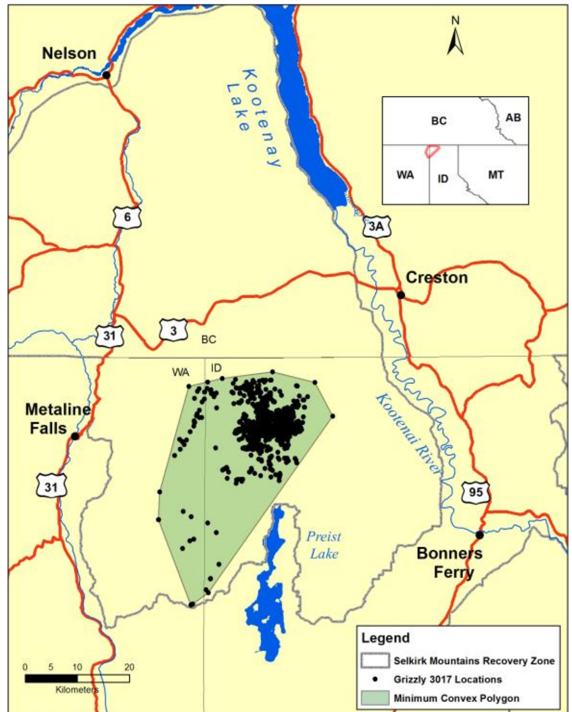

Figure A26. Radio locations and minimum convex (shaded) life range of female grizzly bear 13017 in the Selkirk Mountains, 2013-16.

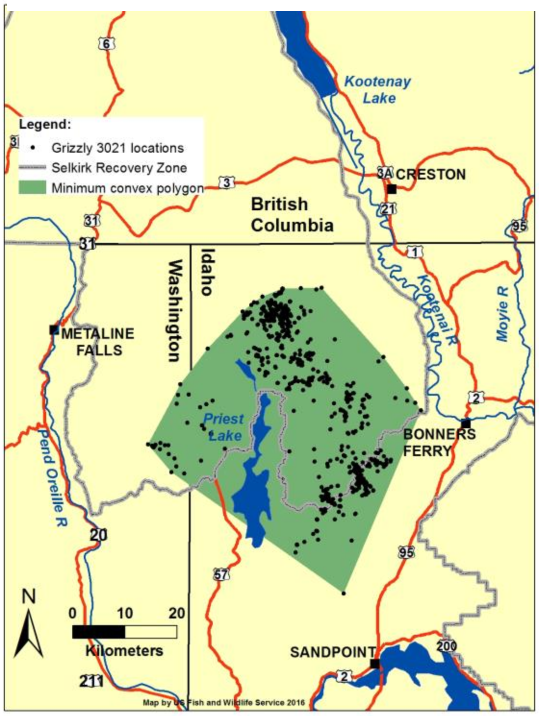

Figure A27. Radio locations and minimum convex (shaded) life range of female grizzly bear 13021 in the Selkirk Mountains, 2013-15.

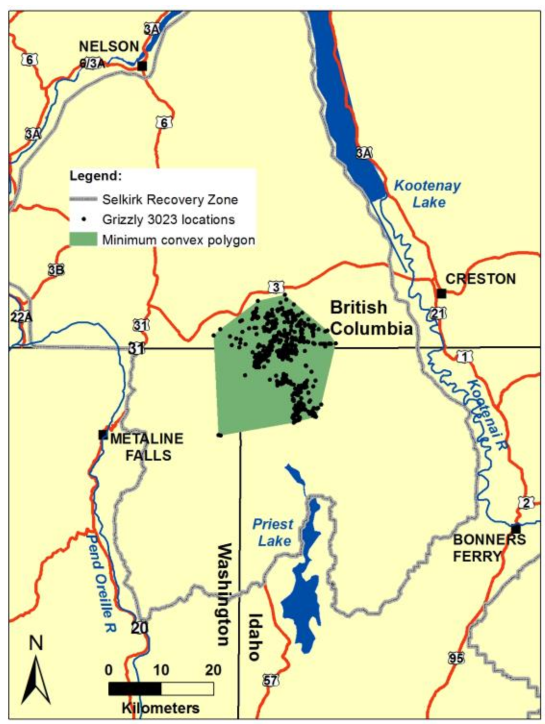

Figure A28. Radio locations and minimum convex (shaded) life range of female grizzly bear 13023 in the Selkirk Mountains, 2013-15.

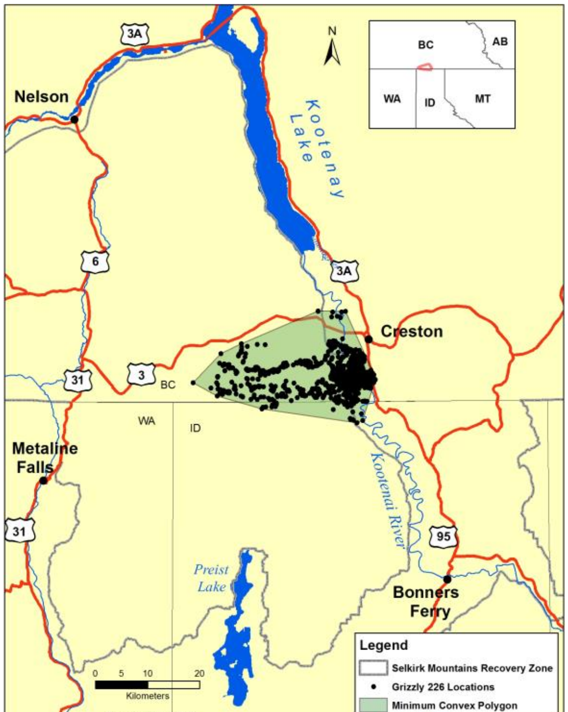

Figure A29. Radio locations and minimum convex (shaded) life range of female grizzly bear 226 in the Selkirk Mountains, 2013-18.

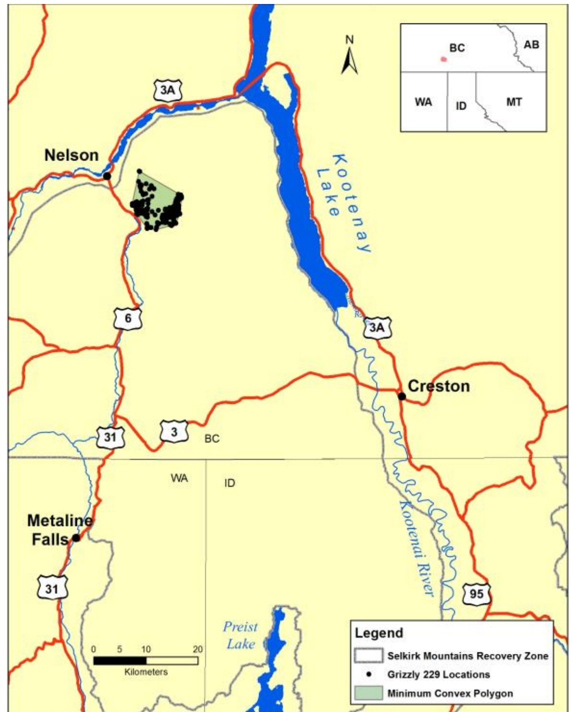

Figure A30. Radio locations and minimum convex (shaded) life range of female grizzly bear 229 in the Selkirk Mountains, 2014-16.

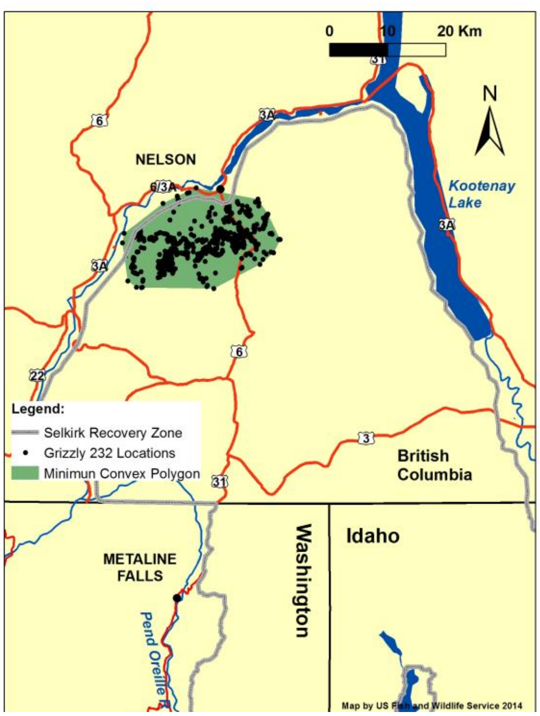

Figure A31. Radio locations and minimum convex (shaded) life range of male grizzly bear 232 in the Selkirk Mountains, 2014.

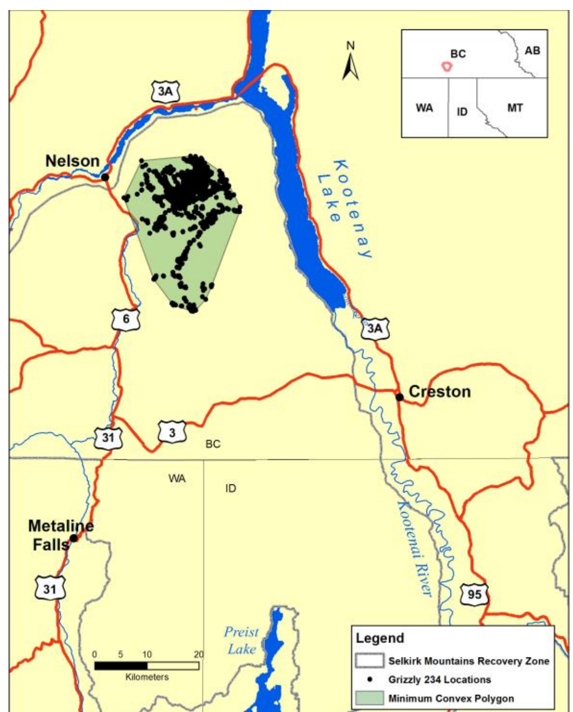

Figure A32. Radio locations and minimum convex (shaded) life range of male grizzly bear 234 in the Selkirk Mountains, 2014-16.

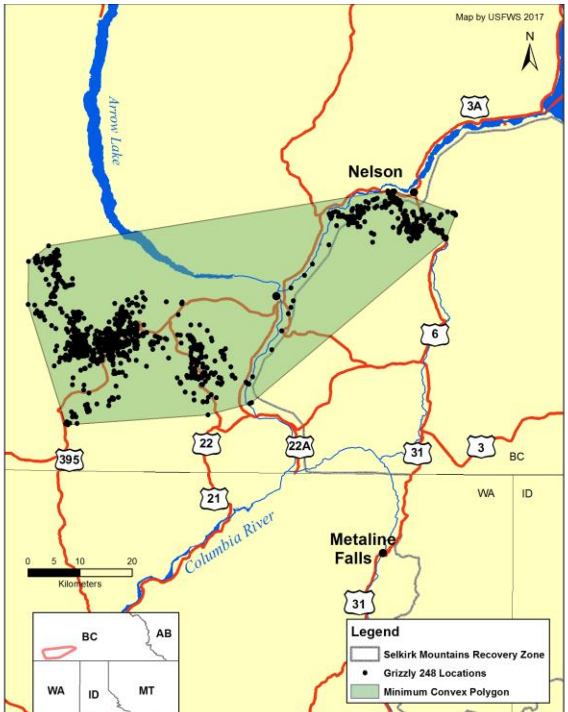

Figure A33. Radio locations and minimum convex (shaded) life range of male grizzly bear 248 in the Selkirk Mountains, 2014-16.

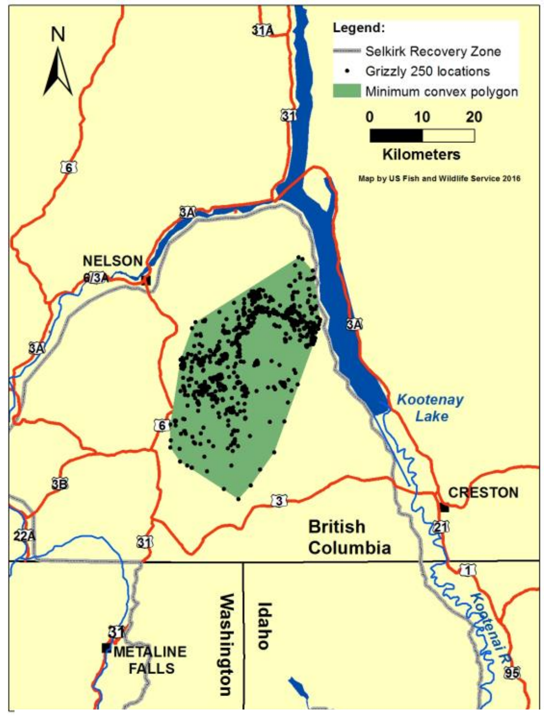

Figure A34. Radio locations and minimum convex (shaded) life range of male grizzly bear 250 in the Selkirk Mountains, 2014-15.

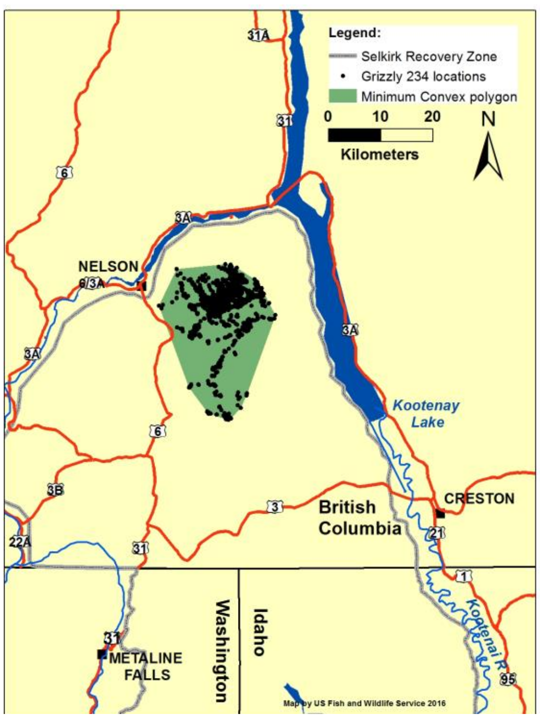

Figure A35. Radio locations and minimum convex (shaded) life range of male grizzly bear 4250 in the Selkirk Mountains, 2014-15.

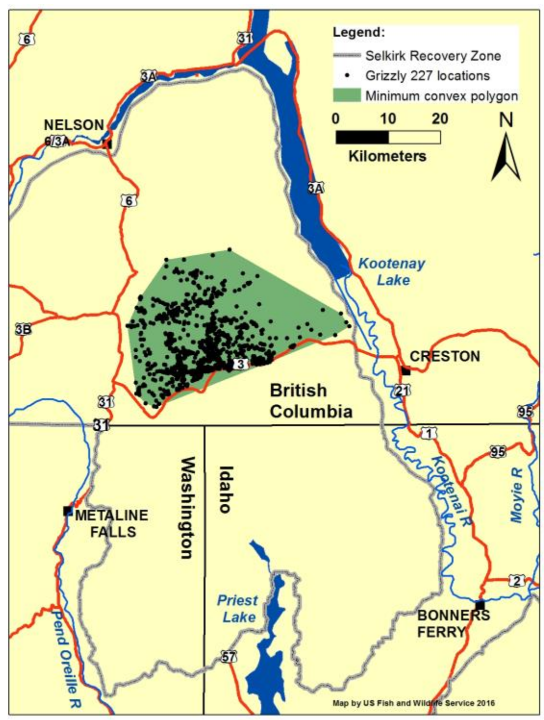

Figure A36. Radio locations and minimum convex (shaded) life range of male grizzly bear 227 in the Selkirk Mountains, 2014-15.

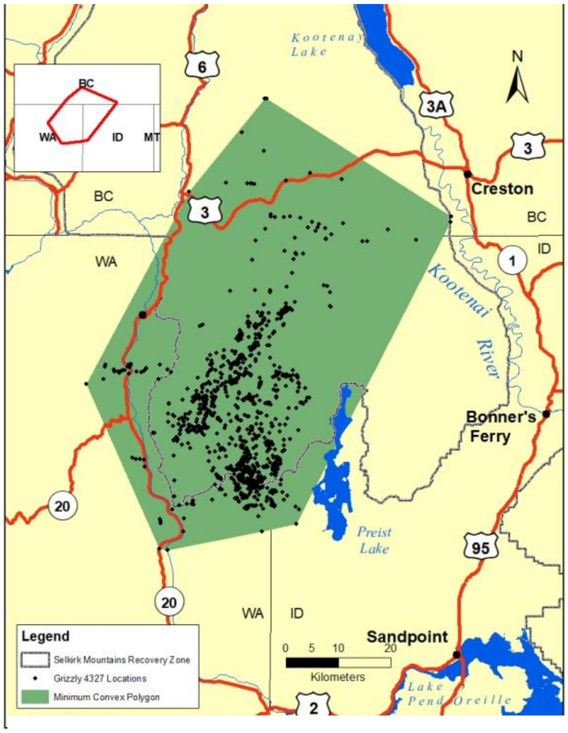

Figure A37. Radio locations and minimum convex (shaded) life range of male grizzly bear 4327 in the Selkirk Mountains, 2014-16, 2018.

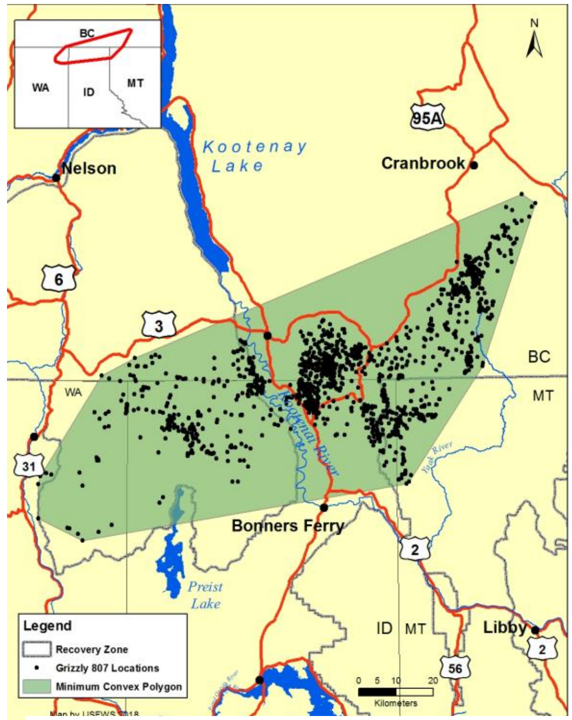

Figure A38. Radio locations and minimum convex (shaded) life range of male grizzly bear 807 in the Yaak River and Selkirk Mountains, 2014-17.

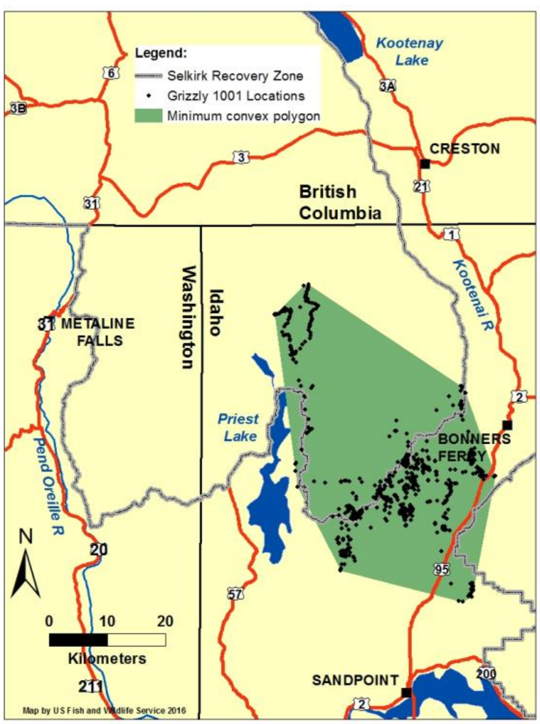

Figure A39. Radio locations and minimum convex (shaded) life range of male grizzly bear 1001 in the Selkirk and Cabinet Mountains, 2015-16.

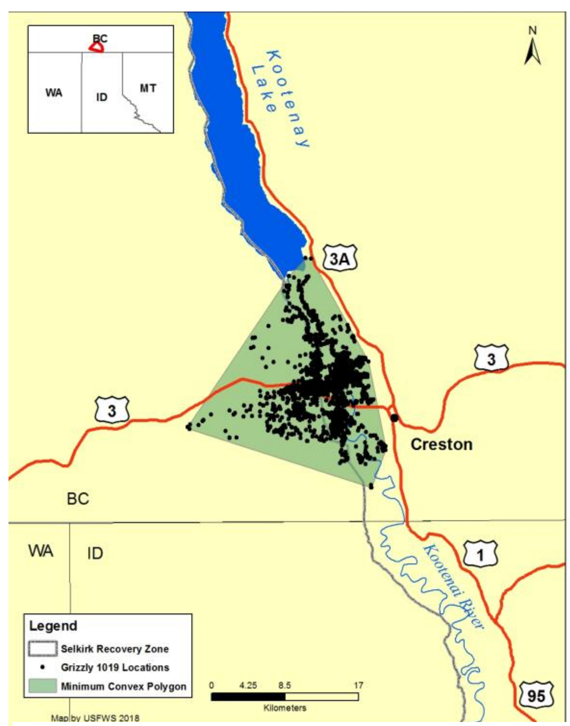

Figure A40. Radio locations and minimum convex (shaded) life range of female grizzly bear 1019 in the Selkirk Mountains, 2015-17.

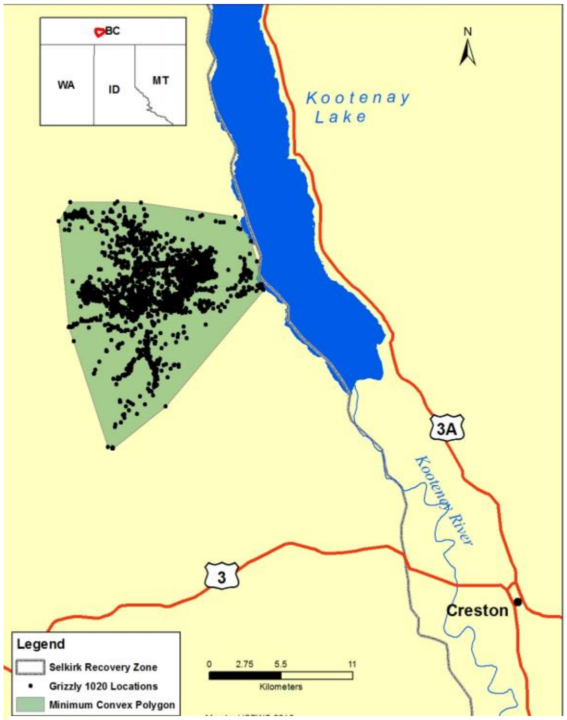

Figure A37. Radio locations and minimum convex (shaded) life range of female grizzly bear 1020 in the Selkirk Mountains, 2014-17.

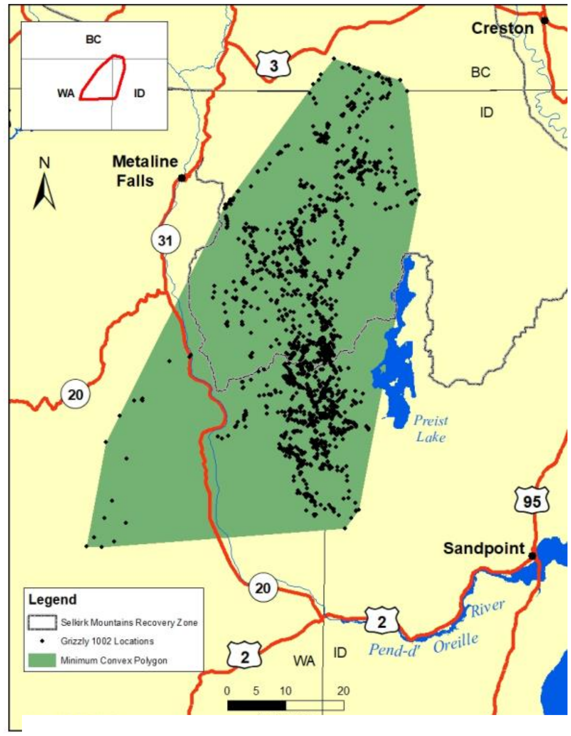

Figure A38. Radio locations and minimum convex (shaded) life range of male grizzly bear 1002 in the Selkirk Mountains, 2016-18.

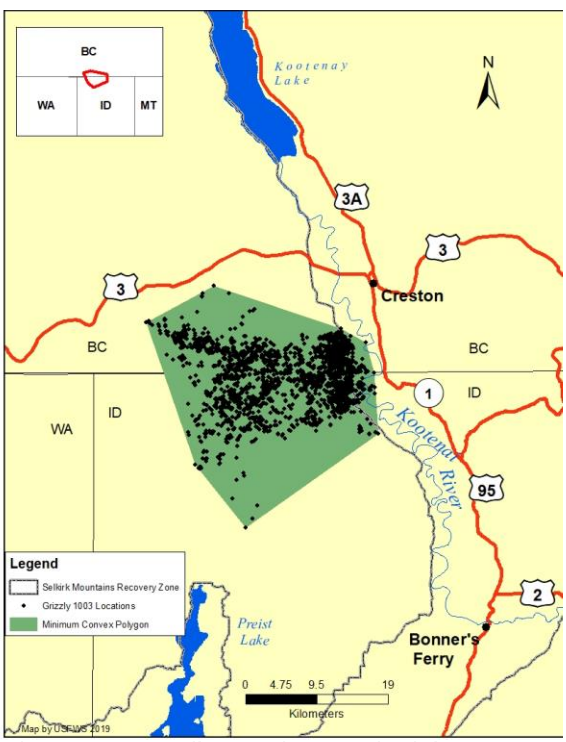

Figure A39. Radio locations and minimum convex (shaded) life range of female grizzly bear 1003 in the Selkirk Mountains, 2016-18.

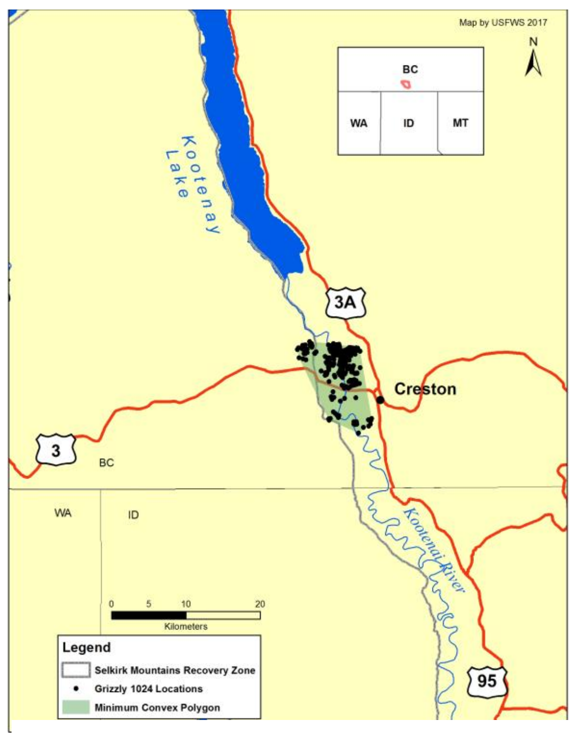

Figure A40. Radio locations and minimum convex (shaded) life range of male grizzly bear 1024 in the Selkirk Mountains, 2016.

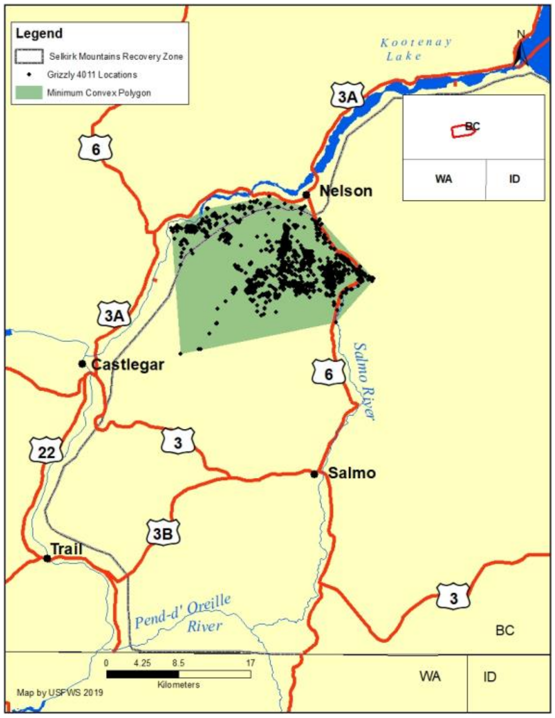

Figure A41. Radio locations and minimum convex (shaded) life range of male grizzly bear 4011 in the Selkirk Mountains, 2016-18.

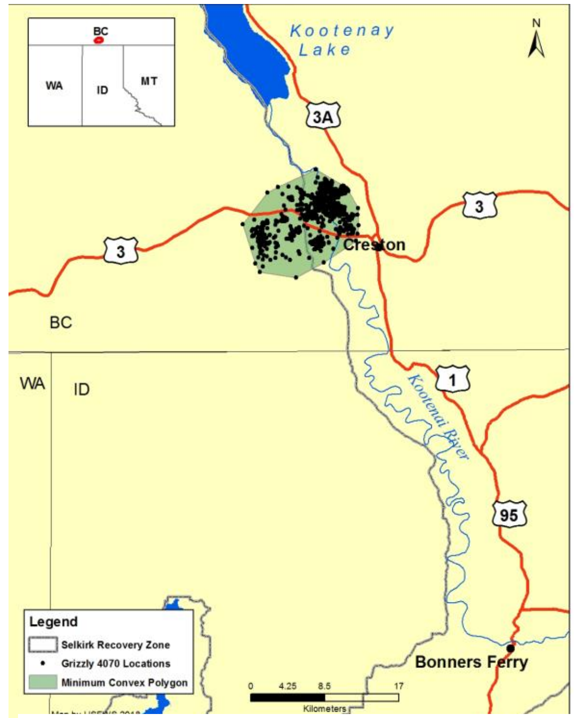

Figure A42. Radio locations and minimum convex (shaded) life range of female grizzly bear 4070 in the Selkirk Mountains, 2016-17.

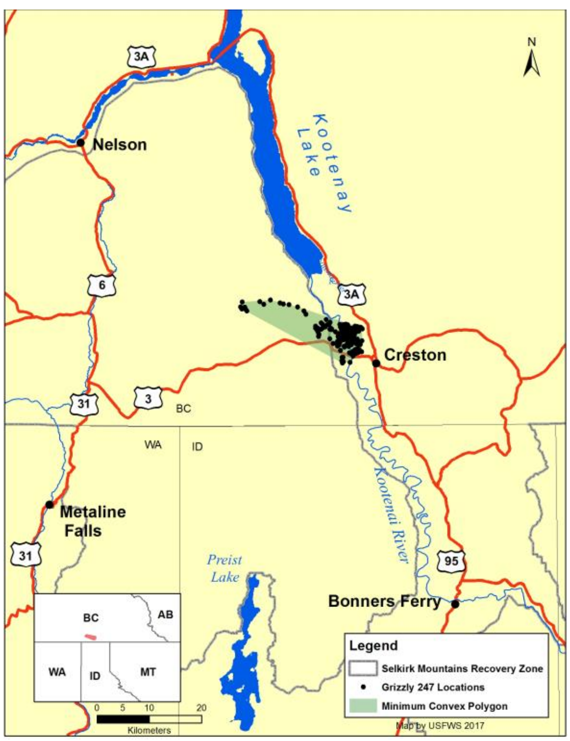

Figure A43. Radio locations and minimum convex (shaded) life range of male grizzly bear 247 in the Selkirk Mountains, 2016.

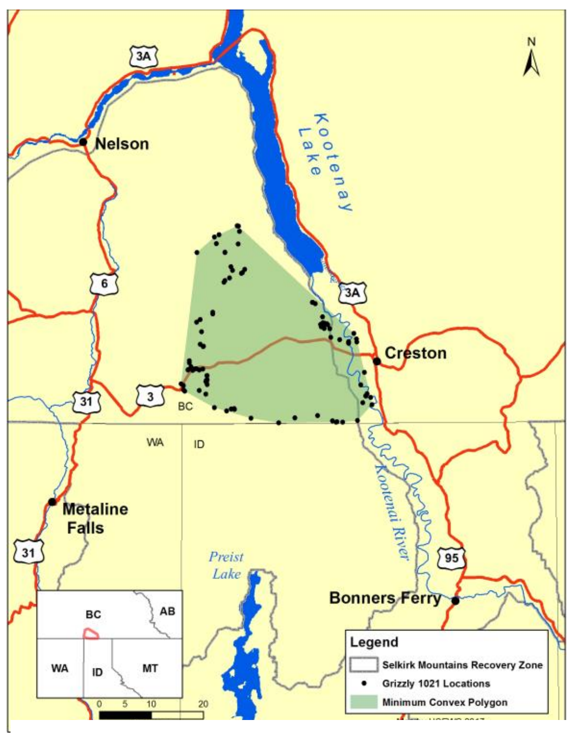

Figure A44. Radio locations and minimum convex (shaded) life range of male grizzly bear 1021 in the Selkirk Mountains, 2016.

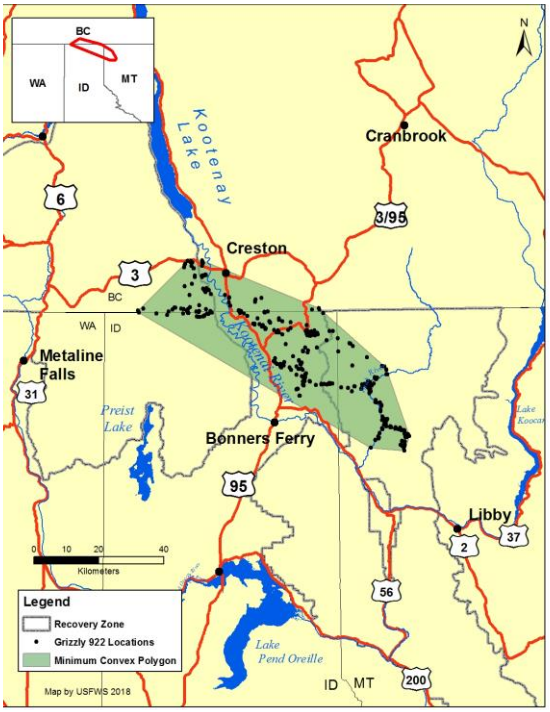

Figure A45. Radio locations and minimum convex (shaded) life range of management male grizzly bear 922 in the Yaak River and Selkirk Mountains,

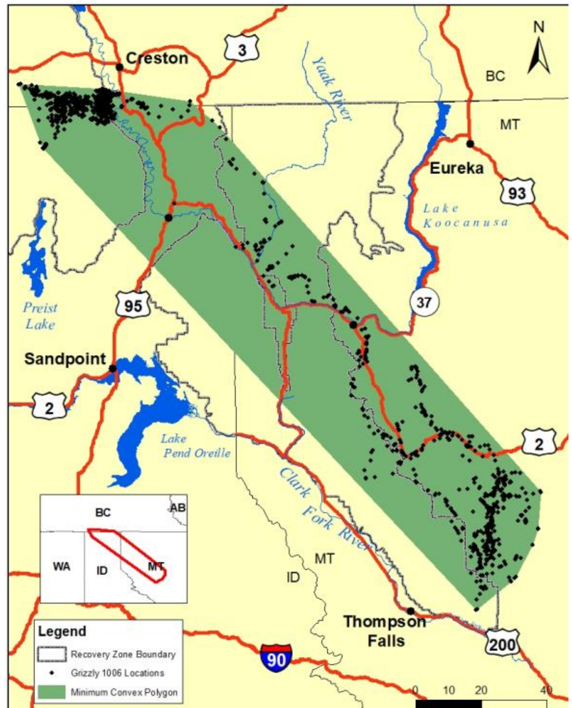

Figure A46. Radio locations and minimum convex (shaded) life range of male grizzly bear 1006 in the Selkirk Mountains, 2017-18.

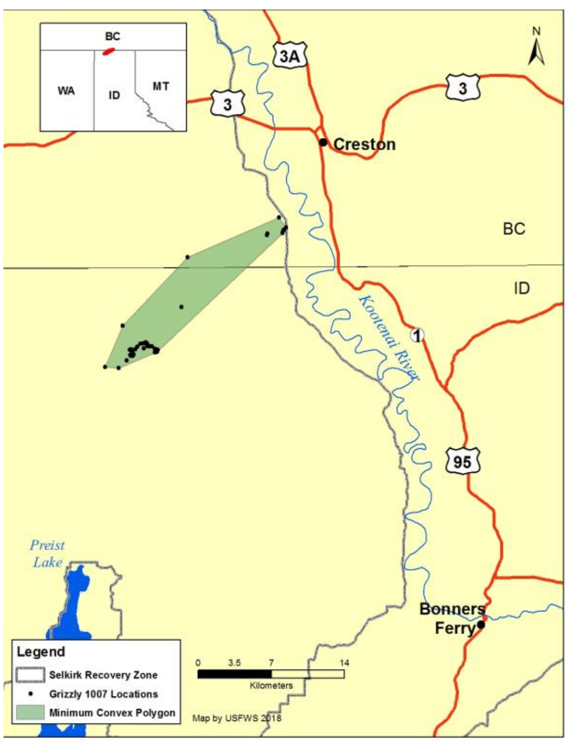

Figure A47. Radio locations and minimum convex (shaded) life range of male grizzly bear 1007 in the Selkirk Mountains, 2017.

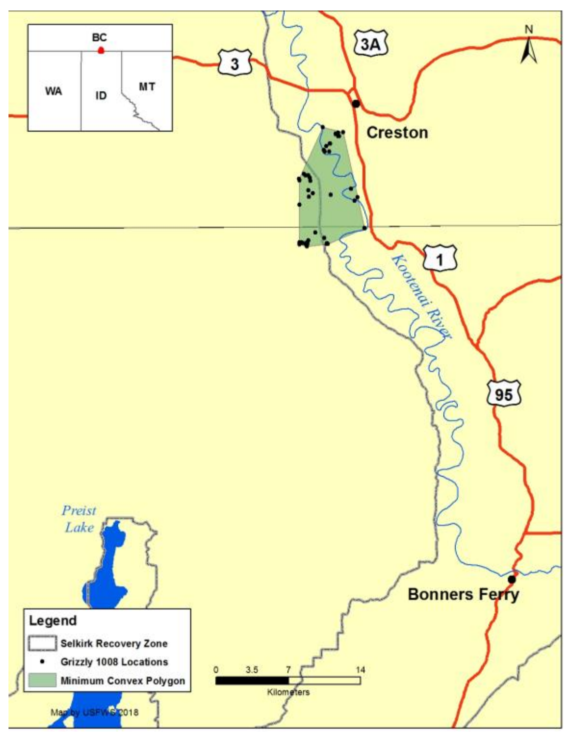

Figure A44. Radio locations and minimum convex (shaded) life range of male grizzly bear 1008 in the Selkirk Mountains, 2017.

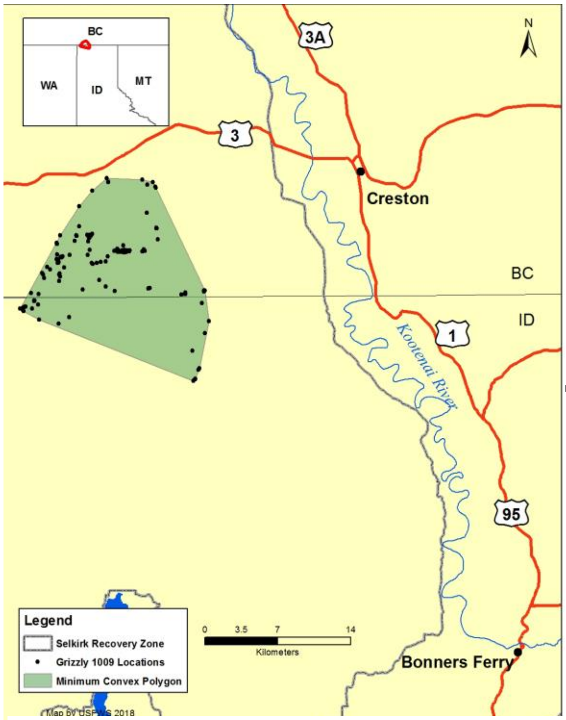

Figure A45. Radio locations and minimum convex (shaded) life range of male grizzly bear 1009 in the Selkirk Mountains, 2017.

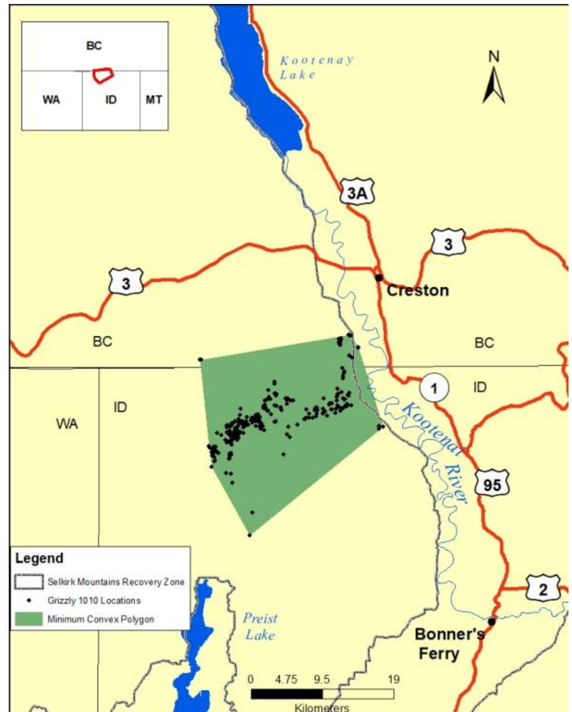

Figure A46. Radio locations and minimum convex (shaded) life range of female grizzly bear 1010 in the Selkirk Mountains, 2017-18.

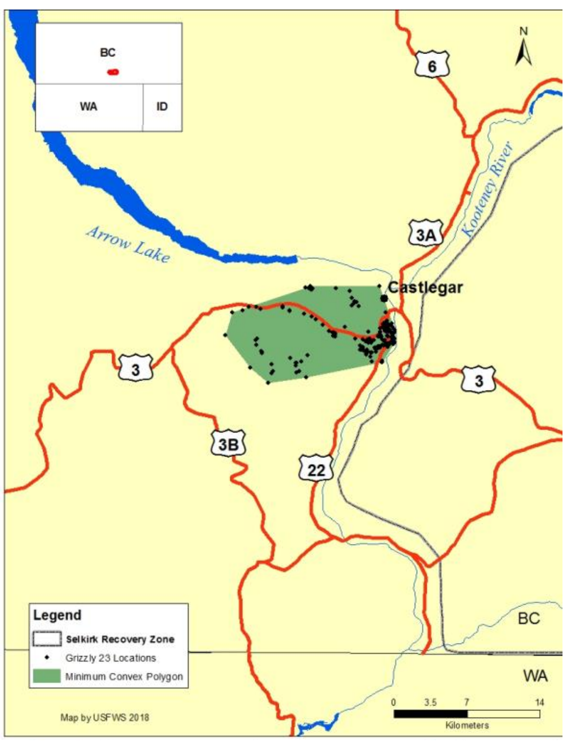

Figure A47. Radio locations and minimum convex (shaded) life range of male grizzly bear 23 in the Selkirk Mountains, 2017.

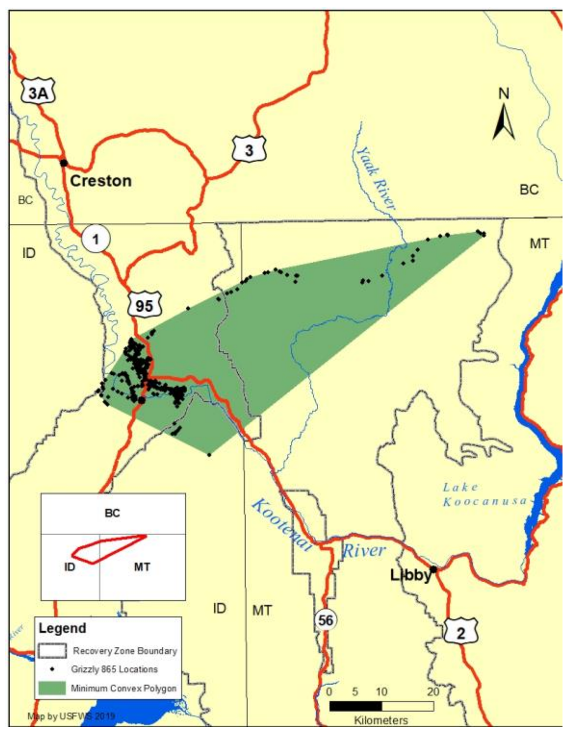

Figure A48. Radio locations and minimum convex (shaded) life range of management male grizzly bear 865 in the Selkirk Mountains and Yaak River, 2018.